March 2013

ptj

eJournal

Pipeline Technology Journal

Industry & Practice

- Reports about new, short term technological developments
- Personnel and administrative developments

Research | Development | Technology

- Special focus on Line Pipe Materials
- Collaboration on Pipeline Research
- Offshore Pipeline System
- Cost Efficiency
- Inline Inspection

Conferences | Seminars | Exhibitions

- The success of PPIM
- 63 speakers from 26 nations at Pipeline Technology Conference
- First Integrity Seminar in connection with ptc


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DEAR PIPELINE COMMUNITY,

Dr. Klaus Ritter
Euro Institute for Information and Technology Transfer, EITEP

the energy network of the world consists of pipelines.

They more and more cross state borders with different cultural and technical background.

Technical failure of pipelines, but also the non-fulfillment of delivery and transmission contracts can significantly disturb life and economy in the consuming regions.

That's why reliability, security and longevity are the main requirements for pipelines today. To use up-to-date technique can help to meet the requirements.

With this in mind, the permanent and worldwide exchange of experiences is indispensable for every pipeline operator. A lot of conferences perform internationally, but mostly with a regional effect.

In 2006 the Euro Institute for Information and Technology Transfer has therefore originated the international Pipeline Technology Conference, ptc. Today important operators, planners, and scientists worldwide, as well as technologies and service provider for pipeline techniques are visiting the ptc to present and discuss their newest developments.

With the cooperation with IPC , PPIM and Rio Pipeline conferences this exchange will be strengthened.

Today, with the publishing of the electronic Pipeline Technology Journal (ptj), a new instrument is launched to give the international exchange a global basis. In this first issue we mainly referred to information from the ptc. But the Pipeline Technology Journal is open for information and influences, for successful and promising examples.

The international Editorial Board ensures that all reports are up-to-date and that all aspects that improve the reliability, security and longevity of pipelines are considered.

You, dear readers can help that this journal will succeed, with sending us your results about research and development and reports about successful case studies.

We are sending this electronic journal to 11.000 pipeline experts worldwide.

You can help, that all relevant people will get their copy of ptj by forwarding this and the upcoming issues to your business partners.

We know that this first issue is worthy of improvement in some parts. Please let us know your thoughts and suggestions.

Yours sincerely

Dr. Klaus Ritter

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EDITORIAL BOARD OF THE PIPELINE TECHNOLOGY JOURNAL

The Pipeline Technology Journal, ptj is a further development of the idea of the Pipeline Technology Conference which enables a regular exchange of experiences about all relevant areas of the pipeline industry, worldwide. The idea, to launch the ptj came from the members of the ptc Advisory Committee.

With the composition of this first issue, the publisher of the ptj was supported by their professional competence. That's why the Advisory Committee is also the Editorial Board of the ptj.

The below listed Committee/Board of high-ranking experts is internationally diversified and its internationality will be strengthened.

Conversation at the exhibition during ptc 2012

discussion during ptc 2012

PIPELINE TRANSPORT WITH FOCUS ON EUROPE

The twin driving forces behind the Pipeline Technology Conference (ptc)—Dr. Klaus Ritter, president of the Euro Institute for Information and Technology Transfer (EITEP) and Mr. Heinz Watzka, technical director of Open Grid Europe (OGE)—answer questions from the editorial team.

Preview:

The Pipeline Technology Conference (ptc), which has been held in Hanover for the last seven years, has since developed into one of the most important international events in this field. Two significant events in particular have led ptc to record growth rates in excess of 20% (including sponsors, exhibitors and participants): the cutting of its ties with the Hanover Exhibition Center and its relocation to the city center Hanover Congress Center (HCC) with its very own hotel and amenities, and the appointment of Heinz Watzka, technical director of Germany's largest pipeline operator Open Grid Europe (OGE), as co-chair of ptc's high-powered international advisory committee. Between them, Dr. Ritter and Mr. Watzka head up the 35-strong advisory committee.

Dr. Klaus Ritter
Euro Institute for Information and Technology Transfer, EITEP

Heinz Watzka,
Open Grid Europe, OGE

Question:
Dr. Ritter, according to estimates presented on the occasion of the 6th ptc, over 25,000 km of new high-pressure pipeline are laid across the world every year. Where are the current pipe-laying hotspots and how long do you think this boom will last?

Answer:
On the one hand, the reserves, for instance, of fossil fuels, are rarely found where most oil and gas is consumed. On the other, there's no getting away from the fact that people and production throughout the world are concentrated in conurbations. Add in significant rates of economic growth and it becomes clear that ever-increasing amounts of energy are needed in these areas. Even if the use of regenerative energies, nuclear power and coal fired in modern power stations can take on the job of meeting part of this growing need, a significant proportion of it will still have to be covered by oil and, in particular, natural gas. The needs are great wherever we have high rates of economic growth — that is, in China and India as well as Central and Southeast Asia. Other hotspots are situated in South America, as well as North and West Africa. Nor should

we forget the consolidation and optimization of networks in North America, Europe and the Middle East. So, today, you can actually say that an annual requirement of 25,000 km for the next few years is a conservative estimate.

In future, the demand for new pipelines will be accompanied by an increasing need to rehabilitate outdated and badly laid and maintained oil and gas lines, as well as a demand for pipelines for the transport of other liquids (e.g., water, refinery products, etc.) and gases (e.g., CO2). So, it's my view that the demand for high-pressure pipelines will remain as high as it is now for a long time to come.

If we take a look at the cross border gas trade movements in 2011(see picture on page 06-07), we can see that the focus of the pipeline transport is on Europe. Regarding this, it was the right decision to let the ptc take place in the middle of Europe.

Question:
Mr. Watzka, what is interesting about ptc for German operators?

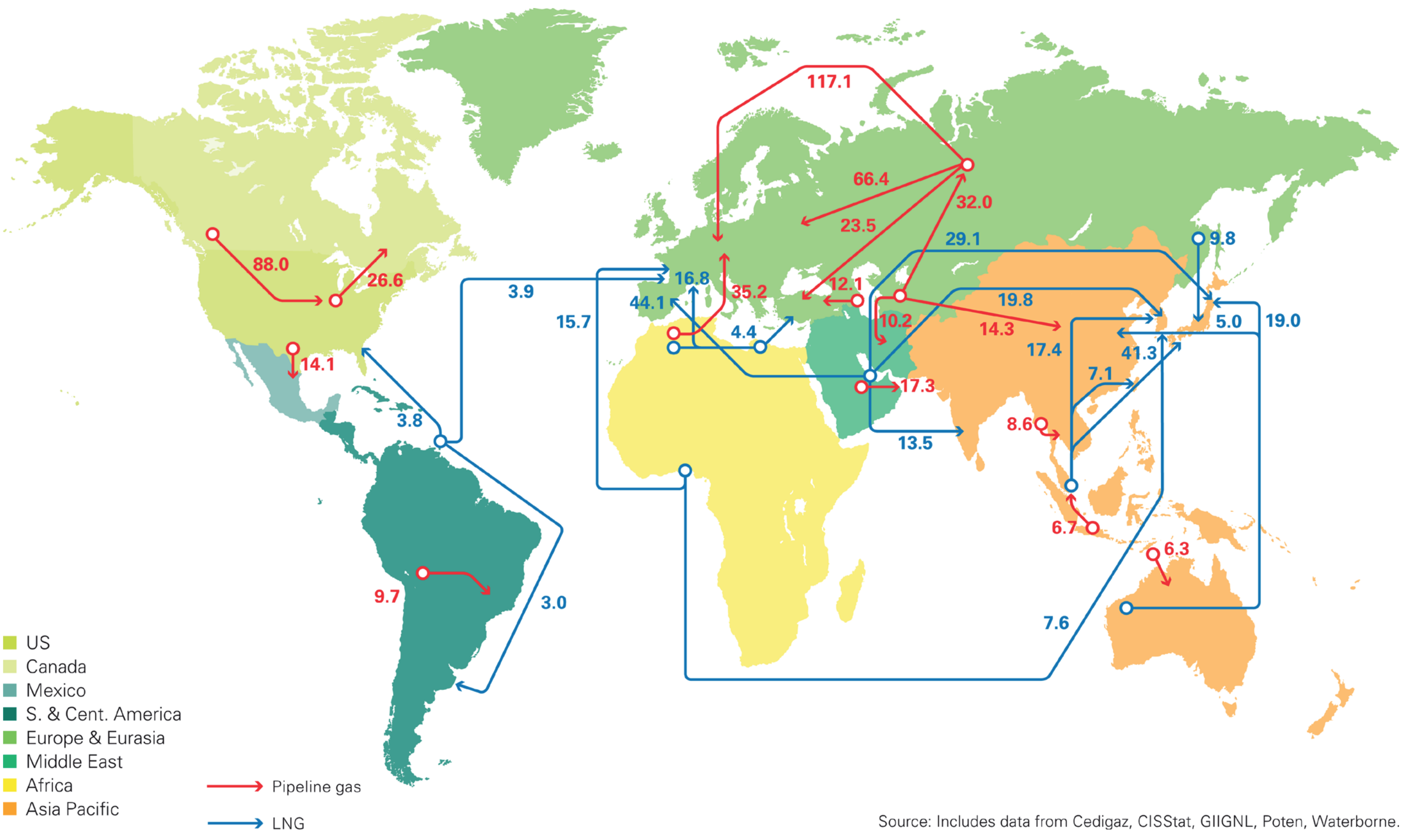
Answer:
We're always interested in finding out about and helping to shape state-of-the-art science and technology across the world so that we can operate our pipelines safely and economically in line with the most up-to-date knowledge. To have such an event in Germany saves us time and travel expenses. I think that my fellow pipeline operators in the advisory committee see things just as I do, because it's the Germans in particular, with our technical and environmental standards, who set the international benchmarks.

At the same time, German and European gas transporters are at the sharp end of new challenges set by the European Union's third energy package for the internal gas and energy market and the energy transition which has been decided on for Germany.

Where the networks were originally designed merely for transport from the production site to the target country, they now have to be adapted to satisfy altered European and German requirements.

What the creation of a new single European energy market means, for instance, for the transport of gas, is that:

- There is a need to find ways to enable non-discriminatory cross-border transportation.
- There is a need to guarantee coordinated, forward-looking planning and solid technical network development (Netzentwicklungsplan [network development plan] or NEP; see www.Netzentwicklungsplan-gas.de [in German only]).
- There is a need to create sufficient capacities, together with reverse flow options, between countries.



Major cross border gas movements 2011

Source: BP Statistical Review of World Energy June 2012

- There is a need to be a fair partner to all market participants.

These tasks have been taken on in particular by the European Network of Transmission System Operators for Gas (ENTSOG) which is developing these elements of implementation for the proposed single European gas market.

The German energy transition, on the other hand, requires that we concentrate on:

- Biogas feed-in plus methane from regenerative sources.

- Optimized use of the storage capacity of the transport networks, also for synthetic natural gas (Power to Gas or P2G).

- Intelligent capacity solutions for natural gas storage and the supply of power stations.

The natural gas distribution network forms a life-giving artery between European business locations. The competitiveness of Europe also depends on their reliability. In future, optimization of the interaction between energy networks (electricity and gas transportation) will have a key role to play in the energy mix. We're very interested in the high-level exchange of experiences in our country here at the heart of Europe because it will help us maintain the reliability of our networks and make use of new developments to improve them. Ptc is the best possible way of guaranteeing this technical forum.

Question:
Dr. Ritter, there are just a few weeks to go until the conference. Are some trends already beginning to emerge?

Answer:
What is so impressive is the speed with which the pipeline sector has responded to our call for papers and the initial announcement. We've already received over 100 paper submissions, most of which have already been assessed by the advisory committee. At the end of the day, we expect about 60 papers to pass the quality and relevance tests and to be accepted to the program.

In response to recommendations from participants of earlier ptc events, the advisory committee formed itself into three working groups on the subjects of:

- Steel line pipe materials,

- Stations and components, and

- Public perception.

The international pipeline sector has responded positively to suggestions from the working groups, with the effect that these focal points will accordingly be taken into consideration in the next ptc as well.

It has also been interesting to see that there's been a disproportionate increase in the number of papers coming out of North and South America — an indication of the increasing recognition and high quality of ptc.

The most up-to-date program schedule can be viewed in the box. For further updates, please go to www.pipeline-conference.com.

We're assuming that the conference will be attended by 400 participants and that 40 exhibitors will be on hand to show their products. We predict that 60% of the participants will come from abroad.

Ptc is increasingly being integrated into corporate marketing strategies. For instance, Siemens, Rosen and Krohne are using the ptc framework to invite customers to attend training sessions.

As event organizer, we take the international transfer of information very seriously and offer in-depth training seminars on specific subjects, e.g., "The In-Line Inspection of Transmission Pipelines".

On the other hand, we are looking to:

- Cooperate with the organizers of PPIM in Houston, IPC in Calgary and Rio Pipeline in Rio de Janeiro in order to ensure that an exchange of information on the conference results takes place.

- For two years, we have been publishing all of the papers in our essay database (see www.pipeline-conference.com/abstracts).

- Moreover, since February 2013, we have had at our disposal an electronic version of the Pipeline Technology Journal, in which we publish groundbreaking essays from the sector twice a year.

Question:
Mr Watzka, are there any objective reasons as to why ptc in particular is so much in demand internationally?

Answer:
A lot of pipeline events have sprung up around the world in recent years. But no other event concentrates as clearly as ptc on technological developments and the discussion of tailor-made technical solutions.

This makes ptc particularly relevant for operators who are facing technical challenges, even though their installations are in some cases still relatively new. These operators come to Hanover to find out how we're still operating high-pressure pipelines without any problems even after a service life of 80 years.

Question:
Dr. Ritter, what in your view is of interest to technology and service providers at ptc?

Answer:
The pipeline business is to a great extent a cross-border one. For this reason it's extremely important for technology and service providers to see what developments are being worked on internationally and what operators from different countries expect of the services and products they provide.

In the case of European technology and service providers, another attitude comes into play, expressed here by Mr. Eginhard Vietz, former member of the advisory committee: "Why should I travel around the world with my portfolio when it's also possible to bring the entire pipeline sector together in Europe in one place and at one time?"

EITEP / Pipeline Technology Conference

EITEP is worldwide organizing international, infrastructure-related conferences and exhibitions.

One of them, the Pipeline Technology Conference (ptc) with accompanying exhibition is Europe's leading conference on new pipeline technologies.

The 8th ptc will take place in Hannover, Germany March 18-20, 2013. Since 2006 the main focus of ptc has been on latest technologies and new developments in the international pipeline industry. Besides an overview on international key projects, new construction methods, and an insight into new operation and maintenance, rehabilitation, in-line inspection and integrity management field studies and technologies, ptc 2013 will provide special focus sessions on „Materials - Steel Line Pipe", „Stations and Components" and „Public Perception".

Open Grid Europe GmbH

Open Grid Europe is Germany's leading natural gas transmission company; it employs approximately 1,600 people and operates a gas pipeline system with a length of 12,000 km. Open Grid Europe is the first German company to set up as an Independent Transmission Operator (ITO). The company's core activities are:

- Planning and construction of pipelines, from concept stage, project management and engineering to realisation
- Operation of the pipeline system, including servicing and maintenance, as well as management and monitoring of the grid and the storage stations
- Capacity management, from determination of capacity to the development of new standards
- Capacity marketing and customer care
- Determination and charging of volumes

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MAIN FEATURES OF THE NEW GERMAN ENERGY CONCEPT

A change of thinking in dealing with energy
Pasche

The energy concept of the German federal government sets the timetable for the implementation of a long-term, overall strategy for an environmentally friendly, reliable and affordable energy supply by the year 2050. This „energy transition" is a unique energy program designed to increase energy efficiency, expand renewable energy use and reduce greenhouse gas emissions. The rapid entry into a new era of energy supply includes the phase-out of nuclear energy by the end of 2022.

The energy transition thus essentially rests on two key pillars: the reduction of primary energy consumption and an increase in the share of renewable energies. In particular, the intention is to reduce primary energy consumption by 20% by 2020 and 50% by 2050 in comparison to 2008 consumption levels. The share of renewables in electricity consumption is to increase from 20% in 2011 to at least 35% by no later than 2020. This figure should be at least 50% by 2030 at the latest and rise further to no less than 80% by 2050.

The energy transition allows in principle for all fuel types, with the exception of nuclear power, to be available for power generation. The structure of the energy transition must, however, focus on the federal government's ambitious climate protection targets, which were adopted in the Energy Concept of September 28 2010. According to this, climate change inducing greenhouse gas emissions should fall by 40% by 2020, 55% by 2030, 70% by 2040 and 80-95% by 2050 (in each case compared to 1990). Currently, about 80% of greenhouse gases are emitted by the combustion of fossil fuels for energy generation.

The federal government maintains that climate protection goals can be achieved simultaneously with the complete replacement of nuclear power given the quick and consistent implementation of the measures contained in the energy concept and the energy transition decisions of the summer of 2011: This requires the construction of new generation plants based on renewable energy, as well as significant progress in the exploitation of energy efficiency potentials.

Most of the country's electrical power in the future will be generated from wind and solar energy. This is where growth has been at its most vigorous in recent years. But biomass, geothermal energy and hydropower will also contribute to electricity generation by 2050. Fossil power plants will still be required in the future to make up for the shortfall. To compensate for fluctuating power generation from renewable energy sources, highly efficient and flexible gas power plants will be considered. These can, however, be made to operate increasingly with hydrogen or methane in the future, which are produced using renewable energies and transported via pipeline to the local points of consumption. The efforts of power plant manufacturers to improve energy efficiency are already finding success. New gas turbines for a gas and steam power station can achieve efficiencies of 60%, considered impossible in power plant construction just a few years ago.

Germany is, of course, under close international scrutiny as a pioneer of this technology. To be a pioneer however, also means being the one who sets the standards and who leads the market in one of the key economic sectors.

The methanisation of the new Power-to-Gas plant.
Photo: Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

ZSW DEVELOPS POWER-TO-GAS ELECTROLYSIS ON THE MEGAWATT SCALE

New research project on hydrogen generation from green electricity begun
Together with its project partners SolarFuel and ENERTRAG, the ZSW is building an electrolysis system for the coming generation of power-to-gas (P2G) plants.

An innovative electrolysis technology will pave the way for P2G plants to enter a new performance category. The Baden-Württemberg Center for Solar Energy and Hydrogen Research (ZSW) is coordinating the development work on a 300 kilowatt electrolysis system with a cell stack whose output can be increased, with a corresponding enlargement, to more than one megawatt. This so-called short-stack comprises some 70 cells featuring expanded surfaces and an increased gas output. This allows the electrolysis prototype to be built more compactly than its predecessors. A number of additional technical innovations are being tested, including a 1 megawatt rectifier, an innovative electrode coating and a modular structure for the overall system. At the same time, the project partners intend to show how costs for electrolyzers can be decreased. „With the further technical development of our electrolysis system we are taking a significant step towards low-cost hydrogen generation for the P2G process," explains Andreas Brinner, electrolysis expert at the ZSW. The SolarFuel and ENERTRAG companies also represent competent and experienced partners on this pioneering project, Brinner adds. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) will promote the project to further develop alkaline pressure electrolysis, due to run for over three years, with an approximate total of 3.3 million euros.

Just at the end of October 2012, the ZSW commissioned a P2G plant with an electrical connected load of 250 kW to produce hydrogen and methane. The plant in Stuttgart is considered the largest of its kind in the world. The new, higher-output electrolysis system will be constructed in the direct vicinity of this plant. The P2G concept developed primarily at the ZSW aims to convert surplus green electricity from solar or wind energy into hydrogen using electrolysis and then to methanize it together with carbon dioxide. The methane produced this way can be fed into the natural gas grid and stored for months with no losses, allowing it to be re-electrified in case of a power shortage. It can also be used directly as a fuel for natural gas vehicles, thus contributing to CO2-neutral mobility.

Contact:
alexander.delregno@zsw-bw.de

MORE USEABLE GAS IN THE REHDEN NATURAL GAS STORAGE FACILITY

Astora has been offering its customers additional capacities in the Rehden natural gas storage facility since 1 January 2013. The working gas volume is increasing from 4.2 to 4.4 billion cubic meters; the cushion gas volume is therefore decreasing from 2.8 to 2.6 billion cubic meters. "By increasing the working gas volume, more useable natural gas can now be stored, which also means Western Europe's largest natural gas storage facility will make an even bigger contribution to supply security," astora Managing Director Andreas Renner explained.

The volume available in the storage facility is divided into working gas and cushion gas. The working gas volume is the useable gas, while the cushion gas maintains the minimum pressure in the storage facility and stays in the formation. It is possible to raise the working gas volume by mixing long-term the original low-calorific gas cushion gas (L-Gas) from the natural gas reservoir, which is not completely depleted, with the high-calorific working gas (H-Gas). Thanks to comprehensive technical tests and the relevant restructuring measures at the storage facility's compressors, more working gas can now be stored in the facility.

The additional storage capacity of 200 million cubic meters of working gas volume is available immediately as astora-add. This is an unbundled storage product with a fixed storage capacity and a minimum duration of one day.

The astora storage facility in Rehden in North Germany is the largest in Western Europe with a working gas capacity of now 4, 4 billion cubic meters and an underground surface area of about eight square kilometers. It has about a fifth of the overall storage capacities available in Germany and thus makes a sustainable contribution to the country's supply security. The crude oil and natural gas producer Wintershall has produced natural gas from the natural gas reservoir since the 1950's. After that the reservoir was turned into a storage facility and started operations in 1993. astora markets the storage facility's capacities. Today the annual consumption of about two million single-family homes can be stored 2,000 meters underground.

Contact:
press@astora.de

The Rehden natural gas storage facility
Photo: Astora GmbH & Co. KG

NDT SYSTEMS & SERVICES CLOSES SEVEN-YEAR GLOBAL INLINE INSPECTION SERVICES CONTRACT WITH OIL AND GAS GIANT BP

NDT Systems and Services GmbH & Co. KG, a leading supplier of ultrasonic pipeline inspection and integrity services, has signed a global pipeline inspection contract with British oil and gas giant BP.

The renewed global contract – one of four awarded by BP – is effective 1 December, 2012. It emphasizes quality and HSE issues and significantly enlarges NDT's scope of services by providing pipeline cleaning, pipeline integrity assessment, and relevant engineering services.

„This contract has been preceded by a thorough audit", says NDT Services EMAA Executive Vice President Ulrich Schneider. „We are proud that our long-time customer and partner BP has selected us as one of its preferred ILI partner in general, and as experts for ultrasonic inspections in offshore deepwater environments in particular".

Close cooperation with BP dates back to 2006 with the delivery of metal loss and crack inspection tools made by NDT for a deepwater project in the Gulf of Mexico. The cooperation further expanded into other platforms and regions and resulted in a first four-year inspection contract covering inspection activities in thirteen countries.

NDT has successfully completed relevant ultrasonic inspection projects, such as the Angola deepwater pigging Block 18 southern and northern flowline inspection campaign.

Contact:
peter.smorscek@ndt-global.com

SYNODON LAUNCHES FIVE NEW AIRBORNE SURVEY SERVICES

Synodon Inc. ("Synodon") [TSXV-SYD] announces the launch of five additional airborne pipeline integrity management services.

In addition to Natural Gas Leak Detection and Liquid Leak Detection, the new services offered are:

- Pipeline Threat Assessments – Analyzing the visual images collected during flight and identifying potential threats to network integrity due to human or natural incursions
- Right-of-Way (RoW) Change Detection – Monitor changes over time for evidence of excavation, flooding, slumping, etc.
- Tree Canopy Encroachment – Identifying vegetation encroachments along a pipeline operators RoW to ensure compliance with regulatory requirements
- Water Crossings Analysis – Profiles, slope analysis, and visual images for pipeline water crossings
- Pipeline Location Classification – Determine class locations based upon pipeline's proximity to buildings, places of public assembly, and population density.

"We are very pleased to expand Synodon's offering with these new services that were driven by our customer's requirements," stated Adrian Banica, CEO of Synodon. "Pipeline operators have been expressing their desire to simplify their supply chain while looking for additional support in managing their regulatory compliance needs. Our new services complement our existing portfolio to allow customers a 'one-stop-shop' in meeting many of their survey requirements while realizing cost savings."

The new services went through successful customer trials throughout 2012 and are now officially offered to all pipeline operators looking to enhance their existing integrity management and leak detection programs.

Contact:
Adrian Banica
investors@synodon.com

LEAK MONITORING OF SUPERCRITICAL PRODUCTS AND MULTI-PRODUCT TRANSPORT IN PIPELINES

KROHNE is offering a series of lectures to provide an overview of the official guidelines, technical requirements and technologies behind modern leak monitoring systems for pipelines as part of the nationwide seminar series entitled „System and process solutions in the oil and gas industry" which starts on March 5. KROHNE will also present an overview at a lecture and workshop at the 8th Pipeline Technology Conference PTC from 18-20 March in Hanover.


PipePatrol leak monitoring system for single and multi-product pipelines

Transporting materials via pipeline is a growing market all around the world. To take maximum advantage of these transport routes, there is growing interest in using pipelines to transport several products successively („multi-product"). The transport of supercritical fluids such as ethylene, hydrogen and carbon dioxide is also on the rise: supercritical fluids feature high fluidity and are thus particularly suitable for transport through pipelines. As the volume of substances transported increases, so too does the significance of leak monitoring. Selecting a leak monitoring system is a very detailed process dependent on each individual case.

The PipePatrol leak monitoring system can be used for pipelines containing supercritical products and multi-product pipelines. With supercritical products, it is particularly important to include the thermodynamic equation in the leak monitoring system. KROHNE is currently the only supplier that can monitor supercritical products based on a model.

PipePatrol is a leading E-RTTM-based system for continuous internal leak monitoring of pipelines. RTTM stands for „Real-Time Transient Model", a mathematical model that compares the measurements taken during the actual operation of a pipeline in real time with a computer simulation of the pipeline. KROHNE has been an established system supplier to the oil and gas industry for over 30 years and has expanded its range to include E-RTTM (Extended-RTTM) systems, which also feature leak signature analysis using leak pattern detection.

An E-RTTM leak monitoring systems creates a virtual image of a pipeline based on real measured data. Measurement values from flow, temperature and pressure sensors installed at the inlet and outlet of the pipeline and along the pipeline in places such as pump and valve stations are crucial. The flow, pressure, temperature and density at each point along the virtual pipeline are calculated from the measured pressure and temperature values. The model compares the calculated flow values to the real ones from the flow meters. If the model detects a flow discrepancy, the leak signature analysis module then determines whether it was caused by an instrument error, a gradual leak or a sudden leak. PipePatrol can process the dynamic values extremely quick and can therefore model transient operating conditions in the pipeline as well as steady state.

Info:

Krohne-Workshop: Pipeline Leak Detection
This workshop is aimed at all operators as well as manufacturers of Oil, Gas, Chemical and refined product pipelines. The intention is not only to share the basic fundamentals of leak detection, but also for the information to be exchanged between the attendees. Real life pipeline examples from the attendees will be used to design possible leak detection systems directly in the workshop.

Workshop Timing:
Wednesday, 20th March 2013, 13:30-16:30

Target Group:
Pipeline operators of oil, gas, chemical and refined products, pipeline manufacturers

Organizer:
Krohne Messtechnik
www.krohne.com
More Information:
www.pipeline-conference.com/workshops

MONITORING SYSTEM FOR PIPELINES

In spring 2010 the state-owned Russian JSC Transneft operating the world largest (appr. 70.000 km long) oil and oil products pipeline system announced the creation of the OMEGA Company to install the OMEGA developed System of Monitoring of Extended Objects (SMEO) based on Fiber Optic Distributed Sensor System (FODSS) on all newly build pipelines.

The System provides high-precision detection of location and nature of acoustic vibrations, spatial displacements and temperature characteristics of extended facilities such as pipelines, oil wells, railways, highways, bridges and power lines. The extended object is monitored through the whole length of optic fiber used for the System`s sensor and not requiring electric power along the line in real time mode.

As for January 2013, the OMEGA Company equipped 5.288 km. of Transneft pipelines with its innovative systems making OMEGA one of the most implemented leak detection and activity control systems worldwide. Among the most important OMEGA facilities commissioned in 2012 are the 484-kilometer main pipeline „Malgobek - Tikhoretsk“ and several spans of the trunk pipeline „Kuibyshev-Tikhoretsk“ (297 km).

„A special honor for us was the installing of the OMEGA System on a number of spans of the second stage of the East Siberian Pipeline System (2000 km.) built to transport Russian oil to China and put into operation on December 25, 2012“, - the OMEGA Director General Dmitry Pleshkov says. The OMEGA SMEO monitors already a series of Transneft pipelines, a.o. the 1000-klilometer long Baltic Pipeline System transporting oil from the Timan-Pechora region, West Siberia and Urals-Volga regions to the Primorsk oil terminal at the eastern part of the Gulf of Finland.

Contact:
Aleksey Turbin, turbin@omega.mn

EU ENERGY COMMISSIONER OETTINGER WELCOMES AGREEMENT ON TAP

EU Energy Commissioner Günther Oettinger welcomed the signature of a tri-lateral intergovernmental agreement (IGA) as an essential step in the preparation of the Trans-Adriatic Pipeline project (TAP). TAP is an important gas pipeline between Italy, Albania and Greece with a starting capacity of minimum 10 billion cubic metres per annum (bcma). EU Energy Commissioner Oettinger said: „This pipeline is instrumental to connect the gas markets of Italy and Greece and to bring gas to Albania and potentially to other of our Energy Community neighbours. It could be among the first components of the Southern Gas Corridor which aims at linking directly the European Union with the rich gas sources in the Caspian Region.“

Concluded on February 13th in Athens between Albania, Greece and Italy, the IGA sets out the legal framework for the TAP pipeline. It includes a range of commitments by Greece, Italy and Albania and will ensure that the states cooperate in the development of the TAP pipeline.

Background

The Trans-Adriatic Pipeline starts in Komotini/Greece and goes via Albania to Italy, connecting existing infrastructures in Italy and Greece. In the beginning of 2012, TAP has been selected by the Shah Deniz Consortium in Azerbaijan as preferred gas transportation for the Southern route.

Also in 2012, the Shah Deniz Consortium has selected „Nabucco West“ as preferred partner for the distribution of gas within Central Europe. Rather than opting for a one-step-approach, the Consortium had decided to go ahead on the basis of a regional pre-selection. These regions are: Central Europe, Southern Europe and Turkey.

The Shah Deniz Gas field is the largest natural gas field in Azerbaijan. The production from Shah Deniz II (second phase of exploration, starting in a few years), will produce 16 bcma. In January 2011, Commission President José Manuel Barroso and Commissioner Oettinger visited Baku and, with President Ilham Aliev, agreed that Azerbaijan will be „the substantial contributor“ and „enabler“ of the Southern Gas Corridor and of Europe's future gas deliveries from the Caspian region.

Contact:
media@tap-ag.com

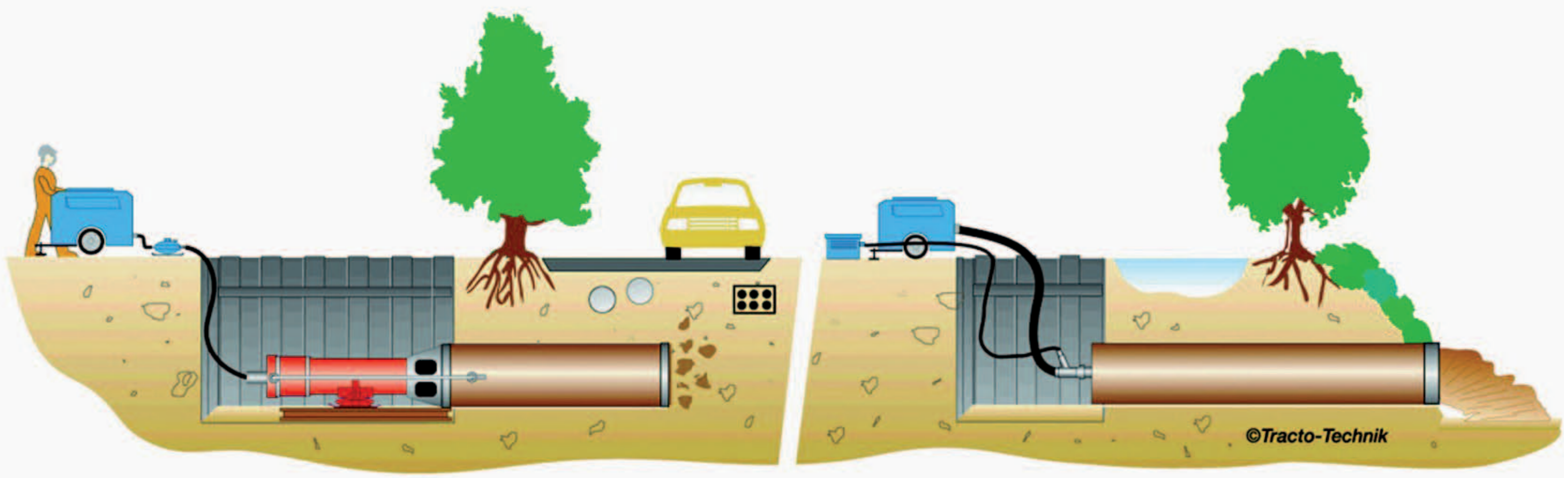
STEEL PIPE RAMMER BY TRACTO TECHNIK

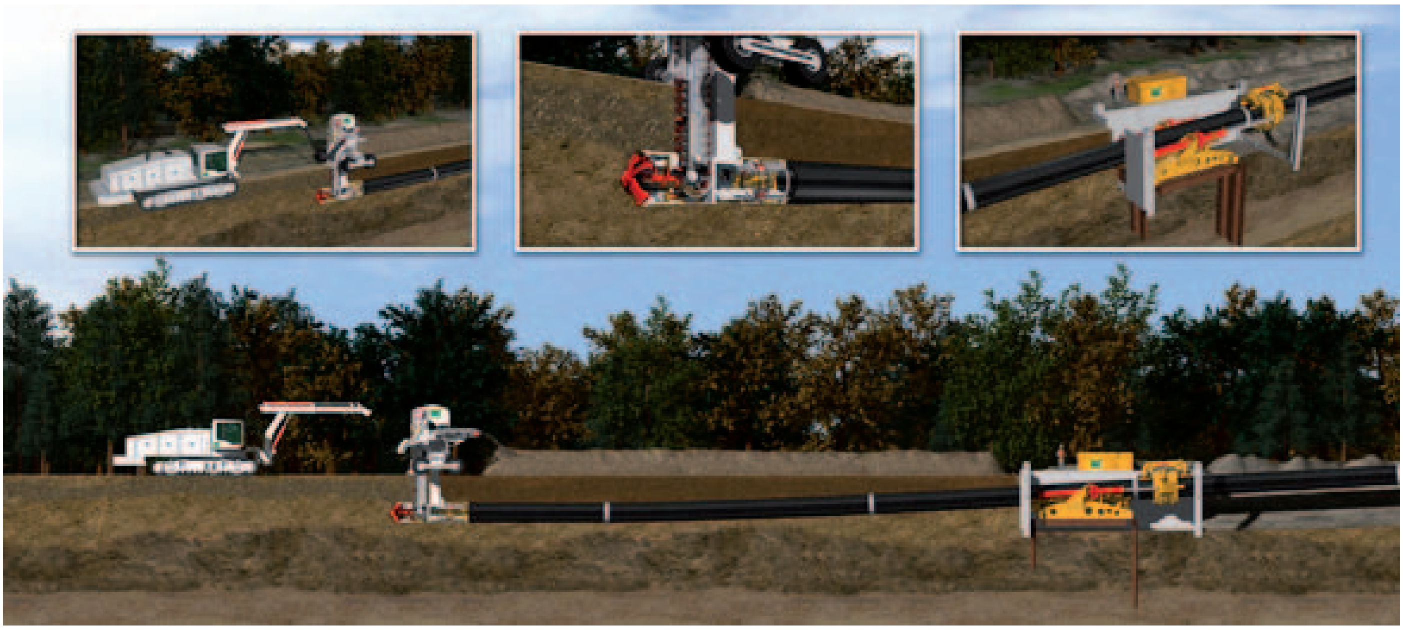
Grundoram pneumatically driven pipe ramming machines are used for the dynamic installation of steel pipes underneath roads, waterways, railway tracks, parks, etc. over lengths up to 80 m. The TT ramming technology provides thrust forces up to 40.000 kN (4.000 t), enabling the economic installation of open steel pipe up to 4000 mm diameter in soil classes 1 - 5 (partly even class 6 - easily soluble rock) without jacking abutments.

Advantages of the technique:

- less disruption and damage of surfaces worth conserving (road surface, front gardens etc.) and minimal restoration – giving economic advantages
- low social costs because detours, half-sided barriers, traffic signal facilities etc. are avoided
- acknowledged pipe installation technique
- short setting-up times - short installation times
- the dynamic impact when ramming can shatter obstacles and easily overcome difficult starting resistance after standstill periods. The aiming accuracy is improved because the dynamic impact shatters various soil formations within the diameter range and obstacles don't have to be displaced or pushed aside in one piece
- no jacking abutment, no auger cutter required, which could get jammed
- the soil core remains in the pipe during ramming, i. e. no inrush of water when rivers or high water table areas are under-crossed
- minimal covering, i. e. no large-scale pits
- simple operating technique
- adaptation to all pipe diameters with special ram cones
- wide application range

Contact:
export@tracto-technik.de





NOMINATED FOR THE BAUMA INNOVATION AWARD: PIPE EXPRESS® FROM HERRENKNECHT.

With Pipe Express® the Herrenknecht AG has developed a new semi-trenchless method for installing pipelines. In comparison with the open construction method, routes are considerably narrower, no groundwater lowering is necessary and there is less impact on nature. This has a very positive effect on the grid operators' construction costs. Because of the especially ecological and cost-efficient working method, the development of this new system is subsidized by the German Environment Ministry. An expert jury has now nominated Pipe Express® for the bauma Innovation Award 2013.coming generation of power-to-gas (P2G) plants.

Pipe Express® is a new mechanized method for the near-surface installation of pipelines of up to 1,000 meters in length and with diameters of 800 to 1,500 millimeters (32" to 60") using the half-open construction method. A tunnel boring machine loosens the soil which is then directly conveyed aboveground using a milling unit which is carried along. At the same time, the pipeline is installed underground. Since earthwork is reduced to a minimum and no groundwater lowering along the route is necessary, Pipe Express® has very little impact on the environment. This method is unique so far: For the installation of pipelines with a diameter of up to 1,500 millimeters, the soil is directly removed and not pushed aside. Pipe Express® is ideal, for example, for projects in which the groundwater level is only a few centimeters below the terrain's surface, in mainly swampy terrain or when nature protection is of special importance.

Minimum manpower and a high degree of work safety

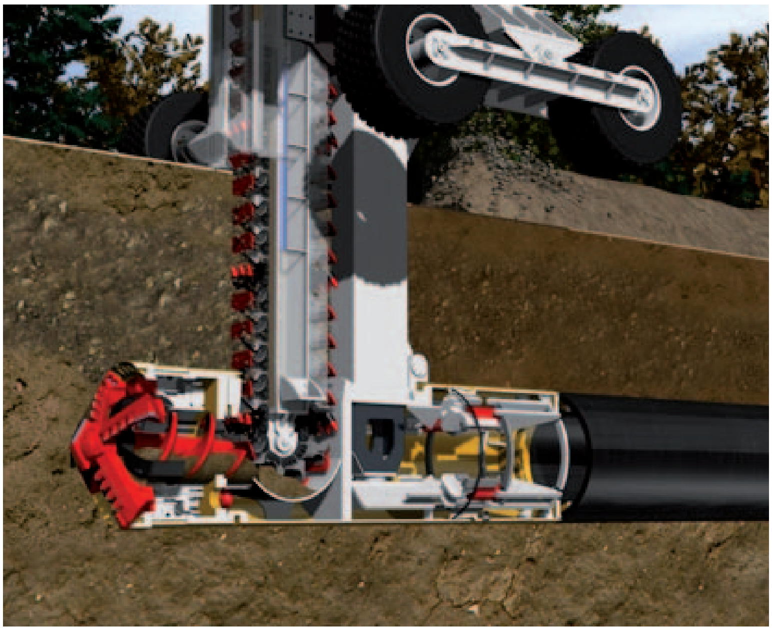
The main components of the new installation system include a tunnel boring machine that works underground, a trenching unit with a buggy and an operating vehicle on the terrain surface. The modular design of the entire system allows easy transport and relocation, as well as high flexibility in changing project conditions. The compact system is remote controlled from the operating vehicle and no trenches have to be dug. This means that minimum manpower is needed, increasing work safety at the same time.

Cost savings thanks to minimum earthwork

The new method has a positive influence on the realization and renaturalization costs in projects taking place in particularly challenging areas with unstable ground, water-bearing layers and at great installation depths. Compared to the conventional open construction method, with Pipe Express® the route width can be reduced by up to 70 percent, thus reducing the necessary earthwork. When crossing agricultural land, major losses of harvest and thus long-term compensation payments can be prevented compared to the open construction mode.

Test drillings and a first reference project completed successfully

After Herrenknecht AG had initially carried out test drillings on the company site at the Schwanau headquarters over one year, the new machine technology could be applied in a first reference project in Sevenum, Netherlands at the end of 2012. „Pipe Express® has exceeded all expectations," noted project manager Andreas Diedrich



with satisfaction and continued to explain: „The machine works with a tunnelling speed of up to one meter per minute, which means that 500 meters of pipeline were installed in three days." The construction company Visser & Smit Hanab is currently building a new high pressure gas line between Odiliapeel and Melick for the Gasunie grid operator. On a section of this line, the Herrenknecht innovation was put to use. Visser & Smit Hanab's managing director Wilko Koop confirmed: „I am very enthusiastic, everything worked excellently".

Pipe Express® - the method

When installing pipes with Pipe Express®, a tunnel boring machine drills the tunnel for the pipeline which is installed simultaneously. The excavated soil is conveyed directly to the surface via the milling unit and stored alongside the route. At the same time, the trenching unit functions as a vertical connection between the tunnel boring machine and the terrain surface. The operating vehicle accompanies the installation system and provides the entire logistics. These include a control stand for the operator, a power unit room, a high-capacity pump and a storage container for bentonite to reduce the skin friction between the pipe string and the ground. With the integrated crane system, assembly and dismantling work can be done in a very short period of time. The thrust force for the excavation unit and the pipeline is provided by a Herrenknecht Pipe Thruster.

Pipe Express ® - facts & figures

Method:
semi-open construction method

Drive length:
up to 1,000m

Pipeline diameter:
(32" – 60") 800 – 1,500mm

Pipe Thruster:
max. 750t

Overburden:
0.5 – 2.5m

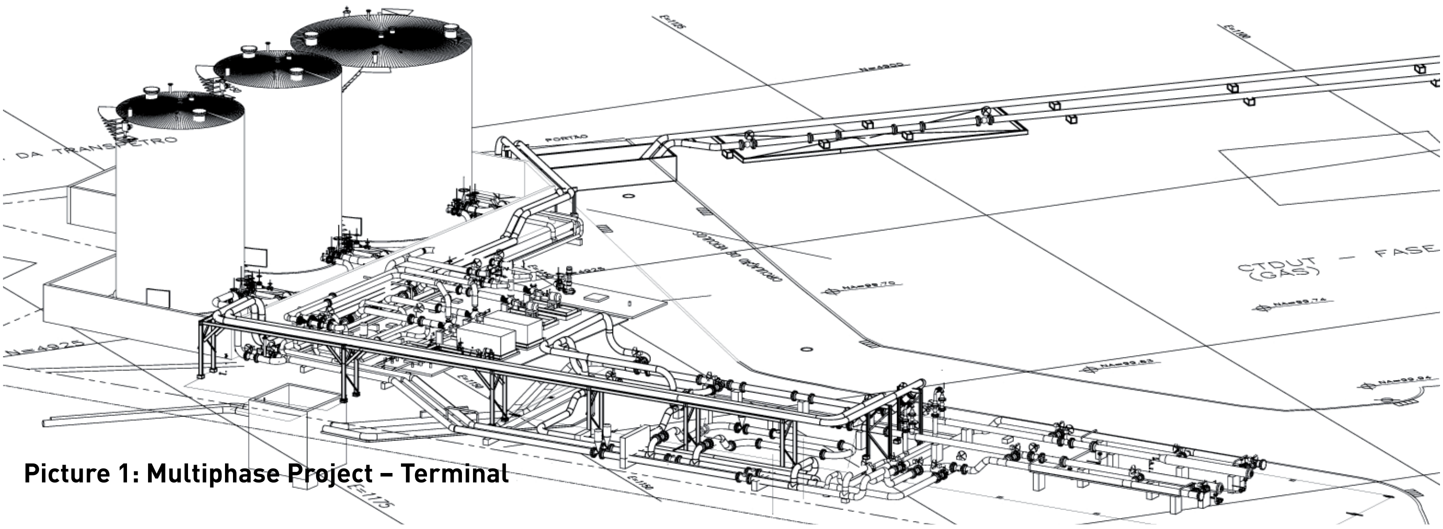
Areas of application:
unstable grounds, preferably swamp, near-surface groundwater level, up to 3 m depth

Components:
tunnel boring machine, trenching unit with buggy, operating vehicle, Pipe Thruster

Features:
minimum route width (< 15m), no groundwater lowering along the route, high installation speed (up to 1.50m/min), minimum disturbance of plants and animals, high degree of work safety, low material and personnel expenses

Subsidies:
Pipe Express® is subsidized by the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and supported by the Jülich project organizer. The basis for subsidizing the project is to develop with Pipe Express® a cost-efficient installation method for (among other things) heating pipes to reduce the connection costs and at the same time improve compatibility with the environment and nature.

Contact:
Achim Kühn, pr@herrenknecht.de



Picture 1: Multiphase Project – Terminal

12” MULTIPHASE LOOP UNDER CONSTRUCTION

The 12” multiphase loop will be able to operate with its full length of 2.700 meters and also with a small length of 200 meters, depending on the requirements of the specific job. Both configurations are piggable with removable flanged spools that can accommodate diameter changes, dents, leaks, internal coatings and flaws or any other feature applicable to pipelines. The full length configuration will also be able to run the pig indefinitely in a closed loop, allowing long distance and inertial systems PIG testing.

Three tanks will be available for crude oil, water and byproducts or any special need like oil/water separation. Despite a small pipeline that eventually feeds the tanks with different types of crude oil from a Petrobras facility nearby, there is a provision to receive oil by trucks. That will enable CTDUT to run tests with any type of oil available worldwide. In this case, the small length configuration helps reducing the total amount of oil to be transported from abroad, saving costs and reducing the problems with discharge of contaminated oil in the case of mixing additives.

Both short track and long track circuit configurations will allow the original pumps to be isolated by valves and an external multiphase pump to be connected on its place through flanges, providing conditions to test and evaluate new designs. Enough physical space and electrical power capability will be provided, according to the usual requirements for this type of application.

The same concept will apply to the phase separation that on this stage will be made on one of the tanks and could be replaced by a third part separator for development and testing. On a next step of the project, the use of natural gas instead of nitrogen will be possible, for close to reality results on the tests.

A provision has been also made for multiphase flow meters evaluation and tests. There will be enough straight pipe run to allow flow stabilization and independent meters for each phase, enabling measurement comparison.

CTDUT is an independent not for profit association of companies created by Petrobras but open for use by any company for testing, training and research on pipelines and terminals. Located in Rio de Janeiro, Brazil, the facilities offered include a fully operational 14” Test Dedicated Pipeline, with 110 meters, working with water or nitrogen, 8” and 9 5/8” Test Lines (see table below), a Bunker for bursting pipes safely, a Cathodic Protection training area and a Pull Rig Unit. All available for use under the shared and confidential philosophy, described before.

Note 1: Pipes with intentional internal and external flaws, with internal liner applied.

Note 2: Threaded pipes with intentional flaws on the threads, 0.525” thickness.

Note 3: Similar to the 14” Test Loop

Note 4: 100 bar pipes, citygate, launching and receiving traps available. Planning.

Contact:
Arthur Braga, arthur@ctdut.org.br

Details → / Diameter ↓	Multiphase	Biphase	Water	N2	Crude Oil	Natural Gas	Operational on	Notes
8”	-	x	x	x	-	-	Q2, 2013	Note 1
9 5/8 “	-	x	x	x	-	-	yes	Note 2
12”	x	x	x	x	x	In the future	Q3, 2013	
14”	-	x	x	x	-	-	yes	-
16”	-	x	x	x	-	-	Q4, 2014	Note 3
16” NG	-	-		x	-	x	Planning	Note 4

Table 1: CTDUT Loops summary

CHARTING THE WAY AHEAD FOR INTERNATIONAL COLLABORATION ON PIPELINE RESEARCH AND DEVELOPMENT

Cliff Johnson, Pipeline Research Council International (PRCI), USA
Gerhard Knauf, European Pipeline Research Group e.V. (EPRG)

ABSTRACT

For many years the Pipeline Research Council International (PRCI) and the European Pipeline Research Group (EPRG) have undertaken the responsibility for identifying and implementing research and development activities in support of the energy pipeline industries in North America and Western Europe. The last six decades have seen substantial increases in the requirements for transporting energy, together with increased public expectations regarding the safety, reliability and environmental impact of the pipeline infrastructure. PRCI and EPRG have played a major role in helping pipeline constructors, operators and regulators to rise to these challenges, providing tools and technologies to underpin the safe, reliable and cost-effective infrastructure we have today.
Since their foundation, PRCI and EPRG have benefited from regular collaboration between their members. More recently the inter-continental exchange has widened, with the formation of a Tripartite Relationship including the Australian Pipeline Industry Association (APIA). This truly global collaboration has highlighted the benefits of comparing experiences in different geographic regions, and working together to address common issues.
Looking further ahead, there is an ongoing need for more inter-continental collaboration.

1 Introduction

Steel pipelines have proved to be an extremely safe, reliable, effective and economically attractive means of transporting oil and gas during the last 60 years or so. During this period the requirements for energy transport have increased substantially, bringing oil and gas from increasingly remote locations to the major centres of population. At the same time there have been increased public expectations regarding the safety, reliability and environmental impact of the pipeline infrastructure. In response to these challenges the pipeline operators have committed substantial effort and funding into research and development to ensure both the continued safe operation of the existing infrastructure and the cost-effective construction of new pipelines.
Because pipeline operators worldwide face a range of similar issues, there is considerable benefit to be gained from cooperation and collaboration on research and development activities. On behalf of their members, PRCI and EPRG have held the primary responsibility for identifying and implementing research and development activities to meet the needs of their members in North America, Western Europe and elsewhere. In North America, PRCI has played a major role for 60 years in helping pipeline operators and constructors to address issues of common concern, providing tools, technologies and underlying technical understanding to support the safety and reliability of the pipeline infrastructure. EPRG has provided a similar collaborative forum for identifying, prioritising and undertaking collaborative research on behalf of pipeline operators and pipe manufacturers in Western Europe for 40 years. Both organisations have had a substantial influence on the pipeline industries in their respective home continents.

Since their foundation, PRCI and EPRG have promoted collaboration between their two groups of members. Meetings and biennial conferences to exchange information on research projects and activities commenced nearly 40 years ago, and have continued ever since. In recent years the geographical extent of the collaboration has broadened, firstly due to the establishment of a Tripartite Relationship with the Research and Standards Committee of the Australian Pipeline Industry Association (APIA), and secondly due to the steady increase in membership of both EPRG and PRCI. There is an added benefit that several major pipeline operators are members of both PRCI and EPRG, facilitating closer cooperation. Collaboration has now reached truly global proportions, and this has highlighted the benefits of utilising the experiences from different geographical and political/regulatory environments to truly understand the nature and extent of issues and opportunities faced by pipeline industries worldwide.

Productive collaboration requires cooperation and working together at many levels over a substantial period of time, based on firm agreement regarding common interests and priorities. This paper describes the ways in which collaboration has been achieved and sustained, identifies the lessons learned and charts a way ahead for future collaborative activities.

2 The organisations and their aims

Founded in 1952, PRCI has grown over the years from a small group of 15 members based in North America to an international organisation with over 60 members spanning five continents, and now includes significant memberships in South America and Asia. PRCI addresses a broad range of topics relating to the design, construction, maintenance and operation of pipeline systems and facilities. PRCI now also includes natural gas and hazardous liquids pipelines and facilities. The outcomes of the research are seen in a variety of methods, procedures, guidance documents and tools that can be utilised by the member companies. The great majority of the work is made available to the wider industry through reports and other publications, some of which form the basis of submissions to improve industry standards and regulatory guidance.

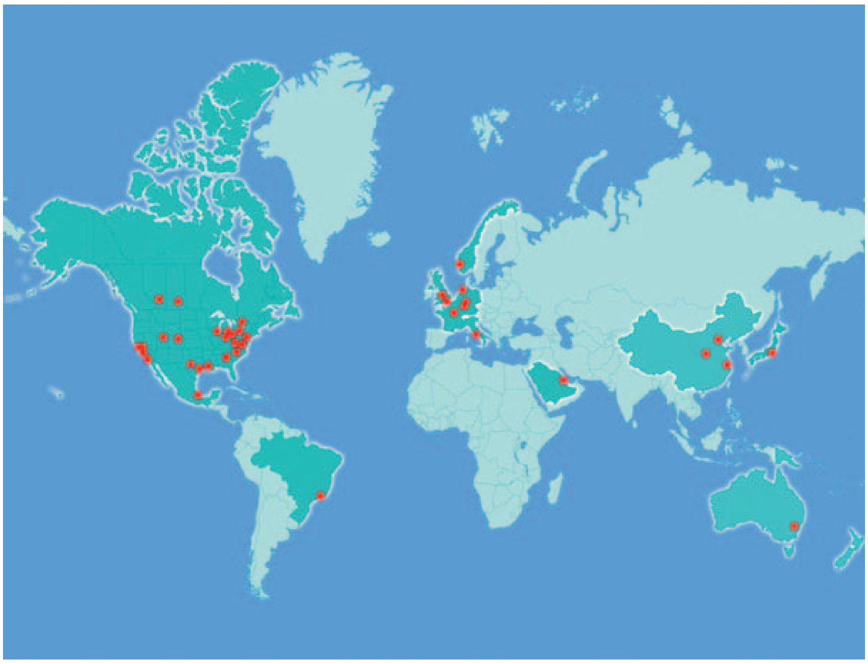


Figure 1: PRCI membership

Founded in 1972, EPRG is now a registered association of pipe manufacturers and energy transmission companies based in Western Europe. Like PRCI, EPRG has changed over the years as the industry has evolved, and now has 20 members who are collectively responsible for line pipe manufacturing capacity of 4 million tonnes/year and over 120,000 km of operational high-pressure gas transmission pipelines in Europe.

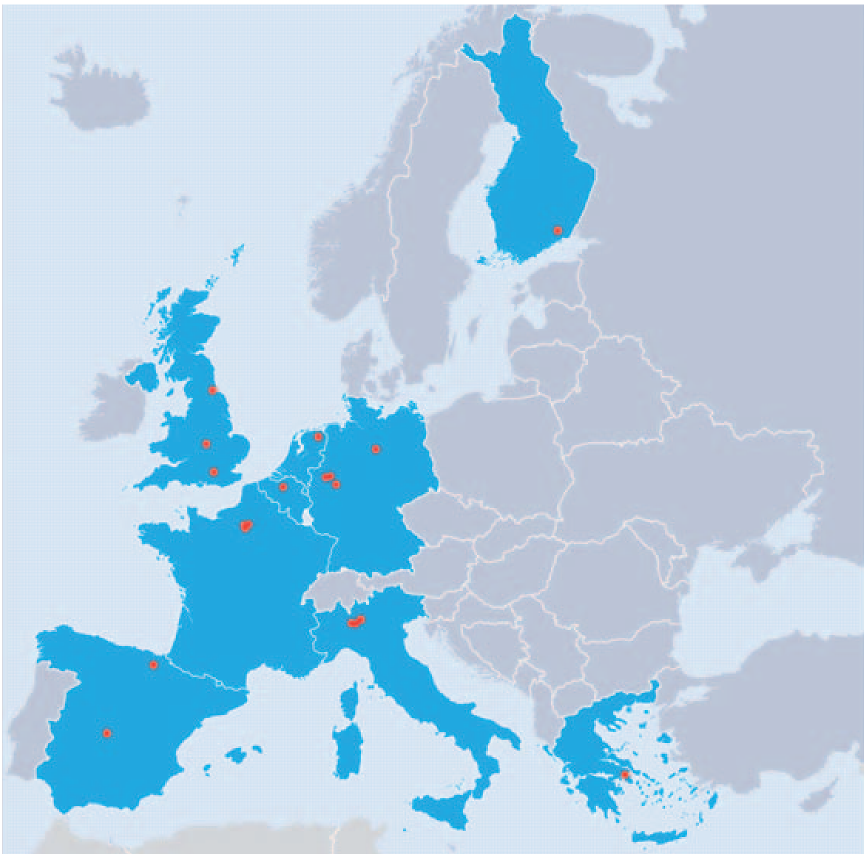


Figure 2: EPRG membership

EPRG utilises the combined expertise of its members to address issues of common interest concerning the technical integrity of gas transmission pipelines, including pipe manufacture, pipeline design, construction, operation and maintenance. Research results, recommendations and guidelines are published in journals and at conferences, enabling the findings to be made available to the wider industry. Much of EPRG's work is incorporated in national and international standards, for pipeline design, construction and operation.

3 Recent accomplishments

PRCI and EPRG have completed a large number of significant research activities in recent years. Among them have been the following:

3.1 PRCI

- Provided guidance on the use of External Corrosion Direct Assessment (ECDA), with particular emphasis on casings within carrier pipe
- Completed an updating review of the issues regarding microbially induced corrosion
- Reviewed and updated the guidance on the selection of girth weld coatings

Figure 3: Curved wide plate testing of pipeline girth welds

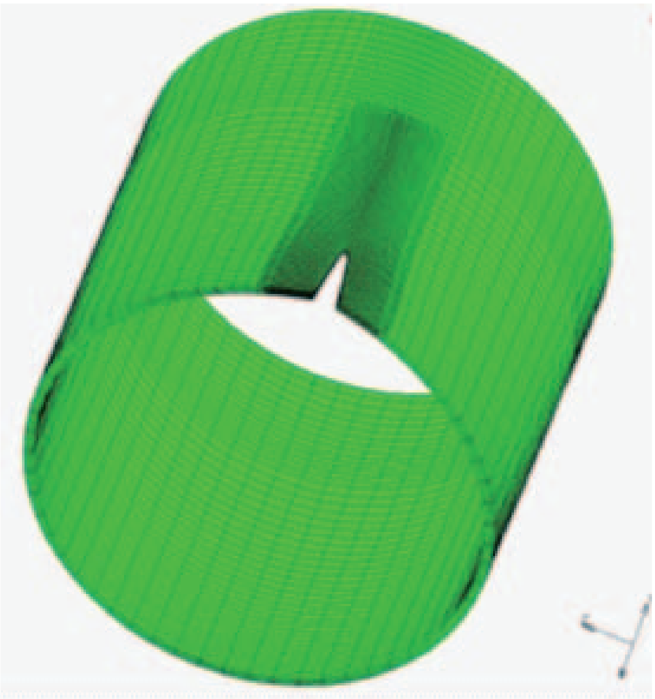


Figure 4: Modelling dynamic fracture of pipelines

- Completed a programme of full-scale tests to validate models for assessing mechanical damage in modern high-strength pipe-lines
- Updated the weld design testing and assessment procedures for high strength pipelines
- Established optimised welding solutions for X100 grade pipe
- Identified the opportunities to reduce onshore pipeline construction times and costs
- Completed several individual studies on advanced inspection technologies for the detection and characterisation of flaws using both in-the-ditch and in-line methods
- Evaluated technologies with the potential for improved leak detection

3.2 EPRG

- Provided guidance on the performance of sweet-service pipe when subjected to mildly sour service conditions
- Explored the operational conditions under which delayed failure might occur following mechanical damage to a pipeline
- Updated the guidance for assessing construction-related defects in pipe girth welds
- Reviewed the criteria for prevention and acceptance of wrinkles that may arise during cold field bending of pipe
- Identified the factors that determine the integrity of high-frequency welded pipe seam welds with low toughness
- Evaluated advanced methods for determining the resistance to ductile facture propagation of high grade pipe (up to Grade X100)

Further information regarding these and other activities can be found on the websites of the respective organisations; www.prci.org and www.eprg.net

4 Organisation of collaborative activities

As was indicated earlier, there has been a long history of cooperation between PRCI and EPRG. For many years the main focus of this cooperation has been the series of Biennial Joint Technical Meetings on Pipeline Research, listed in Table 1; these have proved an excellent platform for exchange of information on topical issues and the latest research results. The 18th Joint

Technical Meeting, held in San Francisco in May 2011, attracted over 170 technical delegates and included around 30 individual presentations as well as a number of workshops.
During the last decade the bilateral collaboration has enlarged to incorporate the Research and Standards

Table 1: Joint Technical Meetings, 1975 to 2011

1975	Columbus, Ohio, USA
1976	Amsterdam, Netherlands
1978	Houston, Texas, USA
1981	Duisburg, Germany
1983	San Francisco, California, USA
1985	Camogli, Italy
1988	Calgary, Alberta, Canada
1991	Paris, France
1993	Houston, Texas, USA
1995	Cambridge, UK
1997	Arlington, Virginia, USA
1997	Groningen, Netherlands
2001	New Orleans, Louisiana, USA
2003	Berlin, Germany
2005	Orlando, Florida, USA
2007	Canberra, Australia
2009	Milan, Italy
2011	San Francisco, California, USA

Committee of the Australian Pipeline Industry Association (APIA). A Tripartite Relationship was formalised in 2005 and the first Joint Technical Meeting in Australia was held in Canberra in 2007. Since that time the venues for Joint Technical Meetings have rotated between the three continents.

In the earlier years the bulk of the collaborative activity amounted to exchanges of information on research projects being undertaken by each organisation. While this was very valuable in ensuring that all those involved were kept up to date with the latest results and understanding, it became apparent that there were benefits to be gained from closer collaboration on specific topics and in particular by technical experts from both organisations being involved at the planning and execution stages rather than just exchanging the results after project completion.

Arising from this move towards a more in-depth relationship, the collaborative activities of the three organisations can now be seen to operate at three levels. The executive level has responsibility for the overall scope and terms of reference of collaboration, including the legal framework and confidentiality arrangements. At the management level summarised information regarding ongoing research programmes and projects is exchanged, and the Joint Technical Meetings provide the means to report on completed work packages and identify possible topics for in-depth collaboration. The working level focuses on developing and executing individual projects. These activities are summarised in Table 2.

5 Identification and development of collaborative project opportunities

Table 2: Summary of collaborative activities

Executive level	Memorandum of understanding Terms of reference Exchange of overall aims and objectives
Management level	Exchange summaries of research in progress Exchange of research outcomes at JTMs Identification of potential working-level collaborative projects Participation in joint Project Teams; establishment of scopes of work, review and direction of project progress, dissemination of results Exchange of detailed reports on selected subjects
Working level	Participation in joint Project Teams; establishment of scopes of work, review and direction of project progress, dissemination of results Exchange of detailed reports on selected subjects

PRCI, EPRG and APIA all regularly review their overall programmes of work to confirm that the needs and priorities are still aligned with their members' requirements. In PRCI, the Research Program Areas each have Roadmaps, long-term plans setting out the overall aims, the expected outcomes and the schedule when they will be delivered; the portfolio of individual projects is reviewed in reference to the Roadmap and balloted annually.

EPRG has two Roadmaps, one for new pipeline construction and the other relating to the integrity of the existing pipeline network, with a similar process for review

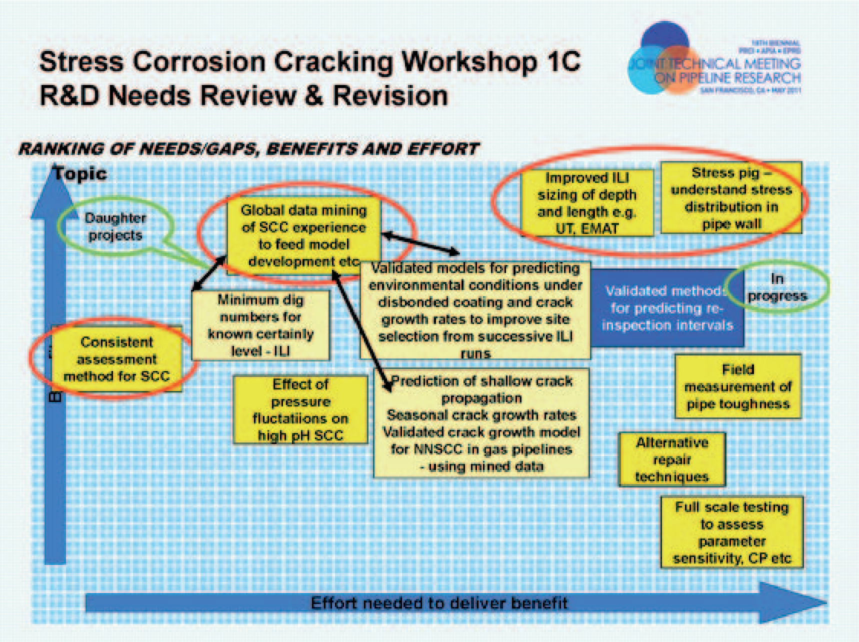


Figure 5: Example of a draft roadmap developed during Joint Technical Meeting Workshops

and alignment of individual projects to the overall plan.

During the Joint Technical Meetings in 2009 and 2011 the opportunity was taken to hold a series of Workshops at which the overall plans, research priorities and Roadmaps of each organisation were reviewed, with a view to identifying potential collaborative project opportunities. Some of these were already aligned with ongoing projects in one or more of the organisations. For new pipeline construction, topics included advanced design methods and effective use of high performance materials. For existing pipelines, understanding and mitigating the threats to integrity were identified as important. There was also a need to address the possible effects of anthropogenic carbon dioxide for carbon capture and storage.

The initial outputs from these Workshops were subsequently reviewed and prioritised by each organisation. From these deliberations a shortlist of high-priority collaborative project opportunities was developed, as listed in Table 3.

Table 3: Potential working-level collaborative projects

Advanced design and operation	Fracture control in modern high-grade steels Defect assessment in high-performance pipes Strain-based design for seismic applications Fracture control in pipelines transporting CO2
Harmonisation of construction processes and standards	Welding of X80 and higher grade pipes Gas metal arc welding and automated inspection for pipeline girth
welds	Rationalisation of girth weld defect acceptance standards Standard for curved wide plate testing
Mechanical damage	Development and validation of improved damage assessment models Delayed failure following mechanical damage

6 Project structure and administration

The establishment of collaborative projects involving complex organisations such as PRCI and EPRG is not a straightforward matter. Each organisation has its own processes for allocating funds and setting timescales. Consequently considerable thought has been given to the management of working-level collaboration. Several models are being piloted at present:

- A single project, administered by the lead organisation and co-funded by the other, with a Project Steering Committee drawn from both organisations.
- A 'virtual joint industry project' incorporating several individual projects, each funded and administratively managed by one organisation, but with common oversight by a Project Steering Committee drawn from both organisations.
- Parallel projects on inter-related subjects, each managed individually by a Project Team but with regular exchanges of information on progress

Based on the experience of the last few years, different management models appear to suit different projects, and there is no single solution. Whichever model is adopted, the key to success is frequent, open, well-distributed information about all aspects of project management and progress.

Among the recent and ongoing examples of collaborative projects are the following;

The susceptibility of pipe steels to stress corrosion cracking

Near-neutral pH stress corrosion cracking (SCC) has resulted in a number of in-service failures of pipelines, particularly in North America. While much of the research on this form of SCC has been directed towards understanding the influence of applied loading and the electrochemical environment on crack development, the inherent susceptibility of the steel to crack initiation and propagation may also play a part. Following several independent research projects addressing aspects of crack initiation and propagation, EPRG developed a test protocol for comparing the relative susceptibility of different pipe steels. To make the best possible use of facilities and resources, parallel research programmes were then initiated by EPRG and PRCI in which a variety of different US-sourced and Europe-sourced pipe samples were tested. Completed a few years ago, this study was one of the first examples of working-level collaboration; the combined study had the benefit of addressing a much wider range of materials than would have been possible in a single study.

Figure 6: Stress corrosion cracking of pipelines

Development and validation of improved methods for assessing mechanical damage.

The management of threats due to mechanical damage by third parties has for many years been an active topic for all three organisations, and many projects have been undertaken over the years. The currently applied methods for assessing the remaining strength of pipes that contain combinations of dents and gouges as a result of mechanical damage are lacking in accuracy.

New methods utilizing advances in understanding of materials behaviour and fracture mechanics offer the potential for improvements, and several projects addressing the models and their validation have been initiated by both organisations.

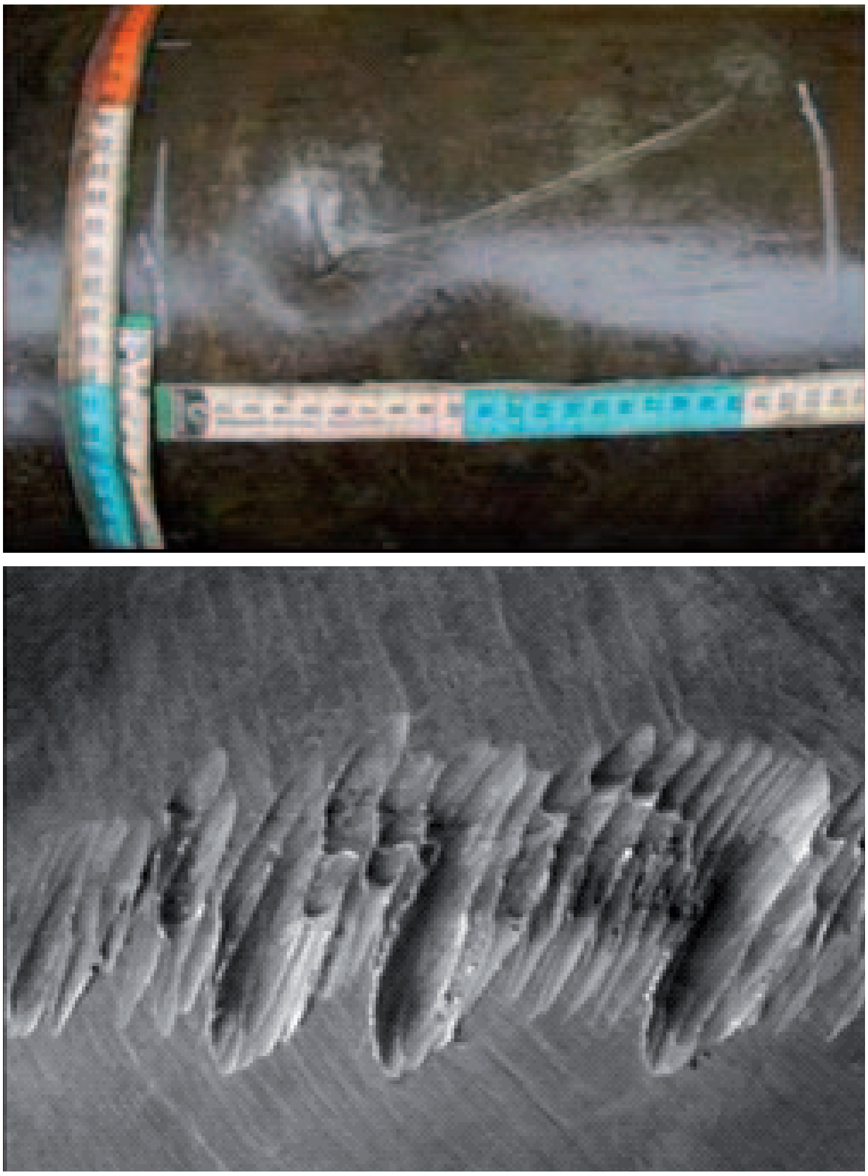


Figure 7: Mechanical damage to pipelines

Figure 8: Gas decompression test facility (courtesy Nova Research and Technology Centre)

To make the most effective use of the sophisticated analytical and experimental resources in specialist research laboratories Europe and North America, these projects have been coordinated via a 'virtual joint industry project' managed by a combined team from PRCI and EPRG.

Transportation of anthropogenic carbon dioxide for carbon capture and storage

In recent years it has become a priority for all three organisations to understand the issues and implications of using pipelines to transport carbon dioxide for carbon capture and storage applications.

Although there are a number of carbon-dioxide-transporting pipelines in operation worldwide, the impurities in anthropogenic carbon dioxide may present particular issues in terms of gas decompression behaviour and ductile fracture resistance. Following a gap analysis conducted by PRCI, a programme of gas decompression tests is nearing completion. This work makes use of specialised test facilities located in Canada, and has been established as a single project managed by PRCI with co-funding by EPRG and APIA.

Delayed failure following mechanical damage to pipelines

Failure can sometimes occur weeks or months after a pipeline has been damaged, as a result of cracks propagating from the zone of damage due to either steady of cyclic load. Following a preliminary study commissioned by EPRG to determine the conditions under which such failures could occur, the possibility of developing a new model to determine the conditions for delayed failure was identified. A joint technical group involving all three organisations was formed to oversee the programme of work; the analytical development and laboratory tests will be undertaken in a co-funded project the US, while the full-scale validation tests will be undertaken in three parallel studies in Europe, North America and Australia. It is noteworthy that three pipe materials, one from each continent, will be included in this study.

Several of the other topics identified during the Joint Technical Meeting Workshops as potentially benefiting from working-level collaboration are expected to be established as collaborative projects in the near future. Also, new topics will arise from future collaborative reviews of research needs and priorities.

7 Observations and Comments

For over 40 years PRCI and EPRG have had the lead responsibility for identifying and responding to the R & D needs of the pipeline industry in North America and Western Europe. During this time many significant advances have been made in the technology, methods and understanding of all aspects of pipeline design, construction, operation and maintenance. The outcome of these activities has generally been very positive; pipelines have largely proved to be the safest and most reliable of energy transport. The role played by PRCI and EPRG, and by their member companies, should not be underestimated.

Notwithstanding this successful experience, there is never room for complacency. Although much of the technology is mature, the industry continually faces new challenges, due for example to the increasing remoteness of energy sources, increasing public concern about safety and environmental impact, the increasing age of the infrastructure and the challenges of transporting new products in a cost-effective manner. In this context it is important to regularly review the changing needs and priorities of the pipeline industry and ensure that the research programmes are delivering useful outcomes in a timely and effective way. Both PRCI and EPRG rely on regularly updated road-mapping to establish their short-term and longer-term objectives; it is important to remember that the way ahead is not fixed, but that direction-changing events can occur at any time.

The road-mapping workshops at the Joint Technical Meetings have provided PRCI, EPRG and APIA with an excellent opportunity to identify technical topics that have the potential to benefit from working–level collaboration. The topics include some that have been the subject of ongoing research for several years, and others that arise from newly-emerging developments in the pipeline industry. Looking further ahead, there will be additional moves towards harmonisation of procedures and standards. Also, it is clear that the retention and refreshment of knowledge among the workforce will become an increasing concern for all participants in the pipeline industry. Both these longer-term concerns will need to be incorporated within the overall requirements and development plans for the industry.

With these issues in mind PRCI has recently taken the lead in unifying and promoting convergence of the pipeline industry R & D agenda. Through a series of high-level meetings that started in December 2011, PRCI has been bringing together the leaders in the pipeline R & D community to examine afresh the top priorities, and to establish more efficient ways of addressing them. The outcome of the exercise will be a new 'Pipeline Industry R & D Roadmap', establishing a consensus on the priorities and determining the research requirements – within PRCI and elsewhere within the research community – to deliver them in a timely manner.

The role of all forms of collaboration supporting these processes is clear. The pipeline industry is a worldwide institution and research organisations such as PRCI, EPRG and others need more than ever to work together to achieve their common objectives. PRCI and EPRG have a long history of collaboration at all stages in the research process, from the identification of needs and priorities to the execution and delivery of the outcomes. The new ways of collaboration, with emphasis on collaboration at the working level, are beginning to bear fruit and more progress in this direction can be expected. PRCI and EPRG will continue to take a lead, working together with APIA and their other inter-continental partners, in promoting such activities for the benefit of the international pipeline industry.

8 Concluding remarks

- PRCI and EPRG have a long record of collaborating to deliver new research outcomes for the benefit of the pipeline industry. Exchange of information on new and ongoing research activities has occurred on a regular basis for nearly 40 years.
- In recent years collaboration has been reinforced by the inclusion of working-level activity in combined Project Teams, further enhancing the value of collaboration throughout the project life-cycle.
- Such activities have been supported by closer cooperation in the development of technical roadmaps; identifying research needs and opportunities and allocating the resources to achieve them in a timely manner. New developments such as the Pipeline Industry R & D Roadmap will help to make this a truly worldwide activity.
- PRCI and EPRG, together with APIA and our colleagues in other international research organisations, will continue to rise to the challenge of providing effective research solutions to meet the changing needs of the modern pipeline industry.

9 Acknowledgements

The authors wish to acknowledge the financial support of our member companies within PRCI and EPRG, and particularly the continuing technical support of the many individuals who contribute so much of their effort and time to ensuring the successful planning, execution and delivery of our research activities.

X80 PIPELINES IN ARCTIC ENVIRONMENT: PREDICTION OF THE LONG-DISTANCE DUCTILE FRACTURE PROPAGATION/ARREST

Igor Pyshmintsev, Alexey Gervasyev, and Alexey Struin - Russian Research Institute for the Tube and Pipe Industries Chelyabinsk, Russia
Taymuraz Yesiev – Gazprom-VNIIGAZ Moscow, Russia
Andrey Arabey – Gazprom Moscow, Russia

ABSTRACT

Several pilot lots of heavy-wall 1420 mm OD X80 steel line pipes supplied by a number of world-leading mills were subjected to full-scale burst test according to the Gazprom technical requirements for "Bovanenkovo-Uhta" pipeline project. Analysis of the test results shows that the crack arrestability of steel depends on straining of the material adjacent to the running crack tip as it increases the specific energy of fracture propagation. It was noticed that low arrestability was accompanied by high intensity of fracture surface separation (splitting). Microstructure parameters leading to high separation intensity are quantified on the basis of X-ray diffraction and EBSD measurements with respect to the position across the wall thickness. Two laboratory test methods giving results which correlate with the results of the full-scale burst test are proposed.

1 Introduction

Over the last several decades, the aim of energy companies to increase the efficiency and safety of gas pipelines has been pushing the metallurgical industry to produce higher-strength line pipes. Modern metallurgical technologies allow achievement of strength grades up to X120 with high toughness and weldability. However, besides standard properties, pipeline steel must have a number of special ones. First of all, the resistance to ductile fracture propagation. Its unpredictability remains a major factor slowing the implementation of pipeline projects with the use of X80 and higher steel grades.

It has been well clarified recently that Charpy absorbed energy which used to be the crack arrestability criterion for lower grade steels cannot be the one for modern high strength steels [1-4]. Alternative material parameters having been proposed are the Drop Weight Tear Test (DWTT) absorbed energy [4] and the Crack Tip Opening Angle (CTOA) [3, 5]. Their evaluation requires specific equipment and techniques, so the implementation of these procedures on the industrial level is highly arguable. Today, the only way to evaluate the crack arrestability of a high strength pipeline steel is to perform a full-scale burst test which can be done only at few fields in the world. No need to say that the development of a

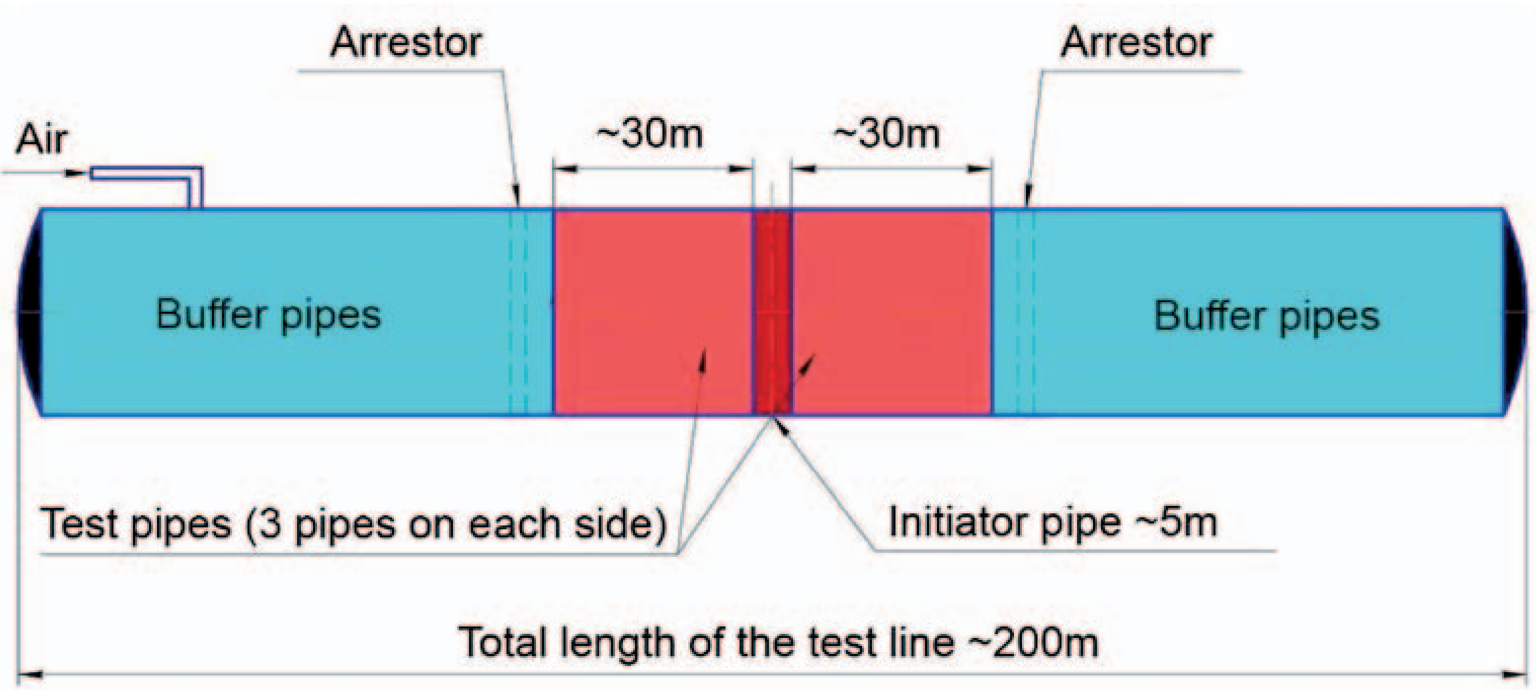


Figure 1: Layout of the test line

Element	C	Si	Mn	Mo	Ni	Cu	Cr	V	Nb	Ti	Al	S	P
Steel#1	0.05	0.21	1.81	0.19	0.26	0.27	0.05	-	0.040	0.010	0.030	0.001	0.013
Steel#2	0.08	0.39	1.85	0.13	0.22	0.17	0.19	0.002	0.050	0.016	0.034	0.001	0.013
Steel#3	0.05	0.10	1.87	0.01	0.63	0.49	0.26	-	0.024	0.019	0.041	0.004	0.007
Steel#4	0.06	0.20	1.69	0.21	0.22	0.06	0.03	0.040	0.070	0.017	0.030	0.002	0.006

Table 1: Chemical composition of steels, wt.%

new approach to predict ductile fracture propagation/ arrest in a pipeline is a very topical issue.

The majority of studies on this matter are dedicated to the relationship between some mechanical property of steel and the crack arrestability of a pipeline. This approach leads to the fact that the crack arrestability doesn't have any link with microstructure peculiarities caused by the technology of plate/strip production, and thus the initial reasons for low arrestability of high strength line pipes are not determined.
In this work it became possible to analyze both microstructure and fracture mechanics of several steels

with different level of arrestability evaluated by the full-scale burst test. Pipe lots were supplied by several mills from Russia, Europe, and Japan to meet the Gazprom technical requirements for "Bovanenkovo-Uhta" pipeline designed for gas transportation from Yamal peninsula to European consumers at 11.8 MPa operating pressure.

2 Materials and methods

Four pilot lots of pipes supplied by different mills are considered here. Chemical composition is presented in Table 1.

Full-scale pneumatic tests were performed at Gazprom test facility near Kopeysk, Russia. X80 OD 1420 mm pipes with 23.0, 27.7, 33.4 mm WT were tested at -10 °C at 12.9 MPa (for 23.0 mm WT) and 14.7 MPa (for 27.7 and 33.4 mm WT) air pressure. The test line is schematically drawn in Figure 1. Crack arrest within three pipe lengths in both directions was established as acceptance criterion.
The specific fracture energy of crack propagation was calculated using stress-strain curves obtained from tensile tests and measurements of plastic strain of pipe walls along the crack route [6]. Mechanical properties of base metal were measured for each pipe before the full-scale test. The layout of special mechanical tests for evaluation of the material's resistance to ductile fracture propagation will be discussed further.
The microstructure and texture of the pipe wall were characterized by means of electron backscatter diffraction (EBSD) and X-ray diffraction (XRD), as well as conventional optical and scanning electron microscopy. Orientation distribution functions (ODF) were calculated to analyze the crystallographic texture on the basis of the data obtained from both XRD and EBSD measurements according to the Bunge convention [7].

3 Full-scale burst test results

Main test parameters for four steels which will be discussed in the paper are presented in Table 2. steel #2 showed insufficient arrestability and crack propagated through all the test pipes. Note that Charpy energy values at -20°C (minimal operation temperature) don't show any correlation with full-scale burst test results.

Analysis of fracture profiles after the burst test showed that low straining of the area around the tip of the pro-

Test #	WT, mm	Test pressure, MPa	Average crack propagation distance, m	Charpy energy at -20°C, J/cm2
1	27.7	14.7	14.4	328
2	27.7	14.7	> 34.0	271
3	23.0	12.9	12.1	376
4	27.7	14.7	8.5	214

Table 2: Full-scale burst test parameters

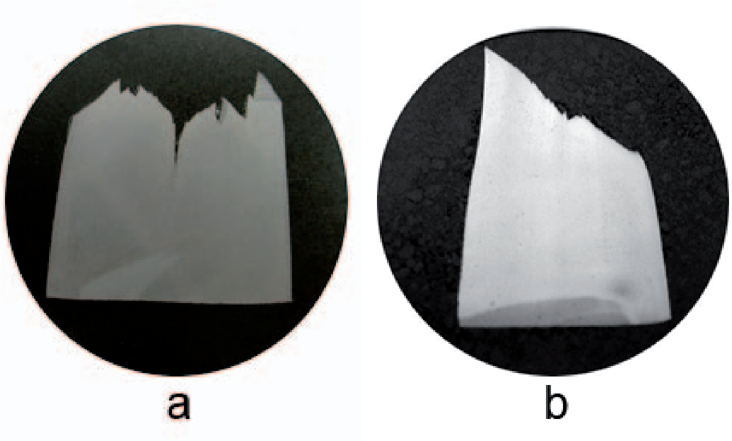


Figure 2: Fracture profiles of steel#2 (a) and steel#3 (b)

pagating crack (and thus low specific fracture energy of the crack propagation) was accompanied by excessive separation (splitting) of the fracture surface (Figure 2). Separation appears as multiple secondary brittle cracks parallel to the pipe wall surface, i. e. perpendicular to the propagating crack. They form due to the triaxiality of the stress state ahead of the crack tip and presence of weak surfaces in the microstructure of steel [8].

The abovementioned results of the full-scale burst test have shown the need to reveal the reasons for high separation intensity and to establish a new type of laboratory testing that can predict the ductile fracture propagation resistance in X80 steels.

4 Results and discussion

4.1 Microstructure and texture studies

Separation was first observed in lower-grade steels after controlled rolling and was related mainly to the ferrite-pearlite microstructure of these steels [9,10]. The mechanism of separation in X80 steels with predominantly bainitic microstructures is not quite clear. The number of factors known as causes for separation [11] in our case of low-impurity steels with predominantly bainitic microstructure can be reduced to two general causes: microstructure banding (whatever it is caused by) and cleavage on {100} planes.

Microstructure of the base metal (on the depth of ¼ of the pipe wall thickness) of studied pipes is presented on Figure 3. All four steels have predominantly bainitic microstructure consisting of polygonal, quasi-polygonal, acicular, and bainitic ferrite, although there are no generally accepted definitions for these structures. Small amounts of MA are also present. Prior austenite grain boundaries not always can be recognized upon etching but it is clear that austenite grains were significantly elongated in the rolling direction due to "pancaking" during finish rolling.

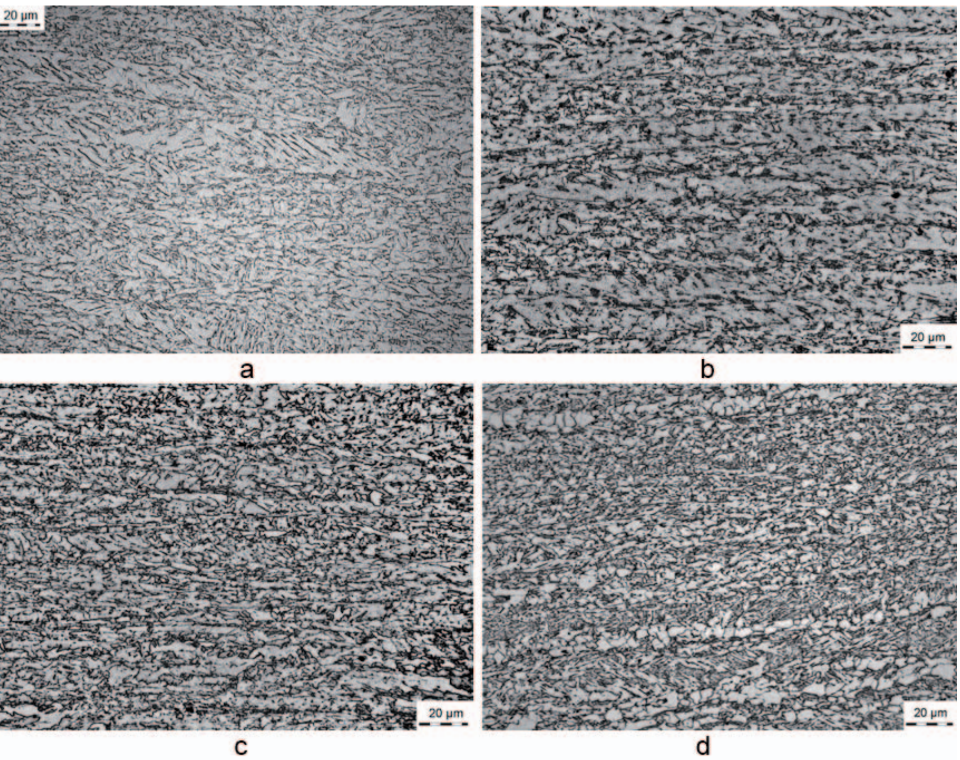


Figure 3: Microstructure of studied steels. a – steel #1, b – steel #2, c – steel #3, d – steel #4

As long as there is a through-thickness gradient of temperature and strain in each instant of time during thermo-mechanical controlled processing, it makes sense to relate the microstructure and texture to the position through the thickness of the plate. That's why EBSD and XRD measurements were done in 4 layers through the half-thickness of the pipe wall in all steels under investigation.

Texture analysis by XRD showed that all steels except steel#3 have large through-thickness texture gradients. The texture in the centre of the plate is much sharper and has higher intensity of {001}<110> component than the texture of the sub-surface layers of the pipe wall. The {001}<110> component is the main component providing {001} planes parallel to the rolling plane in ferrite and thus its large content potentially can lead to separation [12]. However, not only the content in a certain layer but the whole through-thickness distributions of this texture component intensity are very similar in steels #1, #2, and #4 (Fig. 1). Because only steel #2 had a high separation intensity, one can conclude that the macrotexture with the characteristic feature of a large incidence of cleavage planes parallel to the rolling plane cannot be the only reason for separation in the steels under consideration.

Figure 5 shows the distribution of the two "cube" texture components in the microstructure in the central layers of steels #2 and #4. Both steels exhibit a relatively large fraction of {001}<110> orientations, but the distribution of this orientation among the microstructure components is different in the two steels. The longest straight regions with rotated cube orientation can be seen in steel #2, whereas in steel 4 the cube component appears to be more homogenously scattered. This combination of microstructural morphology and texture most likely leads to the high separation intensity in steel #2. It is partially confirmed by Figure 6 showing the areas adjacent to a split propagating along {001}<110> regions in steel #2. Although it is hard to judge whether the split propagates inside regions of {001}<110> orientations or along the prior austenite grain boundaries surrounding these regions, the presence of such regions seems to be critical [13].

Grain size determination can be done using several approaches in EBSD data post-processing software. Two methods were applied in this study: the first one using intercept lines parallel to the ND, and the second one using an approximation of a grain by an ellipse. Both methods indicated that the central layers of the pipe wall have larger grain size than the sub-surface ones.

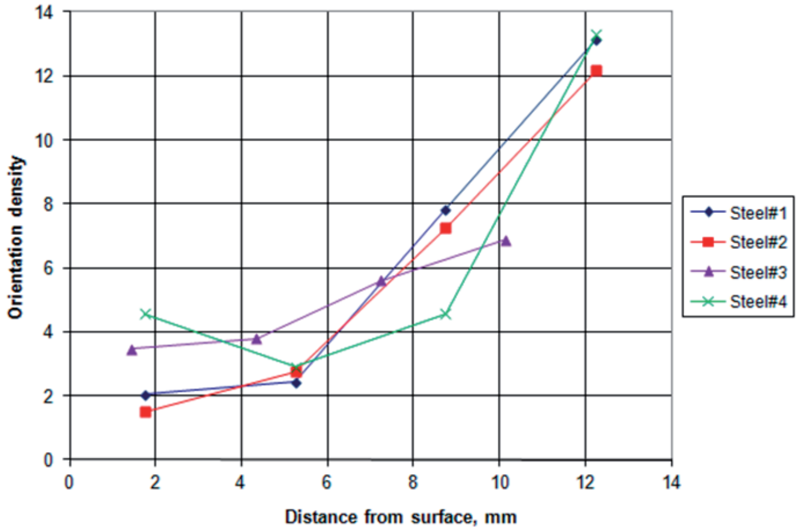


Figure 4: Distributions of {001}<110> intensity across the half-thickness of the pipe wall in studied steels

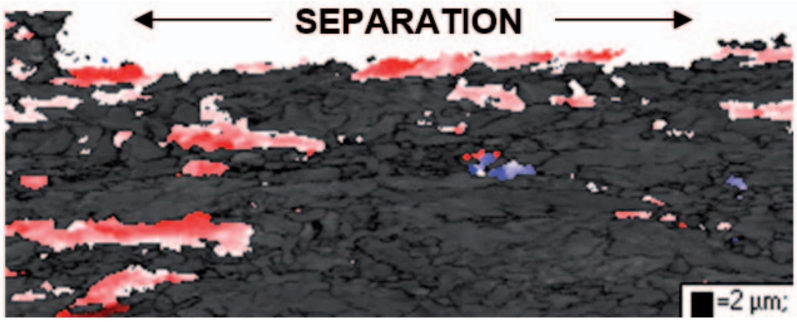


Figure 6: EBSD-map of an area adjacent to a separation in steel #2. {001}<110> orientation is colored red, {001}<100> – blue

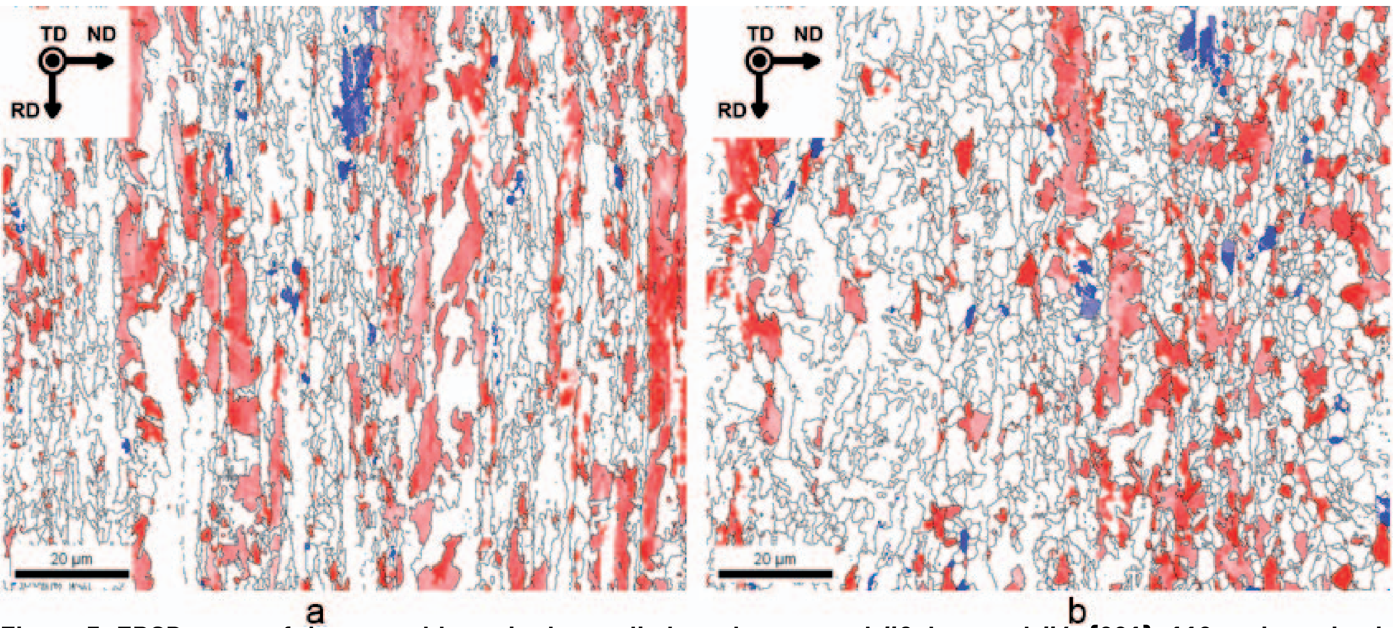


Figure 5: EBSD-maps of the central layer in the studied steels. a – steel #2, b – steel #4. {001}<110> orientation is colored red, {001}<100> – blue

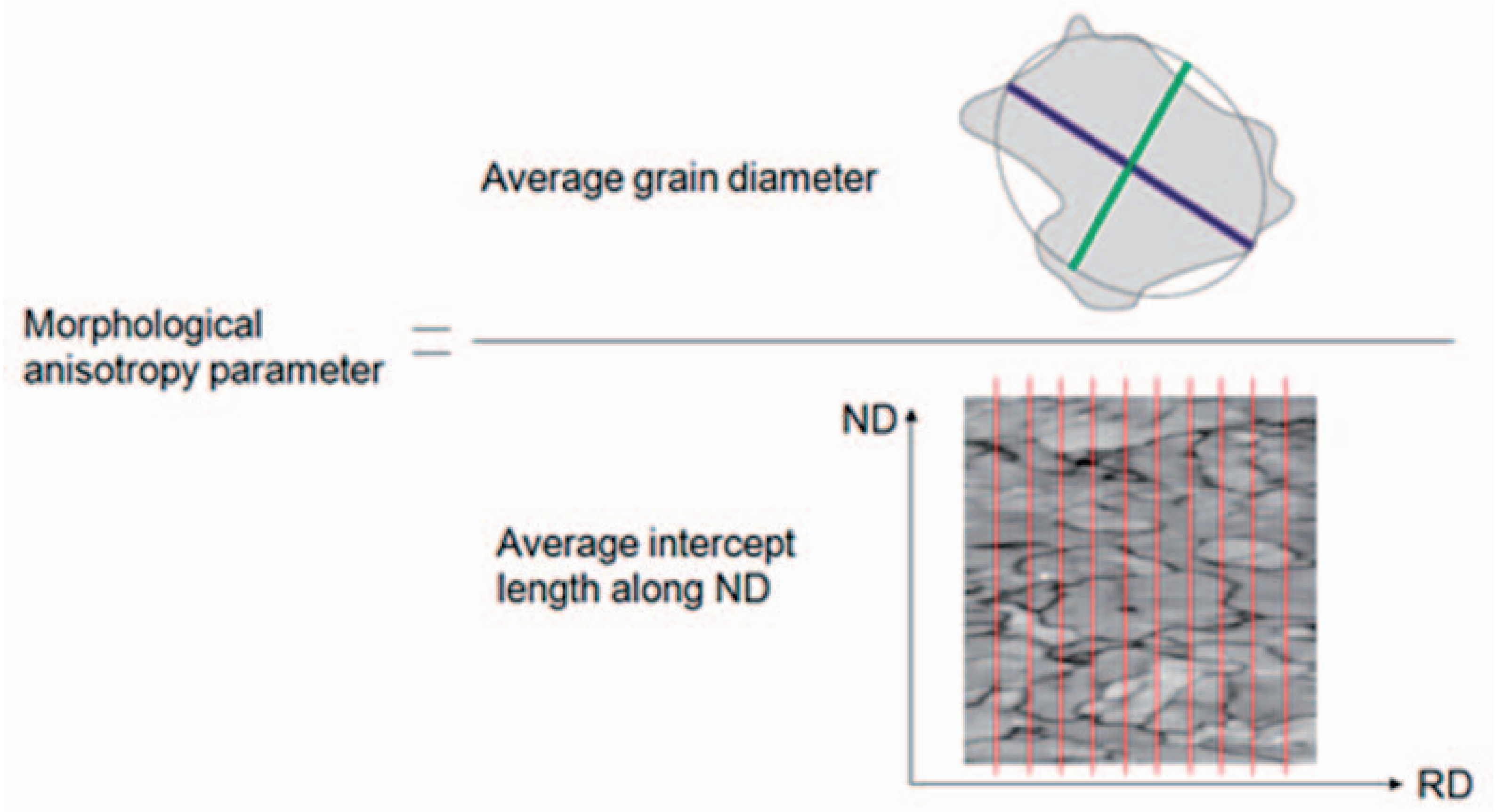


Figure 7: Definition of the morphological anisotropy parameter

The degree of microstructure elongation, or morphological anisotropy, can be estimated by the relation of two abovementioned grain sizes (Figure 7). The average grain diameter divided by the average intercept length is defined as a parameter determining the degree of morphological anisotropy. Distribution of this ratio across the half-thickness (Figure 8) shows that the morphological anisotropy parameter in the center of steel #2 pipe wall is significantly higher than in other steels. Hence it was observed that steel #2 exhibits long grain boundaries parallel to the rolling plane which could lead to separation during fracture. The stress state ahead of a running ductile crack provides the highest stresses in the ND in the center of the pipe wall, which means that the high morphological anisotropy in central layers will cause separation already at the early stages of plastic deformation.

4.2 Ductile fracture mechanics studies

As it was previously mentioned, the application of X80 and higher grade steels to the construction of the new generation of gas pipelines has lead to serious difficulties in determining the toughness of such materials. Standard mechanical tests were designed for lower-grade steels and in many cases are not appropriate for modern pipeline steels with the unique combination of high strength and high toughness.
One can observe that often Charpy samples of X80 steel are not broken completely during the test. A specimen deforms up to the point when the distance between the opposite ends is equal to the distance between the support anvils and then it passes between the support anvils together with the hammer. Usually the complete fracture of X80 Charpy samples can be observed at -60°C and below which corresponds to the ductile-to-brittle transition temperature. This "complete fracture" temperature can be higher in case of severe separation. The four steels under consideration didn't show complete fracture during Charpy test at -20°C. The absorbed energy values presented in Table 2 are thus not quite correct because they were calculated according to the standard procedure as the ratio of the impact energy to the initial area of the specimen cross-section.

Two non-standard mechanical tests were implemented for toughness evaluation of steel#1 and steel#2: the notched plate tensile test and the Charpy test of pre-strained steel.

The notched plate tensile test was performed to create the ductile fracture propagation in laboratory conditions and to define the conditions of the ductile crack propagation.71x22.5x5.0 mm plates taken from the middle of the pipe wall thickness with the long side parallel to the hoop direction were tested. A chevron-type notch with the tip angle of 120° was used for the crack initiation. Templates for plates were not flattened. The sequence of pictures showing the crack propagation in both steels can be found in Annex A.

The crack propagation was stable, i. e. the crack was growing only with the increase of the displacement. Fracture appeared at stresses above the yield stress. As it was determined before, the resistance to ductile fracture propagation is defined by the strain capacity of steel ahead of the crack tip. The notched plate tensile test has shown that this feature is different in steels #1 and #2. The plastic strain zone in steel#1 is significantly larger than that in steel#2 (Annex A) which is in agreement with the full-scale burst test results.
The through-thickness strain distribution was measured after the notched plate test and appeared to be similar to that after the full-scale burst test. Steel#1 showed higher level of through-thickness strain than steel#2 (Figure 9). Besides the difference in strain values, one can see obvious difference between fracture surfaces of the two steels (Figure 9). Multiple separations of different size are present in the fracture surface of steel#2, while most of the fracture surface of steel#1 consists of shear fracture without separations.

Load-displacement curves recorded during notched plate tests can be used for determining the work of ductile fracture propagation. The specific fracture energy (E) was used as a ductility parameter. It is defined as a ratio of total work of the plate fracture to the initial cross-section at notch position. "Load-displacement" curves as well as total work values are presented on Figure 10.

It's important to note that the specimen length also affects the total fracture work. For a given cross-section area, a longer specimen will have larger volume of metal being deformed uniformly and thus the area under load-displacement curve before maximum will be larger. To compare different notched-plate test results the specific fracture energy should be related to the volume of tested metal.

It is found that during the notched plate test the non-uniform strain appears at distances not exceeding 3 thicknesses (3t) from the fracture surface in each direction. Therefore the specific fracture energy was calculated for 6 thicknesses (6t) height. If the working height is equal to 6 thicknesses the specific fracture energy is defined by the next formula:

$$E = \frac{1}{S_o} \int_0^{\Delta_{pl}^{fract}} P(\Delta_{pl}) d\Delta_{pl} ,$$

(1)

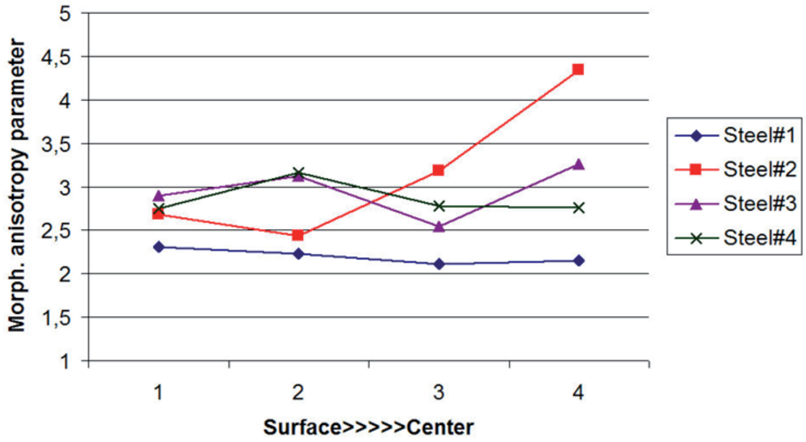


Figure 8: Distribution of the morphological anisotropy parameter across the half-thickness of the pipe wall in studied steels

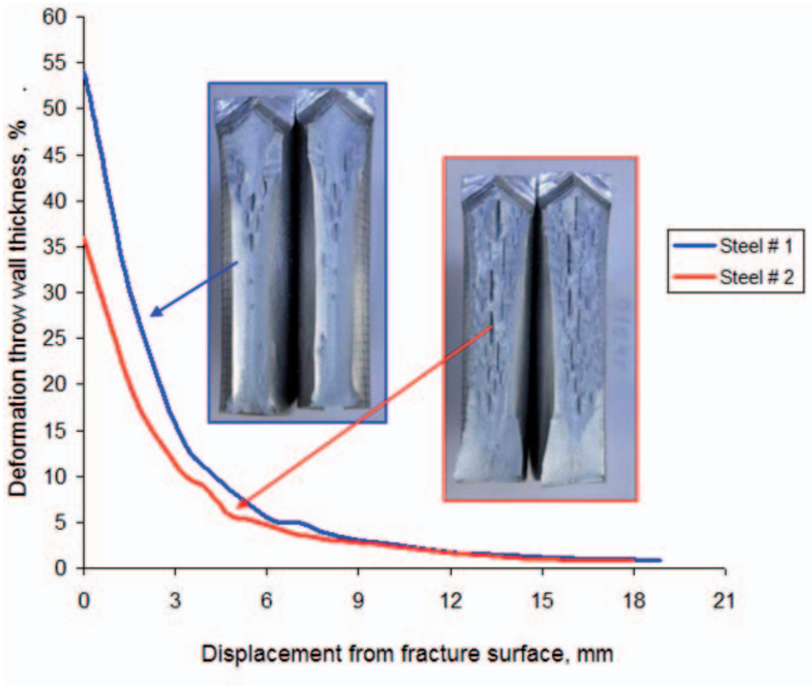


Figure 9: Trough-thickness strain distribution around the fracture surface in notched plates and the appearance of the fracture surfaces

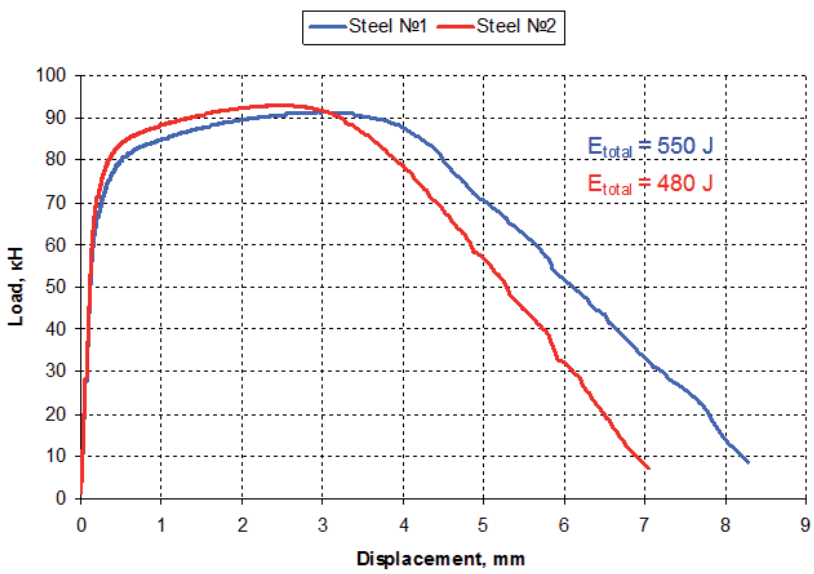


Figure 10: "Load - Displacement" curves obtained for notched plates

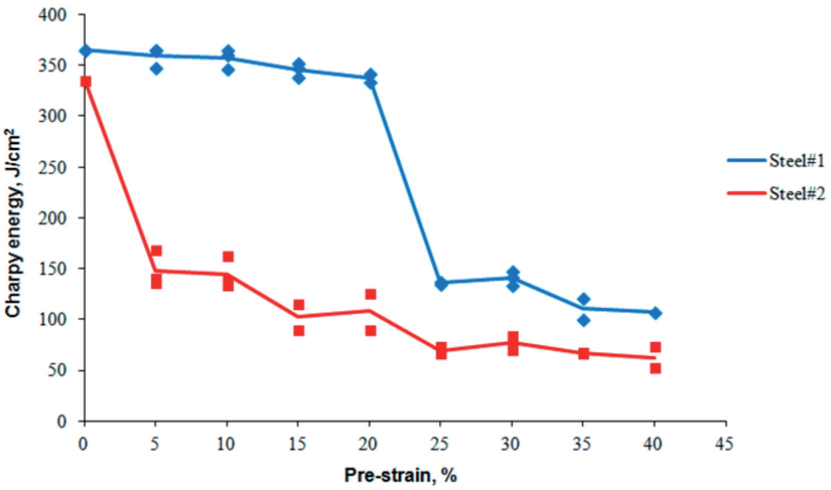


Figure 11: Pre-strain transition curves for steels with different crack arrestability

where S0 is the initial cross-section area of a specimen at the notch position, [mm2].

For longer specimens, the specific energy is determined as shown below:
(2)

$$E = \frac{1}{S_o}\left(\frac{h_o}{h_{6t}} \int_0^{\Delta_{pl}^{max}} P(\Delta_{pl})d\Delta_{pl} + \int_{\Delta_{pl}^{max}}^{\Delta_{pl}^{fract}} P(\Delta_{pl})d\Delta_{pl} \right)$$

where h0 is the initial length of a specimen,
h6t is the length equal to six initial thicknesses.

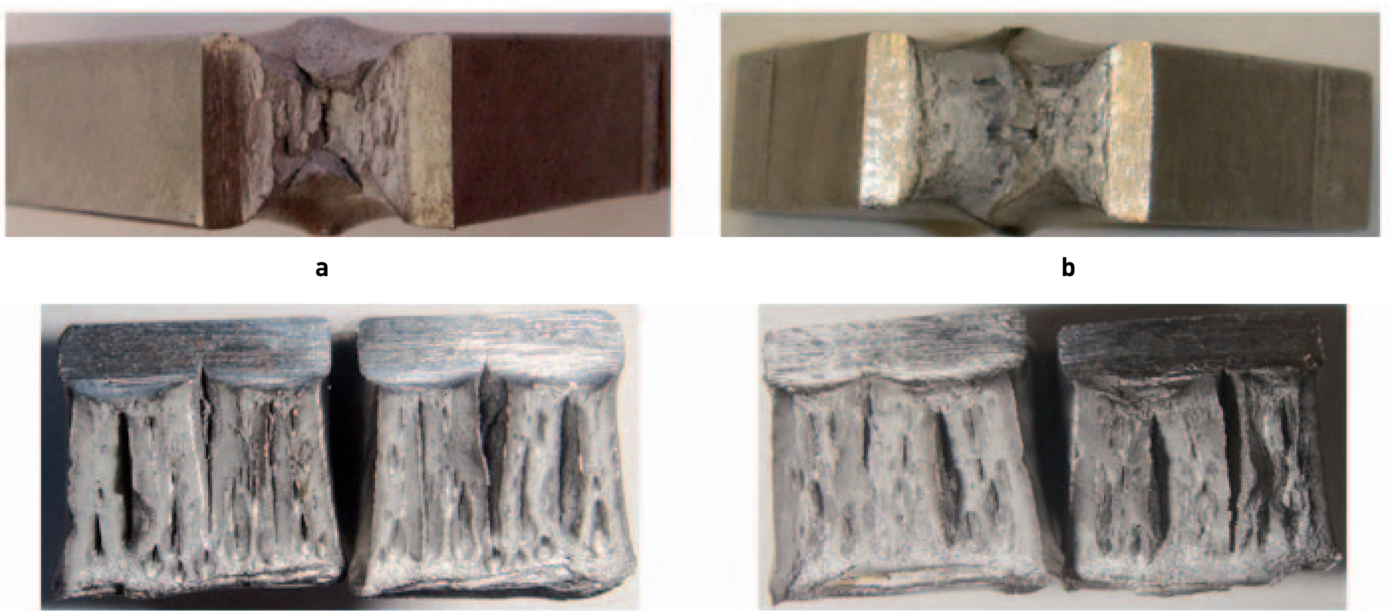
Equation (2) suggests that non-uniform deformation localized only in volume of length equal to six thicknesses (H=6t).

Specific energy values of Steel # 1 and Steel # 2 are 410 and 365 J/cm2, respectively. The difference between the two is thus quite significant and consistent with the full-scale burst test.

Obviously, the specific fracture energy cannot be the general ductility criterion in this case, at least due to the fact that it depends on the specimen geometry.

In the ideal case the resistance to ductile fracture should be evaluated on a sample in which the plastic strain zone ahead of the crack tip would form completely and would not change during the test. It is not possible to create such conditions in case of notched plate test. Nevertheless, this test showed the difference between the resistance to ductile fracture propagation of steels with similar mechanical properties. At the same time all the necessary equipment for this test can be found in most laboratories for mechanical testing.

The second method for evaluating the resistance to ductile fracture propagation is based on modified Charpy test. The essence of the test lies in pre-straining of a template from which standard Charpy specimens are made. The template is subjected to cold plastic deformation to achieve certain amount of strain. After that standard transverse Charpy specimens are machi-



a b c d

Figure 12: Fracture surfaces of Charpy samples of steel#1 (a, c) and steel#2 (b, d) after 0% (a, b), 25% (c), and 5% (d) pre-strain

ned from the template and standard Charpy tests are performed.

The pre-straining of templates nominally models the straining ahead of the ductile crack tip. The subsequent evaluation of Charpy energy shows the change in ductility of steel after plastic deformation.

Templates deformation was done by compression at room temperature with 5% step. Charpy tests were performed at minus 10°C which corresponds to the full-scale burst test temperature.

The Charpy energy dependence on the amount of pre-straining is different in steels #1 and #2 (Figure 11). In steel#2 a significant drop in toughness occurs already after 5% of pre-strain while in steel #1 the drastic change in toughness appears only after 25% of pre-strain.

The toughness drop is accompanied by extensive formation of brittle separations with overall fracture behavior remaining ductile. Also, after the toughness drop the complete fracture of Charpy samples can be seen (Figure 12).

Proposed test methods are in a good agreement with the full-scale burst test results and can be used for prediction of ductile crack arrestability of X80 steels.

5 Conclusion

Full-scale burst tests of X80 grade Æ1420 mm pipes have shown that:

- Ductile fracture resistance depends on plastic strain capacity. Conventional mechanical tests should evaluate this property of steel.

- Separations negatively affect the resistance to ductile fracture propagation in X80 steel pipes.

High separation intensity in studied steels was caused by pronounced morphological anisotropy of the microstructure exhibiting long prior austenite grain boundaries parallel to the rolling plane with rotated cube orientation along them. A high density of cleavage planes parallel to the rolling plane, i. e. sharp {001}<110> texture, does not necessarily lead to high separation intensity in X80 steels. In-depth study of the transformation texture formation mechanism in the case of heavily pancaked austenite is necessary.

Suggested mechanical tests – tensile test of notched plate and Charpy test of pre-strained base metal of pipe, simulate ductile fracture propagation process and estimate fracture resistance of X80 steels without extra equipment. The two test procedures are included in Gazprom Recommendations [14].

Acknowledgments

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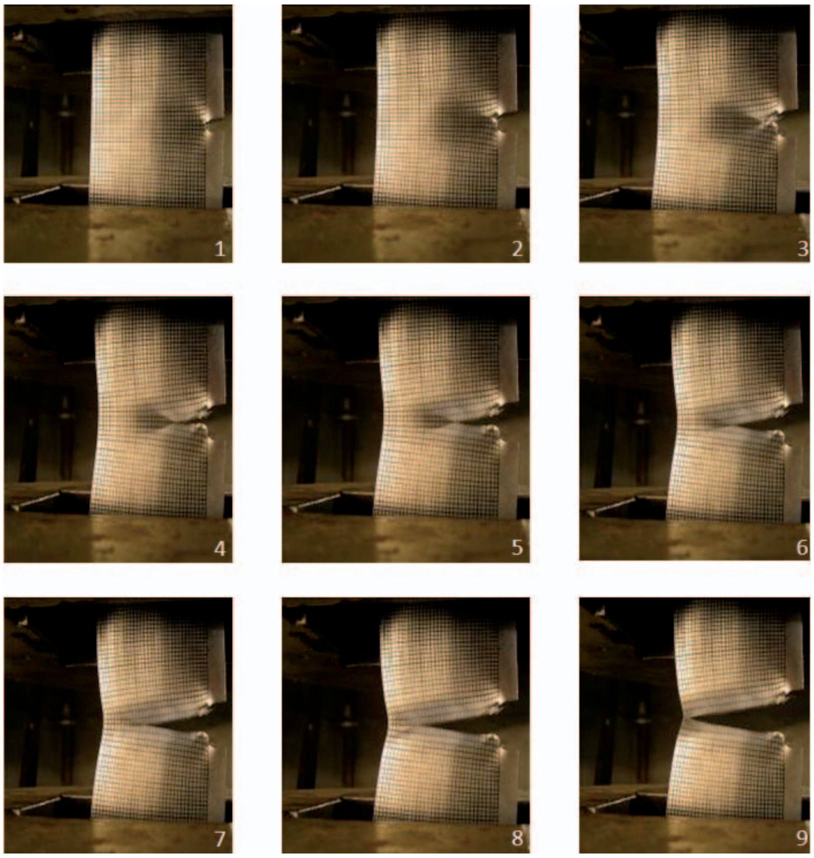
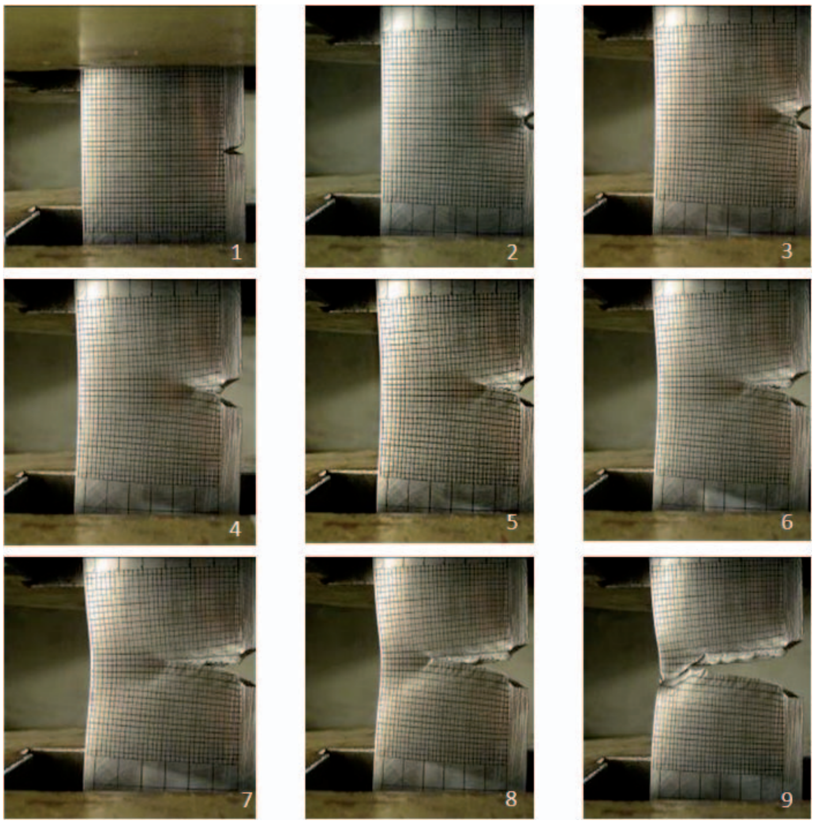


Steel #1



Steel #2

VIEW OF A PIPE MANUFACTURER TO THE DEVELOPMENTS FOR LINEPIPE MATERIAL

C. Kalwa and H.-G. Hillenbrand
EUROPIPE GmbH, Mülheim, Germany

ABSTRACT

Pipeline systems are the safest and most effective means for continuous gas transport to link gas sources and users at medium distance. The fact that these gas sources are more and more located in remote regions with harsh environmental conditions and contain in certain cases corrosive gas portions results in the development of tailored linepipe material that keeps pipeline transport still the most economic way.

This paper gives an overview about EUROPIPE's development activities to cope with the challenges from the operational necessities. Exemplified by recent and future pipeline projects the paper presents developments covering strain based design material, sour gas resistant material, deep sea designed pipes, crack arrest properties and arctic conditions, as well as optimising manufacturing to high pro¬duc¬tivity with a high quality level. The paper gives an outlook to the topics to be solved at the interface material and design.

1 Introduction

The exploration of remote natural gas fields results in the fact that pipe line designers are faced with challenging conditions. The design for deep sea lines has to consider the high external pressure; arctic sources require low temperature design; gas impurities like H2S need to find solutions for corrosion resistance; ground movement implies new design criteria for a safe pipeline operation; cost and handling limits may result in considering high strength steels for the pipeline design. Over all the detail aspects the economic premise rules for building and operating pipelines to transport gas on the long term safely and cost effective to the consumers. Advanced design requires more and more sophisticated pipe material. Pipe manufacturers have to be ready with their solutions for the new design criteria or at least open to cope with the requirements coming up. EUROPIPE has put much effort in research and development to give ready solutions to the market or have a good status to develop further. The main focuses identified from the market are

- sour gas resistant material to transport H2S containing gases,
- collapse resistant pipes for deep sea use,
- strain based design material for pipelines that are exposed to regions with ground movement,
- pipe material resistant to long running ductile cracks and
- low temperature toughness material to be used in arctic conditions.

The material design has to fulfil various requirements considering properties for design as yield to tensile ratio (Y/T) and fracture elongation in the tensile test or CVN toughness and crack arresting in DWT tests. Also weldability for longitudinal seam weld and girth weld has to be guaranteed with sufficient toughness properties in the heat affected zone (HAZ). For application with corrosive gas a certain level of corrosion resistance has to be achieved. Those properties are not only dissimilar but they interact. For the weldability of the pipes the engineers ask for low carbon equivalents (CE) but they need high strength and a low Y/T as well. The toughness requirements Charpy V Notch toughness (CVN), i.e. 50 J @ -30°C, and Drop Weight Tear (DWT) 85 % shear area @ -10 C interact strongly; low carbon steels exhibit excellent CVN toughness with limited DWT shear area ratios. The HAZ toughness may be achieved by expensive alloying approaches those are quite often in conflict with the DWT properties and the low CE as well. Additionally some initial mechanical properties from the pristine pipe may change slightly during heating due to the coating process.

2 SOUR GAS APPLICATION

More and more pipeline design has to consider hydrogen sulphide contents in natural gas. Though the natural gas is dehydrated and gets inhibitors added breakdowns of such equipment cannot be excluded. For this limited periods material has to resist corrosion attack by humid and H2S containing gas.

In the usual procedure the pipeline designer considers testing rules from National Association of Corrosion Engineers as NACE TM 0177 for Sulphide Stress Cracking (SSC) and NACE TM 0284 for Hydrogen Induced Cracking (HIC) to be fulfilled during procedure qualification and production tests. The defined test solutions in these rules are very conservative to real conditions in terms of pH-value (down to 3.0) and H2S partial pressure (up to 1 bar).

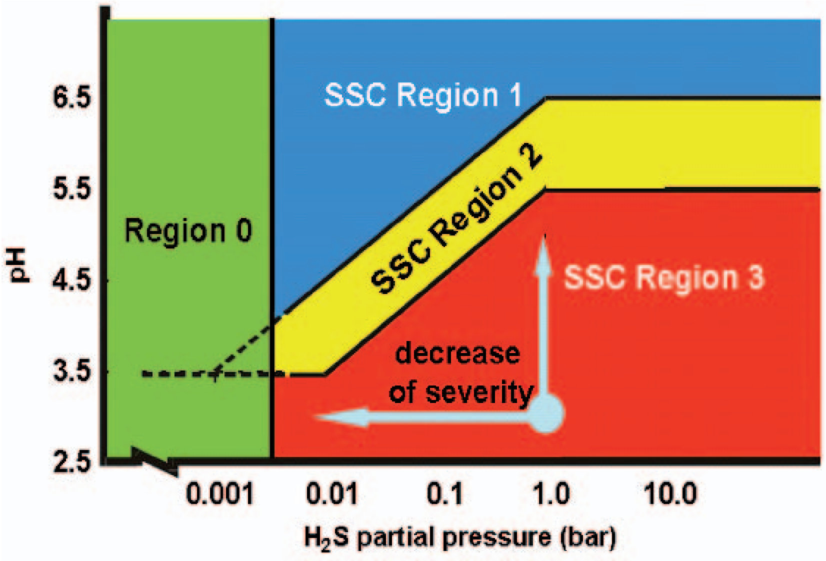
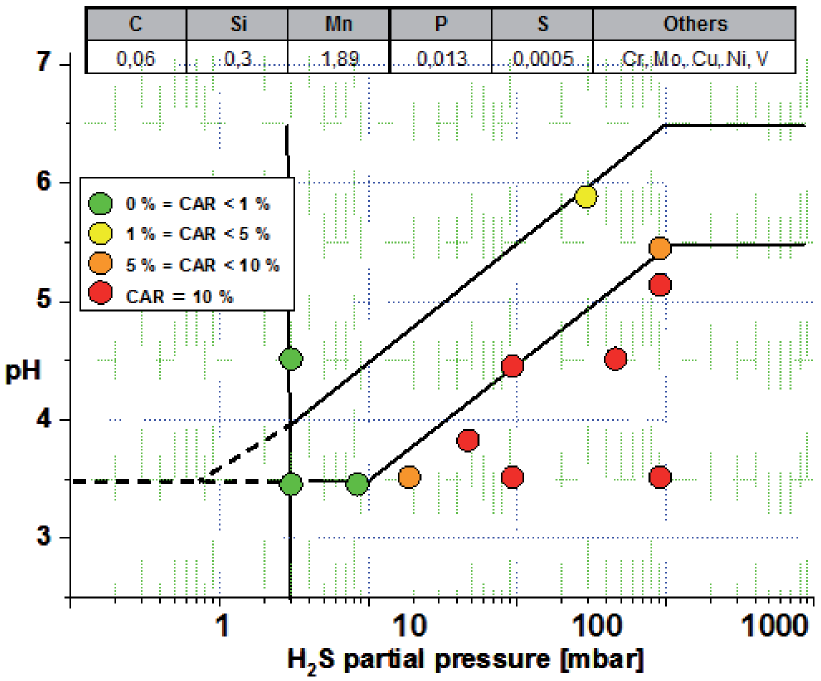


Figure 1: Severity regions for SSC



C	Si	Mn	P	S	Others
0,06	0,3	1,89	0,013	0,0005	Cr, Mo, Cu, Ni, V

Figure 2: Severity diagram for X80 level grade (48" ODx18.9 mm WT)

These severe test conditions can be met only with special procedures and alloying concepts to achieve high levels of steel purety. Elements that tend to form precipitates or are prone to segregate as Carbon, Manganese, etc. have to be limited since those areas are trapping hydrogen and lead to hydrogen recombination. Having this in mind, material design has to abandon hardening effects by these elements that leads finally to the exclusion of higher strength grades above grade X 65 (L450). In parallel the available grades have to be alloyed with more expensive alloying systems as e.g. CuNi which raises the costs for pipeline material to achieve the required strength levels. The development to higher strength sour grades above X65 is a continued effort of EUROPIPE and is ongoing with success but within limits concerning pipe geometry and further properties.

In many cases the procedure of standard solutions for HIC and SSC testing is over conservative. ISO 15156-2 [1] has identified regions of SSC severity on a pH value – H2S partial pressure diagram (Figure 1) for all pipeline material grades. For Region 3 severe SSC testing is mandatory; Region 1 and 2 needs to be tested under adapted conditions; Region 0 requires no SSC testing.

In terms of HIC testing no procedure like the ISO 15156-2 exists. EUROPIPE has performed numerous HIC tests on steel grades with different purity levels. The tests were performed with different severity levels in terms of pH and H2S partial pressure to draw such kind of diagram. The tests showed that the borders of the ISO SSC-diagram are different to the HIC behaviour of the steel material. In contrast to the ISO SSC diagram which is valid for all carbon steels the HIC behaviour depends on the grade, the chemistry and the formation of precipitates [2]. It could be shown that under specific severity conditions even X 80 level grades can be used (Figure 2).

The idea to consider a more realistic environment for material selection was used in the past by different clients. In the period between 2001 and 2003 EUROPIPE produced pipes for the Baku-Tiblisi-Ceyhan (BTC) project connecting the Caspian Sea with the Mediterranean Sea (Figure 3). The test condition for the 42"/46" X 65-pipe material with a wall thickness up to 25.4 mm was 0.5 bar H2S partial pressure in a buffered pH4.0 solution. The NACE acceptance criteria were fulfilled. The Ichthys project connecting the gas sources at the North West Australian shore with Australian mainland is planned to be realised in 2013 (Figure 4). For this project pre evaluation of material was performed in 2010 with respect to fit for service sour gas conditions. The use of X 65 or X 70 level grades for the 42" pipes with wall thickness being 29.6 mm or 27.6 mm respectively is considered for this project. We could show that the NACE requirements were met during HIC tests with 0.02 bar H2S partial pressure and pH4.5 after 28 days long term loading.

The Fit for Sour Service idea enables the pipeline designer to consider higher grades by an economic i.e. alloying element reducing solution. Standardisation bodies as e.g. API are starting to implement such modified severe conditions into there activities.

If operational frame conditions do not allow reducing

Figure 3: Baku-Tiblisi-Ceyhan pipeline project X65 (42"/46"; WT up to 25.4 mm)

severity levels pipe manufacturers have to provide material that are resistant for full sour applications even for grades higher than X65. For this application EUROPIPE developed in close co-operation with its pre-material fabricators solutions on X70 and X80.

Trials were performed on pipes with 20" OD x 19.1 mm WT. Those showed that mechanical and corrosion requirements with respect as well to HIC as to SSC could be fulfilled even at pH3 solutions with partial pressures at 1 bar (NACE TM 0284 Solution A).

The chemistry of this material is shown in Table 1. Besides fulfilment of the requirements to pipe material girth welds with high and low heat input were tested with a comprehensive testing programme. With respect to corrosion SSC-test were carried out, for mechanical testing besides tensile characterisation CVN toughness and CTOD was tested in the HAZ. All tests showed good results even after cold deformation up to 1.2%.

The use of higher strength sour gas resistant steels was triggered by the Brazilian Presalt Project (Figure 5) where deep sea offshore gas fields are linked with the Brazilian gas infrastructure. It promises reducing costs significantly by reducing the required wall thickness.

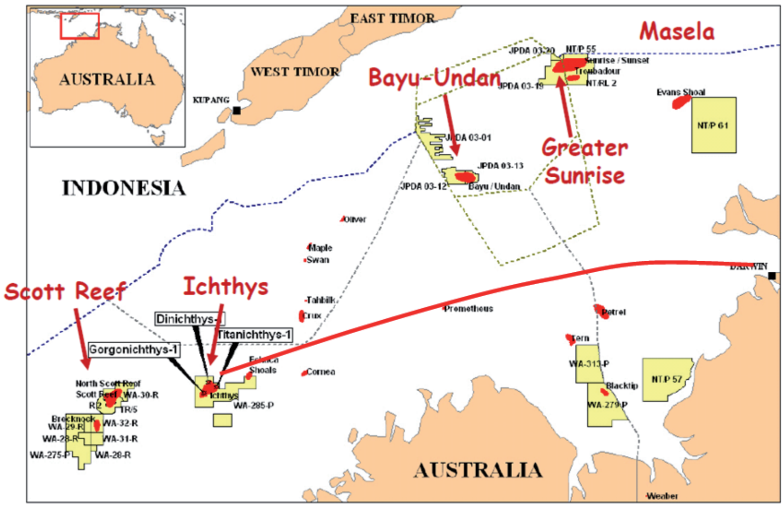


Figure 4: Ichthys project X65 or X70 (42"; WT 29.6 mm or 27.6 mm)

X70; 20" x 19.1 mm
Chemistry

C	Mn	Si	P	S	Others
~0.05	>1.5	~0.3	.011	.0005	Cu, Ni, Cr, Nb, Ti

X80; 20" x 19.1 mm
Chemistry

C	Mn	Si	P	S	Others
~0.05	>1.5	~0.3	.011	.0005	Cu, Ni, Mo, Cr, Nb, Ti

Table 1: Chemistry of X70 and X80 pipe material

Figure 5: Brazilian Pre-Salt Project (source: mercopress.com)

1 DEEP SEA APPLICATION

Deepwater pipelines are exposed to ambient hydraulic pressure and associated bending during pipe laying. In order to encounter pipe collapse, pipes with a lower diameter to thickness ratio (D/t) as well as higher strength materials up to X70 are used for these applications. Besides enhanced require¬ments to ovality [5], the collapse resistance is mainly controlled by the compressive stress-compres¬sive strain behaviour in circumferential direction.

For deepwater applications usually pipes produced by the UOE process were used. But, the cold forming operations during the UOE pipe manufacturing process and subsequent anti-corrosion coating may significantly alter the characteristic stress-strain behaviour of parent plate material [6]. The final production step of the UOE process, the cold expanding, will lead to some reduction of compressive yield strength and therefore to a reduction of collapse pressure.

In accordance with DNV-OS-F101 the resistance for external pressure (pc) can be calculated as follows: (pc-pel)(pc² - ppl²) = pc pel ppl f0 (D/t) with

pc	collapse pressure
pel	elastic share of collapse pressure
ppl	plastic share of collapse pressure
D	outer diameter
t	wall thickness
f0	out of roundness
	pel = function (Youngs Modulus, Poisson Ratio, D, t)
	ppl = function (αfab * yield strength, D, t)
	αfab fabrication factor

This means, that the "plastic" collapse pressure, and therefore the collapse pressure, increases if the yield strength and fabrication factor increase as well.

Based hereon the challenges for deep sea line pipe applications to a pipe manufacturer can be derived, which are geometric and strength requirements.

Pipes manufactured by the UOE process will show an excellent ovality, but, due to the Bauschinger effect [7], a reduction of the yield strength and a consequently a degradation of the collapse pressure is observed after the cold expansion process. This is recovered in the fabrication factor, which is set to 0.85 for UOE-pipes. However, thermal aging, as applied during a coating process, increases the compressive yield strength and consequently compensates the drop of the strength caused by the cold expansion. Admittedly, the fabrication factor may be increased by a thermal treatment or external cold sizing [5].

This is shown by a series of collapse pressure tests carried out in the thermal treated and in the as welded condition.

Figure 6 indicates an increase of the collapse pressure in the thermal treated condition up to 36 % in comparison to pipes in the non thermal treated condition. Considering the earlier data, the increase of the collapse resistance is more than 18 %, which compensates more than the downgrading caused by the fabrication factor of 0.85 [6].

In a further step, the results of the experimental collapse tests were compared with the predictions calculated to the DNV equations. For this, the collapse pressure was calculated with different approaches of yield strength:

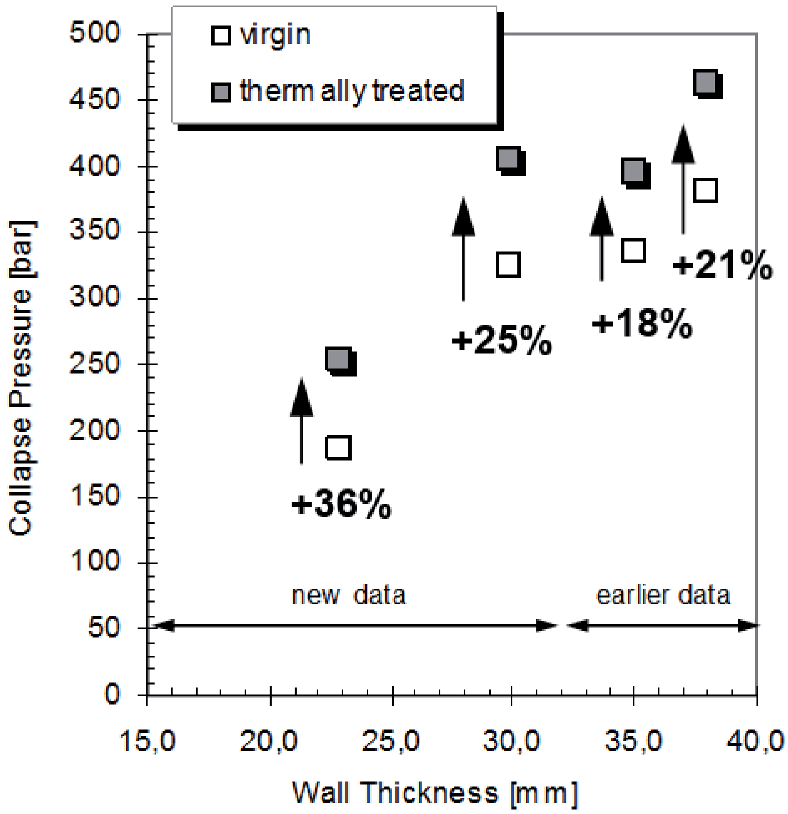


Figure 6: Increase of collapse pressures in the sequel of thermal treatment in the range of 200 – 240 ° C

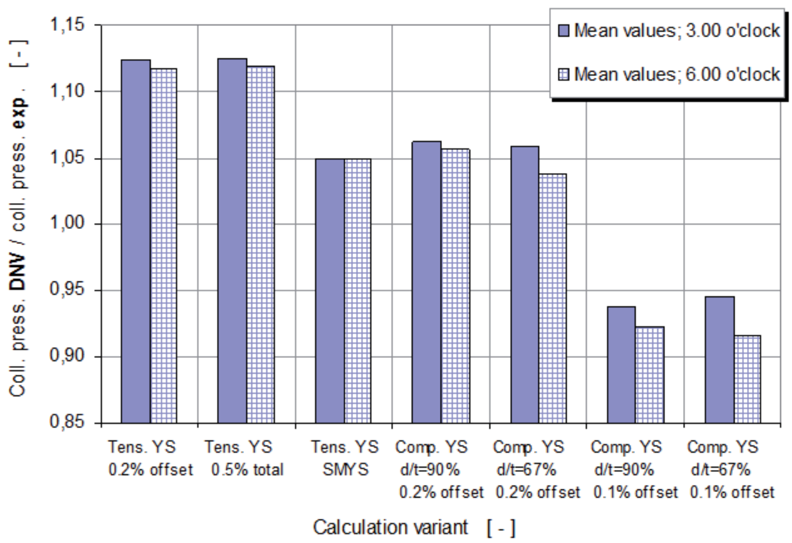


Figure 7: Collapse pressure prediction according to DNV equation (virgin pipes)

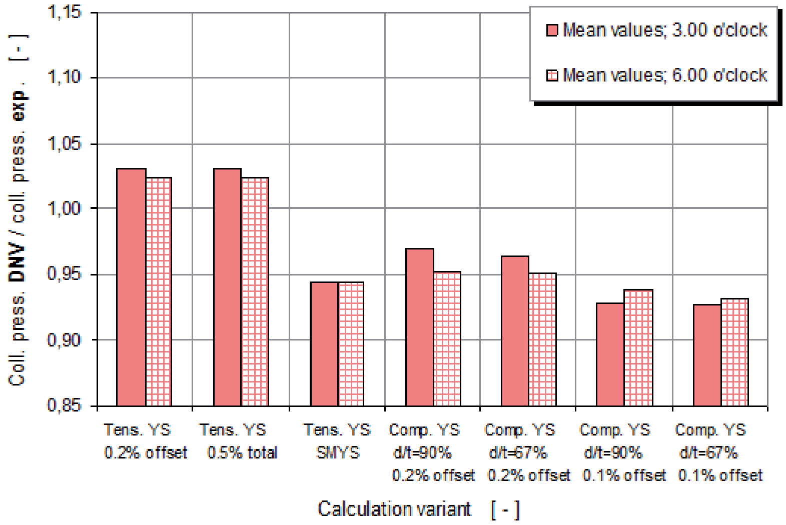


Figure 8: Collapse pressure prediction according to DNV equation (pipes in thermally treated condition)

- Calculation of the collapse pressure based on the compressive yield strength with 0.2 % offset shows that the predictions, independent from specimen diameter, are on the non-conservative side for the virgin pipes. If the calculation is based on the compressive yield strength with 0.1 % offset it can be seen, that the prediction is on the over-conservative side.

- Contemplating the calculations using compressive yield strength for the thermal treated pipes the predictions are always on the conservative side.

Summing up, a conservative prediction of collapse pressure of pipes in the thermally treated condition under following preconditions is achieved:

- Tensile yield strength defined at 0.2% offset strain (Rp0.2)

- Tensile yield strength defined at 0.5 % total strain (Rt0.5)

- Specified minimum yield strength (SMYS)

- Compressive yield strength defined at 0.1% and 0.2% offset strain with specimen diameter of 67% and 90% of wall thickness

The sampling of the specimens was performed at the 3 o'clock and 6 o'clock position of the pipe.

In Figures 7 and 8 the ratio between the DNV predictions and the corresponding results of the collapse pressure experiments are shown. For the calculation of the collapse pressure the fabrication factor was set to 1.0 for all cases to examine the pure influence of the considered yield strength.

On a closer examination of these figures the following observations were revealed:

- Values below 1.00 reflect conservative prediction of collapse behaviour

- The DNV prediction based on measured yield strengths overestimates the collapse pressure in all cases. Calculations based on results from specimens taken from the 3.00 o'clock position show slightly higher collapse pressures than those taken from the 6.00 o'clock position.

- The calculation for the virgin pipes based on SMYS shows an overrating of 5%, whereas the application of thermal treatment leads to a conservative prediction.

- Aging temperature ≥ 200 °C

- Measured compressive yield strength (0.2 % plastic offset) is utilized

- Sampling in the 3 or 6 o'clock position

- Specimen size 90 % or 67 % of wall thickness, respectively

Therefore, the fabrication factor specified by DNV has to be increased due to thermal treatment of pipes as usually applied during the pipe coating process. However, there are some other effects, e.g. plastic strain applied during forming, which influence the compressive strength behaviour. But this will be subject to future research activities.

4 PIPES DESIGNATED FOR STRAIN BASED DESIGN

If pipelines are located in areas where longitudinal displacement is expected the line is designed "Strain Based". The causes for such displacements may result from frost heave and thaw settlement in non permafrost regions or from land slides in sloping landscapes or from earthquakes in seismic active regions. The pipes shall then be able to suffer longitudinal strains in such a way that the pipe dislocates the amount of strain by work hardening over a longer distance. The requirements to the pipe material are specified uniform elongation and in some cases special shapes for the stress strain curve from longitudinal tensile tests. A proper overmatching of the girth welds shall prevent the system from localising high amounts of strain to the weld material.

In close co-operation with its plate deliverers EUROPIPE developed pipe material that was designed for this spe-

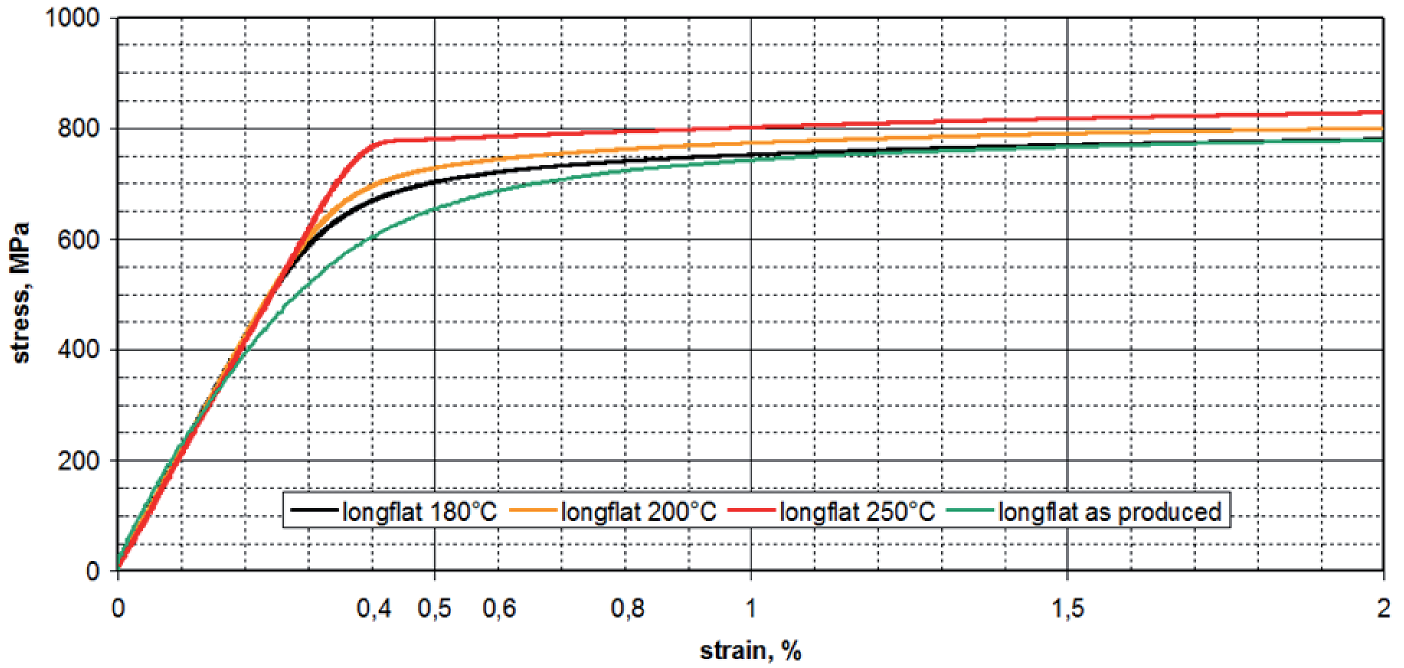


Figure 9: Stress-Strain Curves of X100 pipe material after different coating temperature simulations

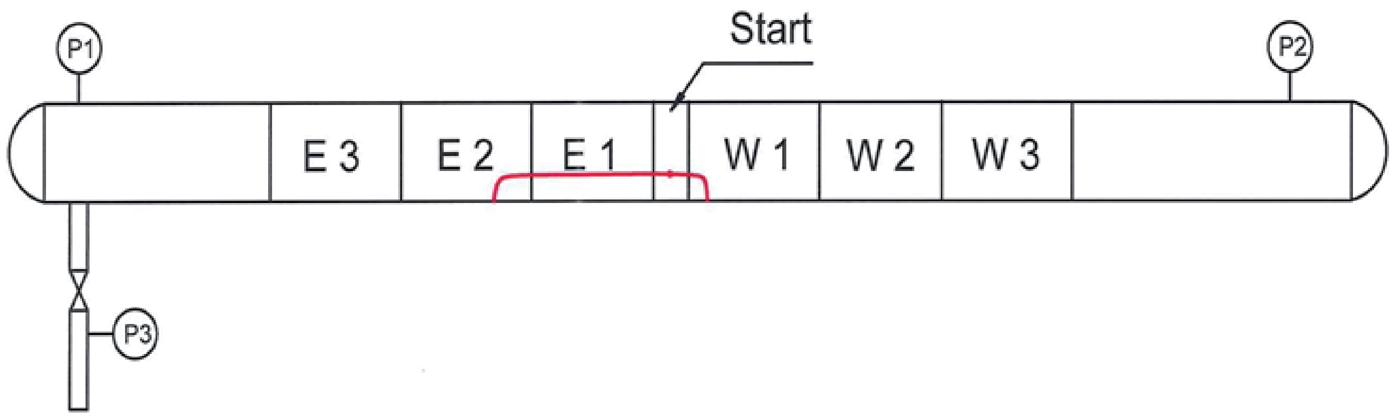


Figure 10: Test setup and crack propagation for the full scale burst test at Chelyabinsk site

cial purpose. Besides the base material properties in as formed condition, the pipe material's behaviour in the coated condition is important. The coating of pipes is performed in a temperature range between 180°C and 220°C depending mostly on the coating type (FBE or 3 layer HDPE). These temperatures influence the steel behaviour in tensile tests significantly. Figure 9 illustrates the stress strain behaviour of X100 pipe material with the simulation of different coating temperatures. The curves for temperatures up to 200°C are continuous whereas the curve at 250°C appears as slightly discontinuous.

5 CRACK ARRESTING PIPES

The production of high strength pipe, i.e. pipes with minimum yield strength of 550 MPa and above, is nowadays standard as long as the requirements are merely according to EN 10208-2 [3], API 5L [4] or equivalent. Along the way of using X80 pipes for onshore projects worldwide, the requirements have been steadily raised. With the tendency to enhancing the usage factor for gas pipelines in combination with the big volume of large diameter pipes crack arrest is playing an important part in pipeline and material design.

A safety concept has to consider that if a ductile crack is accidentally for any reason initiated it does not propagate uncontrolled but is arrested. There are two main measures to ensure that a ductile fracture can be stopped:

- By the use of crack arrestors that are pipe joints with reduced usage factor e.g. by higher wall thickness or fibre enforced resins or
- By pipe material that provides sufficient toughness.

For the latter the Batelle Institute in USA developed a two curve approach that considers the velocity of a ductile crack and the velocity of gas decompression resulting in deloading of the crack tip. The crack velocity is dependent on material toughness for which a relati-

Figure 11: Crack arrest in a test pipe

C	Mn	P	S	Nb+V+Ti	Mo+Ni+ Cr+Cu	Ceq(IIW)	PCM
<0.08	>1.6	<0.02	<0.003	<0.15	>0.6	<0.45	<0.23

Table 2: K65 Steel composition (wt.-%)

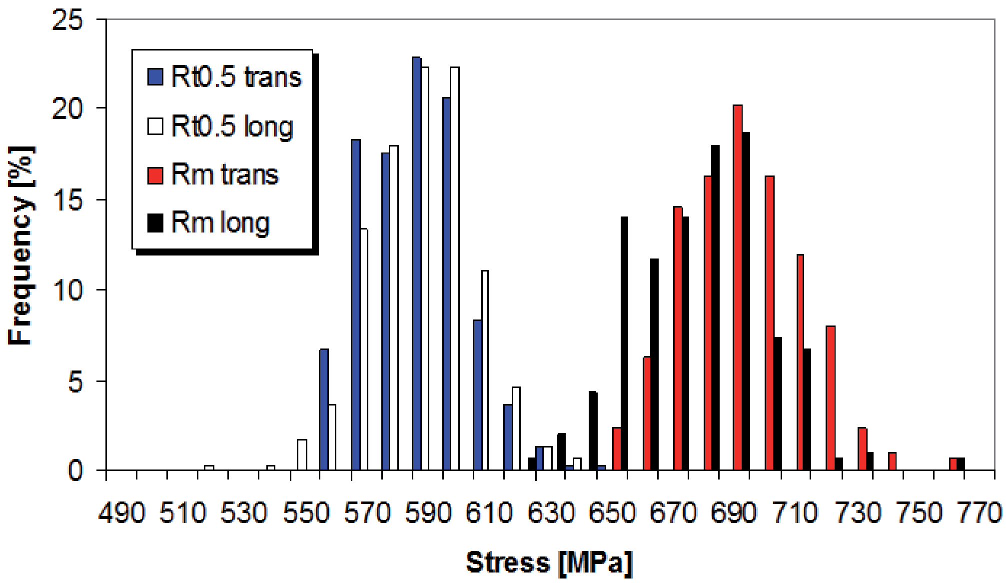


Figure 12: Statistics of tensile properties of OD 56" x 27.7 mm K65 production

onship to CVN toughness was determined empirically. The model of the two curve approach is predicting crack arrest well when grades up to X70 are used. For higher grades full scale burst tests turned out that the basic approach has to be modified. Then full scale burst tests with an initiated ductile fracture has to be carried out to verify the sufficiency of the required toughness level.

This costly procedure was done for the Russian project Bovanenkovo-Ukhta which requested for the grade K65, a Russian type of grade X80. The pipe dimensions are impressing with 56" diameter and 27.7 mm wall thickness. Figure 10 schematically illustrates the test set up with an initiation pipe (Start) six test pipes (E1 to E3 and W1 to W3) and pressure reservoirs at both ends. The test was performed at Chelyabinsk site at 150 bar pressurised air and -10°C. The pipe was partially buried. The requirement to the test was arresting the crack within the three test pipes after the initiation. The fracture was stopped in the first pipe on one side and the second pipe on the other side (Figure 11).

After fulfilling the requirements of the full scale burst test EUROPIPE produced for this project a great quantity of pipes of the grade K65 with the dimension of 56” OD with 27.7 mm wall thickness. The composition used is indicated in Table 2.

Whereas a standard X80 requires an ultimate tensile strength (UTS) of 621 MPa, the K65 specification asks for minimum 640 MPa. Furthermore, tensile testing in longitudinal direction is required, too. However, the yield strength (YS) level is reduced to minimum 500 and 555 MPa, respectively. Figure 12 summarizes the tensile test results for the longitudinal and the transverse direction of more than 300 heats tested for the initial part of the production.

The average yield strength was 584 and 586 MPa in transverse and longitudinal direction, respectively. Only a few values in longitudinal direction were within the range of 520 to 550 MPa whereas their majority was above the more stringent requirement of the transverse direction. The mean UTS in transverse direction was 687 MPa. The transverse to longitudinal anisotropy of UTS is roughly 15 MPa and is more pronounced concerning the minimum values tested.

Since the pipeline will be laid in the tundra with arctic temperatures, the specification is asking for low temperature toughness as well. The CVN test temperature was -40 °C with a minimum requirement of 150 Joule for absorbed energy for the base metal. The CVN statistics is presented in Figure 13 on the left. Only a few values are below 200 Joule and the results document that the upper shelf is reached.

The fracture toughness of the weld seam exhibit a similar behaviour but the upper shelf energy is merely 200¬ Joule compared to 300 Joule for the base metal. The temperature transition curve of the CVN energies in the weld seam is illustrated in Figure 6 on the right. The transition temperatures as well as the upper shelf energies are similar for testing at the outer seam, inner seam and root area, respectively. The toughness in the heat-affected zone is declined towards the fusion line.

The largest challenge has been the Battelle Drop Weight Tear testing (DWT) since the test temperature is -20 °C with a required minimum shear area of 75 and 85 percent for single and mean value, res-

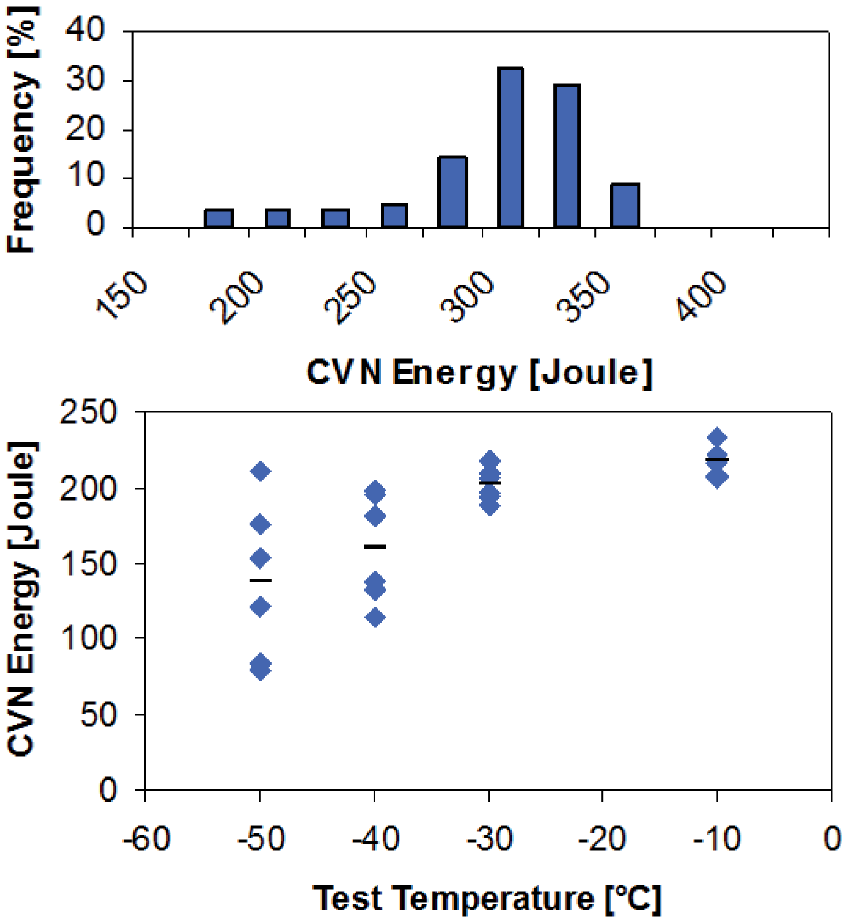


Figure 13: Statistics of base metal Charpy V @-40°C and transition curve of weld metal Charpy V of 27.7 mm WT K65 production

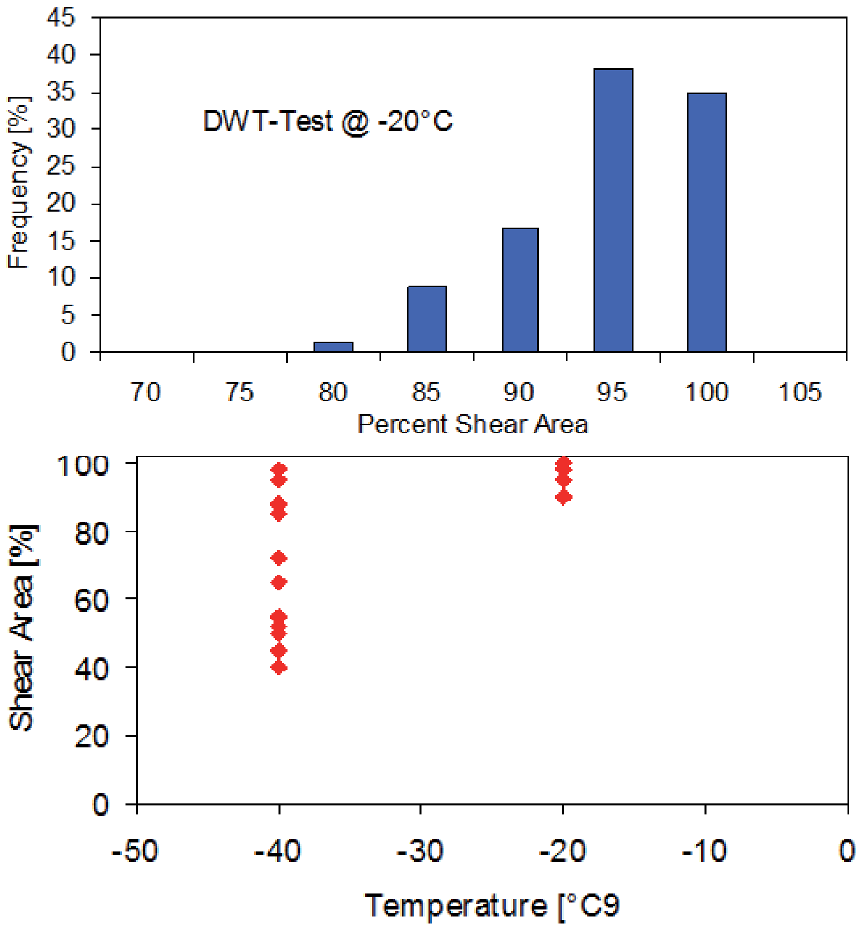


Figure 14: Statistics and Transition curve of DWT Test of OD 56” x 27.7 mm K65 production

pectively. During the qualification of the K65 production even instrumented DWT tests had to be performed. It could be demonstrated that the non-instrumented DWT test work well as release test for produc¬tion as long as the shear area fraction is not borderline. The transition temperature, i.e. the tempera¬ture that compares to 50 percent shear area, of the pipes produced is far -30 °C. The test re¬sults from production tests are given in.

6 ARCTIC APPLICATION

The results from the K65 production have been the basis for the development of pipe material tuned for arctic applications. Customers require pipes for service temperature of -40 °C and below. The design for the K65 allows some minor modifications in order to reach DWT transition temperatures far below 50 °C but not in K65 grade. The tentative steel composition is given in Table 3.

The steel compositions is leaner than for the K65 project but the alloy content is still significant and the key to fulfil arctic requirements.

For a compressor station at gas in feed into the Nord Stream pipeline two different items in X70M grade were produced. The dimensions have been 812.8 mm OD x 32.5 mm WT and 609.6 mm OD x 29.3 mm WT, respectively. The later item exhibited ´arctic´ properties since a lowest design temperature of -40 °C was demanded. The tensile test requirements and their test results are given in Table 4. They have been reached easily and will not been further discussed in this paper.

The uniform elongation in longitudinal direction was for information only with all values above 6.0 percent. The more exiting property is the low temperature fracture toughness and in particular the results of DWT testing.

The customer specified DWT testing and CVN testing @ -40 °C. The latter is these days still a challenge but reachable by means of common measures like reduction of carbon and manganese contents and strict limitation of impurities as long as merely the base metal is concerned.

The plate rolling parameter as well as the pipe forming was optimized for arctic grades. The DWT testing was performed with full-size specimen @ -40 °C and with to 19 mm thickness reduced samples and a test temperature of -57 °C. Both results are shown in Figure 15 and no difference was marked.

The DWT transition temperature was established to be below -60 °C for full-size samples. All results @ 40 °C are unambiguous above the requirement of 75 percent shear area. The subsequent question was whether the weld seam toughness and especially the HAZ toughness follow suite the excellent result for crack resistance. The CVN toughness 2 mm below the outer surface (designated OD) and in the root area (designated Root) were tested. The distribution of the CVN energies vs. the frequency of results is given in Figure 16. The results illustrate that the chosen welding consumables led to manageable properties in the weld metal. The outer weld area exhibit slightly higher energies compared to the root area. The inside weld was tested as well and revealed similar results as the outer weld. The heat affected zone (designated FL) gave a wider distribution of CVN energies from merely 2-digit CVN energies up to 350 Joule. The notch was positioned according to API 5 L as close as practical to the fusion line.

C	Mn	P	S	Nb+V+Ti	Cu+Ni+Cr	Ceq (IIW)	PCM
<0.07	>1.6	<0.02	<0.003	<0.15	>0.6	<0.42	<0.21

Table 3: X70 ‘arctic’ steel composition (wt %)

flat rectangular trans (long)	Requirements		Test Results	
	Min.	Max.	Min.	Max.
YS [MPa]	485	605	495 (505)	503 (525)
UTS [MPa]	570 (545)	690 (665)	588 (572)	612 (591)
A5 [%]	19.0	./.	20.5 (23.5)	27.0 (27.5)
Y/T	./.	0.90	0.81 (0.87)	0.87 (0.89)

Table 4: Tensile Strength Properties of X70M ‘arctic’. The values in parenthesis are for longitudinal direction.

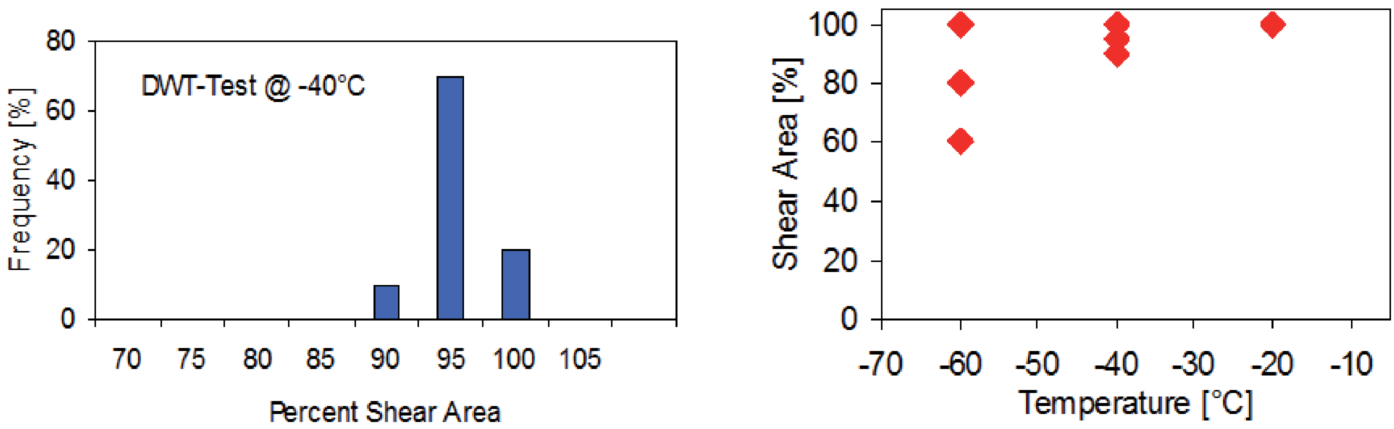


Figure 15: Statistics and Transition curve of DWT Test of OD 609.6 x 29.3 mm X70M production

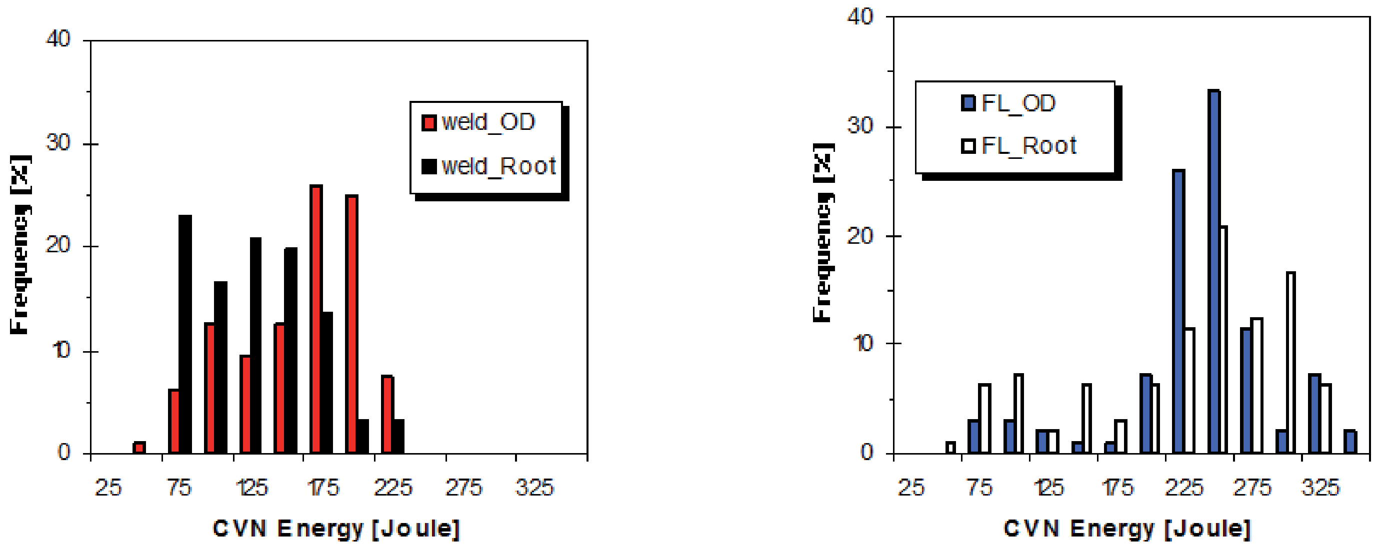


Figure 16: Statistics of CVN Test results @ -40°C of OD 609.6 x 29.3 mm X70M production

7 CONCLUSION

It can be concluded that EUROPIPE is prepared for the challenges of the pipeline industry. The given results demonstrate the ability to react flexibly on market demands and perform modification in the pipe steel design even on short notice.

In the area of fit for service pipeline material for mild and slightly sour media the pipeline industry must not surrender on higher strength grades as long as pipe material with sufficient resistance against corrosion attack can be supplied. Furthermore, the test lab is able to adjust almost every combination of pH value and H2S content. For higher sour gas severity X70 and X80 can be provided.

The DNV rules discriminates the UOE pipe against other pipes due to the recommended low fabrication factor. It could be demonstrated that UOE pipes in service condition, i.e. after coating including the accompanied heat treatment, achieve the necessary collapse resistance. The compression test describes the collapse behaviour adequately with enough conservatism.

For areas with high probabilities of dislocation strain based design has to be considered. Pipes with defined longitudinal tensile properties with respect to stress strain curvature and uniform elongation could be produced.

The high strength grade X80 is established and several hundred thousands of tons have been produced. This grade may be optimized on customer demands for particular requirements, e.g. high toughness at low temperature or large uniform elongation. Crack arrest in high strength steels requires besides the definition of high toughness levels a closer look to the behaviour in full scale burst tests. It could be demonstrated that crack arrest could be achieved within pipes closely after initiation of a ductile fracture.

The emerging developments of the low temperature base metal properties are auspicious. The largest challenge so far is the CVN toughness in the HAZ of the submerged arc weld, even though the relevance of the HAZ toughness is merely marginal.

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INTEGRATED PIMS SUPPORTING AN OFFSHORE PIPELINE SYSTEM

Peter Baars, GDF SUEZ E&P Nederland B.V., The Netherlands
Matthias Lohaus, ROSEN Technology & Research Center, Germany

As an operator of around 1200 kilometer offshore gas (and some liquid hydrocarbon) pipelines as well as around 20 kilometer onshore pipelines in the Netherlands in the Southern North Sea, GDF SUEZ E&P Nederland B.V. has decided to implement a Pipeline Integrity Management System (PIMS) in order to support its existing and future operational, in-service and corporate needs with regard to the management of pipeline integrity.

The scope of the implementation involves various disciplines:

- Collection and integration of data
- Defect and corrosion assessment capabilities
- Assessment of inhibitor efficiency
- Interfaces to external systems
    - Maintenance & Work Order Management (IBM Maximo)
    - GIS (ESRI ArcGIS)
    - Drawing Control (Meridian)
    - Report & Document Management (Microsoft SharePoint)

The main aspect is the implementation of an enterprise pipeline database to support and manage all decision making activities. Besides the implementation of algorithms and regulatory requirements inside the analytical PIMS modules a main aspect is the definition of a Risk Model which will finally lead to an overall Integrity Management plan which is compliant to the Enterprise HSE Policy.

The stepwise approach of the overall project was a key factor to the streamlined execution of the project till todays stage. This presentation outlines the realization of the project, techniques and technologies implemented as well as the challenges alongside with it.

ABSTRACT

Figure 1: The GDF SUEZ E&P Nederland B.V. pipeline system

1 Introduction

Pipeline integrity management is a complex process involving different experts, departments, assets, procedures, data gathering, analysis and commercial consideration in terms of production, operations and maintenance costs. The primary objective of an integrity program is to ensure provisions are in place and effectively implemented to maintain the pipeline in a fitness-for-purpose condition and in a safe and effective manner. Nowadays, good industry standards are available to support logical and consistent approaches to many of the key processes of Pipeline Integrity Management (PIM). Available standards range from supervisory processes such as ASME B31.8S, AS 2885, DOT CFR 49 192, to specialized codes for defect assessment such as ASME B31G, API 579, BS7910, NORSOK M-605, DNV-RP-F101 and RSTRENG.

The Dutch regulations were driving the implementation for GDF SUEZ E&P Nederland B.V. For the transport of dangerous goods in pipelines the regulations oblige an effective Pipeline Integrity Management System which is able to demonstrate reliability and safe operation over the entire life cycle. The pipeline operator has to ensure that all external operations in the vicinity of the pipeline are monitored and managed.

However today, large amounts of information are generated and needs to be integrated during the integrity management process and software tools become a necessity to aid the engineer in its practical implementation. This includes essential elements such as effective data management, appropriate assessment tools, documentation of the integrity assessments conducted, an auditable record of the overall integrity management process, and incorporated rights management.

2 The Project

As an operator of onshore and offshore transmission pipelines (approx. 100 pipeline sections), GDF SUEZ E&P Netherland B.V. (GDF SUEZ) is performing extensive efforts on their integrity management program concerning this network. Since almost 40 years of data collection an extremely large amount of information is available in GDF SUEZ, which is in progress to be better organized and integrated into a software system. This

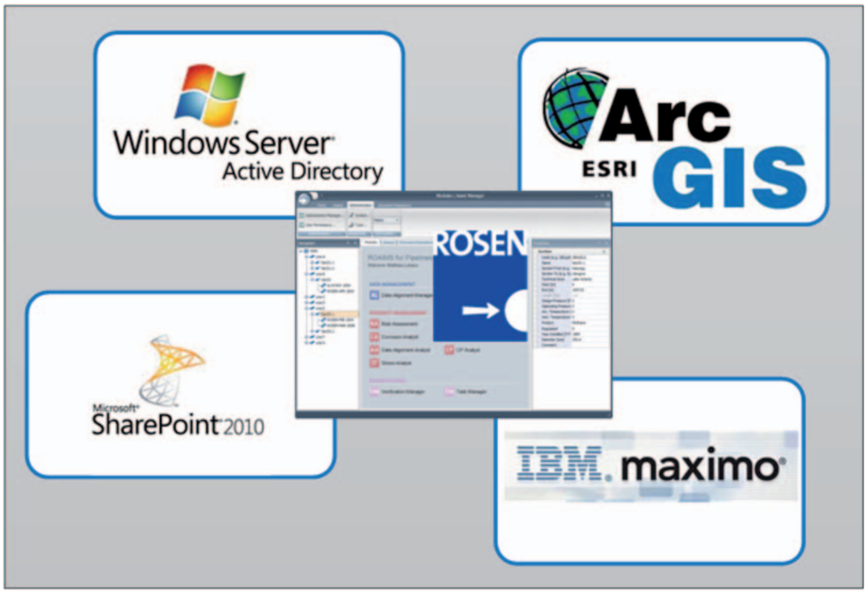

Figure 2: Required system connections

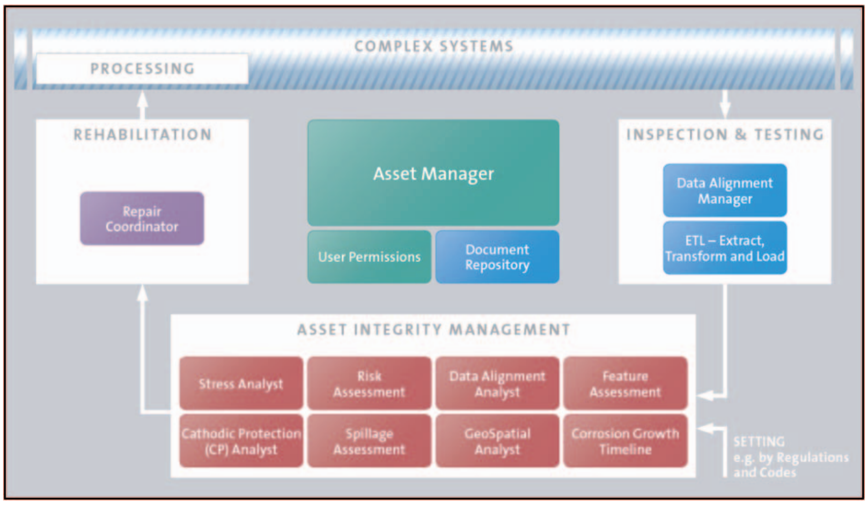

Figure 3: The different areas related to pipeline integrity management

shall finally allow for structured data management and have the data ready for analysis following various standards in the different disciplines of Pipeline Integrity.

In order to meet GDF SUEZ requirements, the ROSEN software solution ROAIMS (ROSEN Asset Integrity Management Software) was implemented. That solution is consolidating all information into a single Pipeline Open Data Standard (PODS) database and implementing the required engineering software modules to allow GDF SUEZ performing all requested analysis methods. Furthermore the interfaces to given IT systems, such as Microsoft SharePoint, IBM Maximo and ESRI ArcGIS were established as required.

An important and not common requirement from GDF SUEZ to the PIMS was to not only focus on technical integrity issues but also to deal with qualitative expert judgments to demonstrate HSE-compliance such as:

- Functionality of protections systems (Shut Down Valves, Pressure Relief Valves)
- Compliance with legal permits
- Monitoring Operating Envelope (Corrosion Inhibitor, Gas Quality)
- Compliance of External Safety Contours

As being long-term member of various industry organizations (e.g. Pipeline Operators Forum, NACE, PRCI, PODS Organization) and having a reliable partner network (e.g. ESRI and Microsoft Business Partner) ROSEN houses the wide pool of experienced resources that can execute such complex enterprise integration projects – on time and within budget range.

The scope of work was delivered by a team of Integrity Engineers, GIS Consultants and Data Management Experts all reporting to one Project Manager. This way ensured GDF SUEZ, that specific expertise needed could be leveraged into the project when required.

ROAIMS is developed and implemented using a fully scalable, industry standard data model (PODS) and providing a wide range of Integrity Management software modules along with it. The plug-in concept allows GDF SUEZ to simply develop the system capability in the future with links to other new integrated software applications or functionality whenever required.

The project was set up in several phases and development cycles which allowed the management to adjust the outcomes to an optimal result. Initially the ROAIMS standard product was provided and new functionality and interfaces were implemented step by step. In parallel available data was reviewed and collection of additional data was organized. A main goal was to continuously integrate data into the system to be able to generate integrity related results in an early stage.

3 Centralized Integrity Management Systems

ROSEN Asset Integrity Management Software (ROAIMS) for pipelines is a collection of inter-operable software tools for maintaining and managing assets in a reliable, safe and cost-effective condition. The key objective of ROAIMS is to enable an efficient, auditable and well-structured integrity process to support operators in their day-to-day work.

The software was designed to follow ROSEN's unique "control loop" approach to asset integrity. The integrity

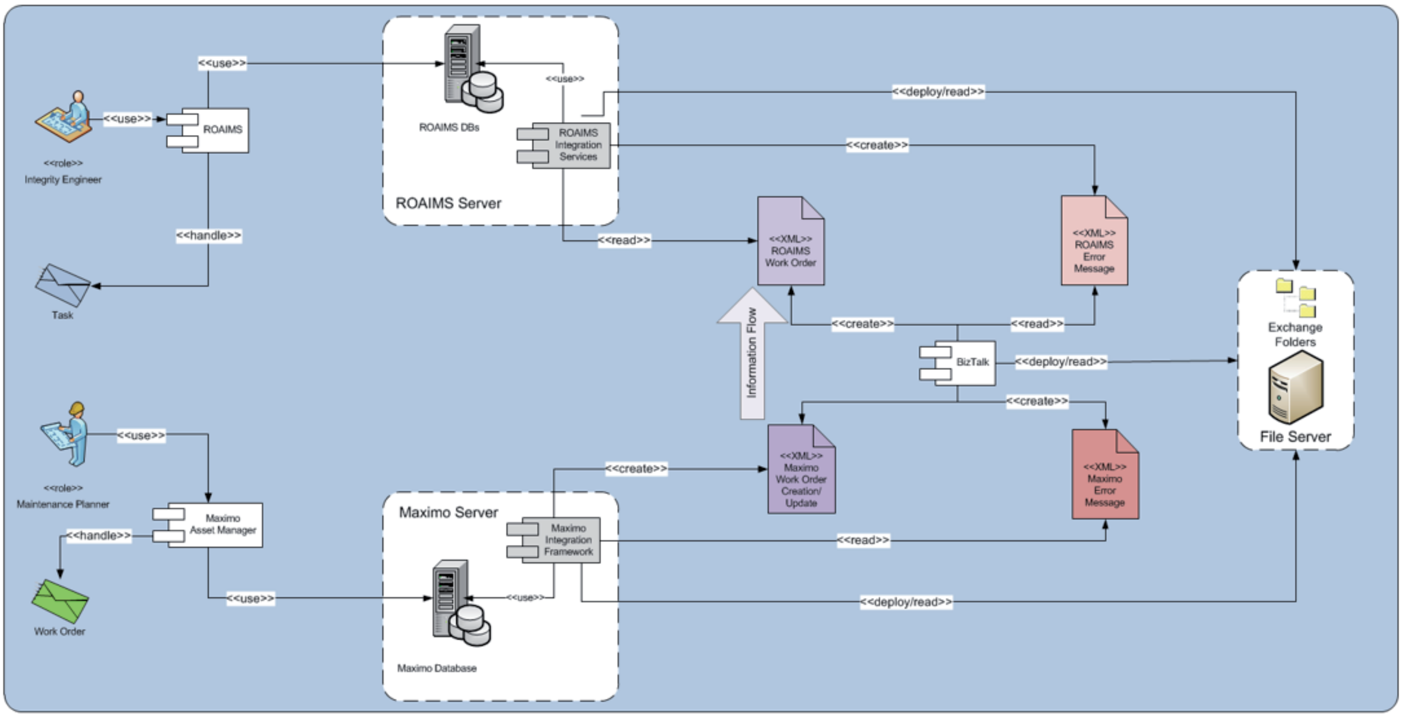

Figure 4: Interface to the Maximo Work Order Management

loop used as part of this approach is broken down into the following major steps:

- Processing
- Inspection & Testing
- Asset Integrity Management
- Rehabilitation

ROAIMS allows users to visualize, explore, and analyze complex information, systems and processes and additionally acts as a storage facility enabling you to manage large amounts of data quickly. ROAIMS can optimize clients' integrity spend by not only identifying the most significant immediate and future threats, but also by allowing virtually any mitigation action to be captured/applied and comprehensive scenarios to be automatically and/or manually constructed and compared. The flexibility of the software allows users to individually select relevant modules to create their own personalized software system.

Industry standards are considered in the specification phase of the general software concept (e.g. AS2885, API 1160, ASME B31.8s) down to each specific algorithmically implementation (e.g. defect assessment based on ASME B31.G, RStreng).

4 Project Execution

The project was split into two parts. The first part focused on the implementation and evolution of the software and the second part focused on the gathering of required data.

4.1 Software Implementation

Requirements to the software as well as to the interfaces with other systems were refined and agreed. Specific regulations and established procedures in GDF SUEZ required software enhancements to the standard ROAIMS product such as customized asset information or refined algorithms for corrosion growth rate calculation. A main focus of the implementation was on the integration of the ROAIMS software with an IBM Maximo system which is used for managing work orders and for maintaining information about all assets along the pipeline system. A continuous synchronization between the systems was realized which lead to an optimized repair and maintenance process.

4.1.1 Interface to a work order management system

The workflow and the interaction with the work order system was implemented in the first stage of the project. As example assessment methodologies for in-line inspection data can be executed to assess the criticality of a defect represented by a numeric value. Rules were defined in order to categorize defects (e.g. resulting in repair deadlines). Based on the calculated criticality value and the defined rules a list of defects was generated which was used to populate work orders in the IBM Maximo system. Changes to the work orders (e.g. repair status) are communicated to the ROAIMS system and the impact to the integrity of the pipeline can be directly analyzed and reported.

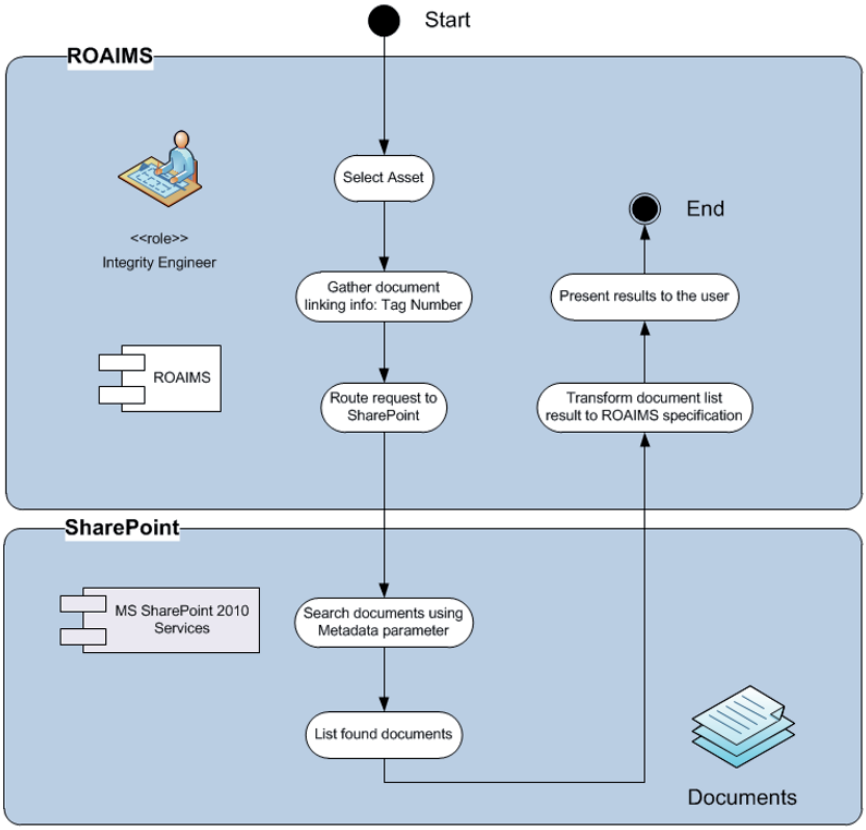

Figure 5: Interface to Microsoft SharePoint

4.1.2 Interface to an asset management system

Besides the interface to the work order system another focus was on the integration of the IBM Maximo Asset Management System. As Assets are primarily managed in the IBM system it was necessary to populate all changes made there to the ROAIMS system. Technically a solution using a middleware (BizTalk) was used to realize that interface. Whenever new assets are created in MAXIMO the process automatically populates new or changes values in ROAIMS. The process was also implemented for the other direction.

4.1.3 Interface to a document management system

A document management solution based on SharePoint was in place at GDF SUEZ and an interface to that system was required as well. A main requirement was the connection of documents to specific objects like assets or assessments in ROAIMS and the automatic upload to the existing SharePoint environment.

Specific topic related reports such as Findings of Deepwater Cathodic Protection Measurements were available, linked to a single asset by its equipment number ('Tag Number') and without any reference to a geographic location (X, Y, Z). Through the upload in the software all documents were automatically georeferenced for usage in the GIS. The location information also became the foundation for a structure in the document management software SharePoint.

4.1.4 Using the existing user rights management infrastructure

To keep access rules consistent across multiple software solutions the user rights management in GDF SUEZ is organized via a companywide Microsoft Active Directory. User and groups in Active Directory were mapped to ROAIMS in order to fulfill the following needs:

- Assign specific functionalities to individual users as well as departmental groups.
- Set restrictions to each specific asset allowing only the responsible to work with them.
- Create and maintain various user classes, reflecting different roles and responsibilities, e.g. Administrator and Domain User.

4.1.5 Corrosion growth rate assessment

A methodology for the calculation of corrosion growth rates was implemented based on an algorithm described by de Waard & Milliams. Input parameters range from pipeline parameters to complex information about CO molar concentration content or Inhibitor Efficiency. The calculated growth rates are applied to existing anomalies along the pipeline to evaluate future repair activities. The results of such prediction are fed into the work order management system to be able to plan the future maintenance strategy.

Combing those mentioned and other functionalities in the software result in the overall integrity management plan.

4.2 Data Gathering

The collection of additional data that was not initially available was a task performed in parallel. This was including data related to the various offshore assets as well as survey data measured by geotechnical surveys or ROV.

Prior to the data collection process a set of more than 50 different assets and its detailed properties were defined. For all properties (e.g. wall thickness, material grade, manufacturer, type, diameter, ...) possible values or value ranges were specified. A team of experts was then collecting the data section by section. After quality and consistency checks the collected data was uploaded to the databases in order to instantly run integrity assessments.

4.3 Training of personal, acceptance testing

Prior to the installation of deliverables at the GDF SUEZ offices a factory acceptance test and training was performed. All involved key-users were trained and got certified for the usage of the ROAIMS software. The factory acceptance test and training activities were held at the ROSEN Technology and Research Center in Lingen (Germany). The certified key-users then supported the site acceptance test and played an important role during the commissioning and the start-up of the application in the GDF SUEZ office as multiplier for other GDF SUZ employees.

5 Summary/Conclusion

The implemented approach of a Pipeline Integrity Management System delivered a demonstrable compliance to HSE-policy.

The first step of gathering and ordering data is the key factor in enabling a cost effective Pipeline Integrity Program along with prioritizing engineering decisions and accelerating the next phase of the integrity program. Considering vast amounts of information are generated during the integrity management process, software tools become a necessity to aid the engineer in its practical implementation. This includes essential elements such as effective data integration and management, appropriate assessment tools, documentation of the integrity assessments conducted, risk assessments, and data crosschecking.

Performing a risk assessment is an important phase in an integrity management program and is essential to assess identified threats to the pipeline, understand the consequences of failure and estimate the risk of failure (or loss of integrity) of the pipeline to the identified threats. Furthermore, having a flexible risk model designer capability can benefit the user/operator with the ability to develop new or edit existing risk models, which could enable the operator to obtain a more realistic understanding of the risk profile of the pipeline and assist in optimizing risk-based mitigation strategies.

As a final conclusion, a centralized approach for managing integrity data and assessing integrity and safety matters of a pipeline system can minimize operators' efforts during their daily decision making activities. Looking not only at the immediate defect prioritization, but also at the future rehabilitation planning and inspection schedules, the assessment of defect growth mechanisms (e.g. corrosion) and the application of appropriate (agreed) rates of growth (for both internal and external corrosion) will help to estimate budgets on required upcoming integrity matters. Furthermore, preventative and mitigation activities coming as a result of both risk assessments and integrity assessments, can be controlled and tracked in a software added process allowing users to keep a record of the activities done, and thus, create and manage an auditable process.

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TOTAL DRAG REDUCTION SOLUTIONS FROM OPPORTUNITY TO OPERATION

Dr. Yung N. Lee, Morgan Brown, Phillips Specialty Products Inc., USA

ABSTRACT

Phillips Specialty Products Inc. (PSPI), a wholly-owned subsidiary of Phillips 66 Company, is the global leader in the science and application of drag reduction to pipelines. For over 30 years, through the use of flow improvers, also known as drag reducing agents (DRAs), PSPI has provided solutions that allow pipelines to maximize their flow potential, increase operational flexibility, and increase bottom-line profit potentials.

DRAs are hydrocarbon-based materials which reduce frictional pressure loss during turbulent flow in a pipeline, enabling companies to strategically reduce or avoid capital expenses, improve pipeline operating costs and/or expand their pipeline system capacity. PSPI has a range of products to drag reduce crude oil, refined products, heavy oil, and multiphase fluids.

PSPI's presentation at the Pipeline Technology Conference will introduce DRA Technology, the benefits of using such a technology for the pipeline and oil industry, and PSPI's expertise in delivering drag reduction solutions from opportunity to operation.

1 Drag Reducer Technology

1.1 Drag Reducer Theory

DRAs are chemicals or additives that reduce the frictional pressure of flowing fluids in a pipeline or conduit. Drag reduction (DR) is governed by the following equation:

$$\%DR = \frac{\Delta P_u - \Delta P_x}{\Delta P_u} * 100$$

where ΔPu is the frictional pressure drop associated with the untreated fluid and ΔPx is the pressure drop associated with the fluid when treated with a DRA.

When added to pipelines, DRAs are typically used for one of two major purposes. The first is energy consumption where the same target throughput is facilitated with less pumping power, and the second is increased throughput of the fluid in the pipeline by using the same pumping power that was used prior to the addition of the DRA. Figure 1 illustrates the effect of treating a continuous, single phase fluid in a conduit. The addition of a DRA can minimize the pressure drop of the same fluid in the conduit at a given flow rate, and the fluid can be pumped with less energy.

In order to achieve drag reduction, a fluid must be above laminar flow. This typically corresponds to fluids with Reynolds numbers greater than 2,100. Typically, the greater the Reynolds number, the higher the levels of observed drag reduction. There is an exception in the transition area marked by Reynolds number between 2,100 and 4,000.

Figure 2 shows a cross section of the near wall region of a pipeline that is in turbulent flow. The three flow regimes shown are the laminar region, the buffer region and the turbulent core. The turbulent core accounts for the majority of the area present in the pipe, and it is in this area that eddy currents and random motions of turbulent flow occur. Nearest to the pipeline wall is the laminar region where the fluid moves laterally. The region between the laminar region and turbulent core is the buffer region. As shown in Figure 2, fluid in the laminar region flows into the buffer region. The fluid flowing from the laminar region to the buffer region creates vortices. Ultimately the flow becomes unstable, thus facilitating turbulent flow. Through the injection of a DRA, the ultra high molecular weight polymers are able to absorb the energy of the random motion associated with turbulent flow. This absorption creates a more stable flow where the applied energy that is necessary to move the fluid is not wasted.

The concentration of the polymer in the pipeline can significantly impact the ability to disrupt turbulent bursts from cross-currents and eddies, but ultimately, an upper boundary for DRA performance in a pipeline exists with respect to polymer concentration. For example, Figure 3 illustrates the concentration dependency of drag reducer performance. As shown, the overall efficiency (the slope of the curve) of the drag reducer decreases as polymer concentration increases. Additionally, the performance is approaching a limit that is near the theoretical limit of the pipeline commonly referred to as Virk's limit. Ultimately, Virk's limit suggests that there is a ceiling value for drag reduction performance for a given additive in a pipeline. Therefore, once the limit for the pipeline is reached, any additional DRA does not effectively redirect the remaining energy produced by turbulent flow.

1.2 Examples of Pipeline Applications

Many users employ DRAs in their pipeline in traditional applications, such as power savings and flow increase. PSPI's brand of drag reducing agents, LiquidPower™ Flow Improvers, for light and medium crude oils, RefinedPower ® II Flow Improver for gasoline and diesel, and ExtremePower™ Flow Improvers, for heavy crude oils, can bring value to your system and ultimately grow your bottom-line. Knowing where flow improvers can apply to your system is the first step in realizing this value.

Every DRA user is unique, based on a variety of needs. These needs present a growing complexity throughout the lifecycle of a pipeline and its operations. Some of the requirements stem from pipeline design limitations, increasing power costs, aging pipeline systems, changes in regulations, safety and environmental challenges and changes in fluid types.

While DRAs are mostly used to alleviate existing mechanical limitation issues; many sophisticated oil producers or pipeline operators use the chemicals to improve operational efficiency, offer a fast response to fluctuating market demands, and ultimately, generate increased revenue and shareholder value at a marginal investment cost. Depending on each application, the DRA's benefits can be summarized as follows:

- Increased oil production
- Pipeline flow (capacity) increase
- Throughput assurance during maintenance periods for example
- Capital avoidance (smaller diameter , less pump stations, ...)
- Reduced tanker turn-around time
- Power cost saving

1.2.1 DRA lifecycle and product quality

DRA can be stored and transported with minor maintenance requirements. Once drag reducers are exposed to shear when dissolved in hydrocarbons, they lose effec-

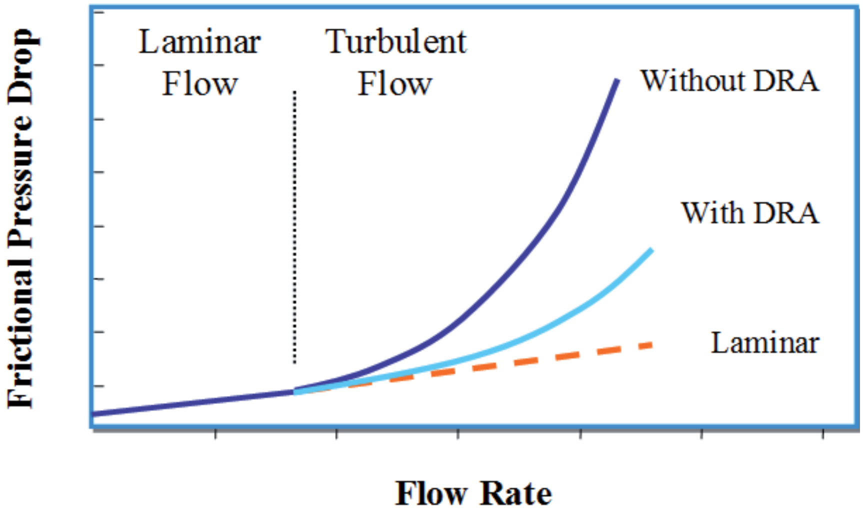

Figure 1: A graphical representation of frictional pressure drop as a function of flow rate in a conduit.

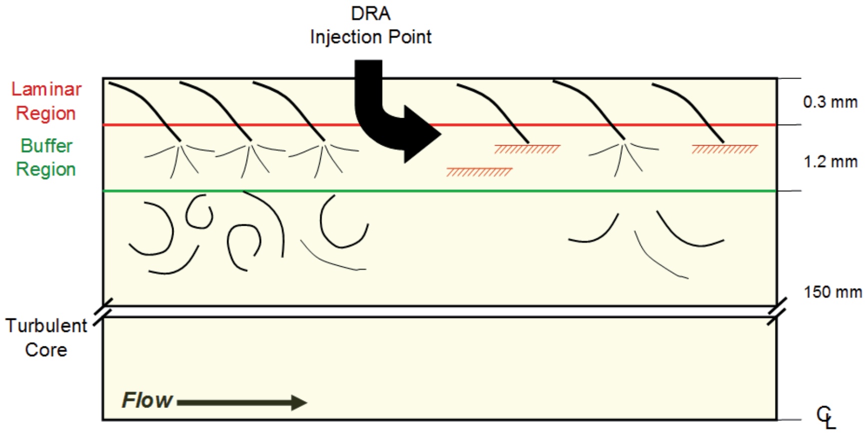

Figure 2: Pictorial representation of the cross-section of a 12" pipeline that is in turbulent flow where half of the section shown is untreated with DRA and the other half is treated with DRA. The DRA molecules are represented by the red brush-like species.

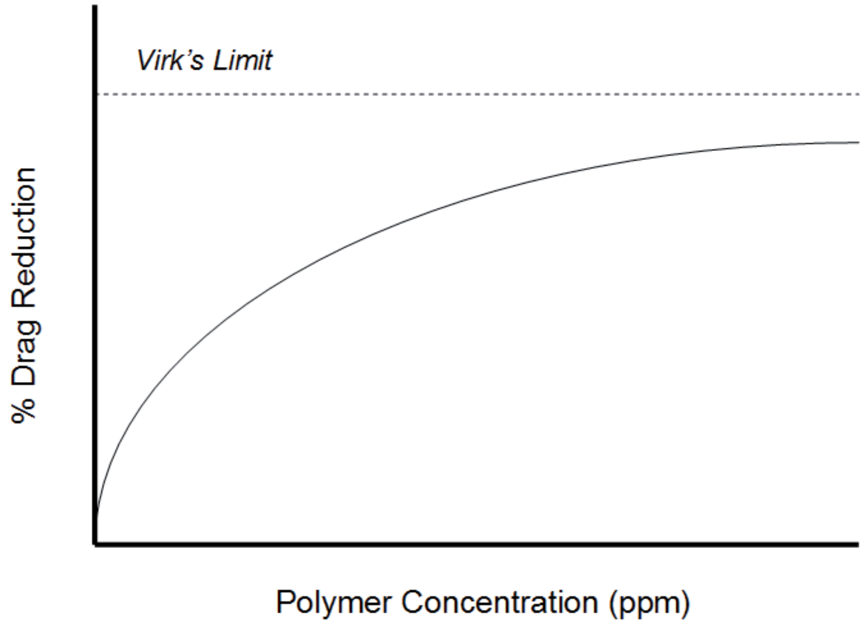

Figure 3: Graphical representation of drag reduction performance as a function of polymer concentration. Also shown is the theoretical limit of drag performance that can be obtained for this system.

tiveness. When drag reducers are exposed to a mainline centrifugal pump, the DRA is completely sheared and there is no longer performance. Drag reducers are added to crude and refined products throughout the supply chain, and PSPI has performed extensive refinery testing and engine testing to ensure our products do not cause adverse effects.

"To ascertain our product quality, we test on our lines... not on yours!!"

When a new DRA product is developed, there is compelling need to test performance outside the labs before it is taken to the end users. As such, the product quality and performance is validated to make sure customers will get what they pay for from the first injection and throughout the life of the application. PSPI, as part of Phillips 66, is the only DRA provider that tests on its pipelines before taking products to the market place.

2 PSPI Services

2.1 Drag Reduction Modeling and Field Testing

PSPI has proprietary software and expertise to model the application and quantify the DRA requirements. PSPI can analyze a segment or the entire pipeline system, and estimate the requirements for flow increase or power savings.

After our analysis, our engineering services work to create a field test protocol. PSPI can install equipment at your sites and test DRA performance to validate DRA requirements.

2.2 Research and Development

The research and development team is made up of scientists, engineers and technicians with more than 200 years of combined drag reduction experience. Technology personnel are frequently called in to assist with customer support. Unique applications, field issues and customer inquiries can be directed to this staff of outstanding professionals.

2.3 DRA Production and Logistics

PSPI is the world-leading supplier of DRAs and associated services. Our headquarters are located in Houston, TX, research in Ponca City, OK, and manufacturing in Bryan, TX. Regional support offices are located in Brussels and Moscow. From these locations, PSPI services a broad international network of customers with locations in more than 50 countries worldwide.

The Bryan, TX manufacturing facility is 100% dedicated to the LiquidPower™ Flow Improver production. Manufacturing is in accordance with our ISO 9001:2000 certified quality systems. Our facilities are equipped to be able to ship product to international warehouses 24 hours a day, seven days a week.

2.4 Equipment and Technical Support

The DRA injection rate depends on the pipeline throughput and operational conditions. Typical LiquidPower™ Flow Improver concentrations are 10-80 parts per million to achieve drag reduction between 30-80%. The DRA injection rate requires specialized metering equipment and controls to inject accurately and reliably.

Equipment is a critical component to the drag reduction technology as any failure can cause disruptions in pipeline operation. To ensure reliability, PSPI provides injection equipment and is responsible for maintaining each skid. We provide critical spare parts, strategically locate technicians worldwide, and perform preventative maintenance programs for all equipment.

PSPI engineering group is global and equipment is fabricated worldwide. We fabricate to international standards for supplying equipment in hazardous and environmentally sensitive areas. Our equipment is designed for fast installation and a skid can be installed as quickly as one day. We keep an inventory of equipment to ensure quick response for any pipeline disruption including a sudden pipeline leak, pipeline equipment failures, or hurricane response in the US Gulf Coast. Not only do we supply a standard design, but PSPI engineering can work with project specifications and consultants to design equipment for a range of project and document requirements.

3 Conclusion

Once a pipeline operator realizes an opportunity for DRA, PSPI offers a total package solution to quickly turn that opportunity into operation. Our portfolio includes products for light, medium, and heavy crudes as well as a product for refined fluids such as gasoline and diesel. PSPI also provides equipment to reliably inject the products into the pipeline to meet the needs of companies that demand high performance and maximum flexibility, while ensuring outstanding time and cost savings.

The PSPI Team has more than 30 years of engineering support service experience to maximize optimization on each application with world-class equipment and supreme product reliability.

For more information on Phillips Specialty Products Inc., please visit our website: www.LiquidPower.com or www.ExtremePowerFlowImprovers.com.

UT-ILI AND FITNESS-FOR-PURPOSE ANALYSIS FOR SEVERELY INTERNALLY CORRODED CRUDE OIL PIPELINE

Abdul Wahab Al-Mithin and Shabbir Safri, Kuwait Oil Company, Kuwait
Andreas Pfanger, NDT Systems and Services AG, Germany

ABSTRACT

KOC constructed a 36" dia. crude oil pipeline in 2005 to transport its share of crude oil from oil field located at Wafra, south Kuwait. The pipeline receives crude oil from a 20" pipeline. The crude oil velocity is very low due to restricted oil production.

Severe internal corrosion was detected during ultrasonic thickness measurement in 2008. Subsequently ultrasonic ILI by NDT Systems and Services detected severe internal corrosion almost through the pipeline length. Initial analysis of anomalies as per ASME B31G code showed that almost half of the pipeline requires repairs. This being uneconomical, KOC decided to carry out Fitness for Purpose assessment and entrusted this work to NDT Systems and Services. The analysis reduced required repair to only 3 km. from 12 km. Simultaneous action to control internal corrosion enabled KOC to operate the pipeline safely.

NOMENCLATURE:

FFP :- Fitness for Purpose
HDPE :- High Density Polyethylene
ICDA :- Internal Corrosion Direct Assessment
ILI :- In-Line Inspection
SRB :- Sulfate Reducing Bacteria

1 INTRODUCTION

In the year 2008, a small section of 36" dia. crude oil pipeline was excavated for installing corrosion monitoring fittings and internal corrosion was detected on the bottom of the pipeline. Based on this inspection finding, KOC requested NDT Systems & Services to carry out ultrasonic In-Line Inspection. The pigging activity was carried out in the year 2009. The ILI revealed the presence of dents, laminations, and severe internal corrosion almost through the entire pipeline length. Initial analysis of the data was carried out as per ASME B31G code. Based on the initial assessment of the corrosion anomalies according to the ASME B31G code, a total of 12 km, nearly the half of the pipeline length, would require repair. This is obviously not an economical repair strategy. Hence, NDT Systems and Services was again contacted to carry out a Fitness-For-Purpose analysis based on advanced assessment methods, such as the RSTRENG effective area method for corrosion anomalies and the API 579 Standard for lamination anomalies and blister anomalies. The FFP analysis reduced the total length of pipeline to be repaired from 12 km to 3 km. and also provided a timeline for repairs to be carried out. For KOC, this was an enormous saving in maintenance cost and resources. It also provided a favorable time to take pipeline shutdown, arrange for pipe material and carry out repairs. The paper discusses the complete process of detection of corrosion, inspection, FFP analysis and repair strategy in detail

1.1 Kuwait Oil Company

Kuwait Oil Company (KOC) is in the business of exploration, production, treatment and export of crude oil in the state of Kuwait. It operates a network of pipelines for transportation of crude, gas and condensate. No other mode of transport is utilized for transportation of products and hence, fully depends on its pipeline network for operational needs. It is a complex network consisting of different feeds, inter-connections and interdependencies. Pipeline diameter ranges from 3" to 56" with maximum single length being 170 km. Total number of pipelines are 442 and total pipeline length being 5000 km. All pipelines are buried and travel through different terrains and soil environment. Maintaining this important asset in healthy condition is a challenge.

In the South of the country, oil reservoirs on the border of Kingdom of Saudi Arabia are shared. The operation of the reservoir is jointly managed by Kuwait and Saudi Arabia and the production is shared. The geographical area is called Wafra. Kuwait share of crude oil produced at Wafra fields is managed by KOC and transported through pipelines to KOC tank farms.

1.2 The Crude Oil Pipeline

A 36" dia., 25 km long pipeline (CR088) was built and put into operation in 2004 to transport R/B crude oil. R/B

Figure 1: 36" dia. pipeline route

crude oil is named after the reservoir located in joint operation (with Saudi Arabia) area. Another 20" pipeline (CR058) originating from Wafra feeds crude oil into this CR088 crude oil pipeline at a manifold MF/TB-1.

The pipeline is longitudinal seam welded, 25 km long constructed in 2004 to ANSI ASME B31.4. The pipeline was successfully hydrostatically tested at 787.5 lbf/in2 (54.3 bar) pressure before entering into the service, i.e. to a level of 1.25 times the pipeline design pressure of 630 lbf/ in2 (43.4 bar). The nominal wall thickness is 0.469" (11.9 mm) and the pipe grade is API 5L Grade X52. The pipeline material confirms to NACE MR0175. Externally, it is coated with 3 layers HDPE coating system and protected with impressed current cathodic protection system. No internal coating was applied.

The pipeline is piggable with launcher at a manifold MF/TB-1 (a crude oil manifold) and receiver at North Tank Farm (NTF). Though the pipeline is meant for transporting crude oil coming from Wafra, piping connections are provided to flow crude oil from other Gathering center through MF/TB-1 header. Offtake and intake connections have also been provided at Centre Mixing manifold (CMM) at a distance of approx. 20 km, as shown in Figure 1.

The pipeline has been in operation for only 82,000 to 90,000 bpd of crude oil though it was designed for higher flow to cater for higher crude oil production. This has resulted in a very low liquid velocity in the pipeline, leading to internal corrosion.

In mid 2008, KOC decided to install corrosion monitoring devices on the pipeline. The pipeline was excavated at two locations and thickness survey was carried out prior to hot tapping work. Internal corrosion was detected at both these locations. Further, as a part of manifold inspection program, thickness measurements were carried out on the pipeline at all isolation valves and branch connections locations, which have been provided with concrete pits for access. Here again internal corrosion was detected. Detection of internal corrosion in a short span of 4 years was alarming, since such high corrosion rate has never been detected in KOC pipelines. It was then decided to carry out In-Line Inspection survey as soon as possible.

2 UT INLINE INSPECTION SURVEY

KOC decided to utilize ultrasonic intelligent pigging for obtaining accurate information on internal pitting and bottom channel corrosion anomalies. NDT Systems and Services was entrusted with carrying out cleaning pigging and In-Line Inspection.

The high sensitivity of the ultrasonic principle applied leads to low detection thresholds and reliable detection of all features with a potential influence on the integrity of the line. The inspection revealed the presence of internal channeling corrosion, dents and laminations. Blistering, a typical feature found in the presence of a sour medium, was detected in a few pipe joints as well.

3 INTERNAL CORROSION FINDINGS

Internal corrosion in oil or gas pipelines is termed „sweet“ or „sour“ depending on the hydrogen sulphide content. The condition „sour“ is defined by the National Association of Corrosion Engineers (NACE) as partial pressure of more than 0.0003 MPa hydrogen sulphide. Below this pressure the condition is called „sweet“. Sweet corrosion can occur when there is carbon dioxide and water in the pipeline. The carbon dioxide dissolves in the water to form carbonic acid which reacts with the pipeline steel causing corrosion damage. Metal loss corrosion due to the presence of hydrogen sulphide is a mechanism similar to carbon dioxide corrosion as hydrogen sulphide dissolves in the water associated with oil production, forming a weak acid .

Sweet and sour corrosion can occur as general corrosion and pitting corrosion. In sour conditions, additional corrosion mechanisms such as hydrogen-induced cracking (HIC), stress-oriented hydrogen-induced cracking (SOHIC) and sulphide stress corrosion cracking (SSCC) can pose significant threats to the integrity of the pipeline.

The ultrasonic inspection performed by NDT in 2009 identified about 60 external and 1600 internal metal loss anomalies in this sour crude pipeline. The majority of the internal anomalies is characteristic of internal corrosion in the bottom area of the pipeline which is designated as channeling corrosion. Their distribution over the distance and the circumference is shown in Figure 2.

Many of the corroded pipe joints are affected by extensive internal channeling corrosion over the entire joint length. Approximately 12 km of the 25 km long pipeline is affected by internal corrosion with depths up to around 60 % of the reference wall thickness. The width of the channeling corrosion varies between 110 and 1200 mm. The internal corrosion anomalies in the bottom area of the pipeline are distributed between 0 and 20 km. In the last five kilometers of the pipeline there is no considerable internal corrosion.

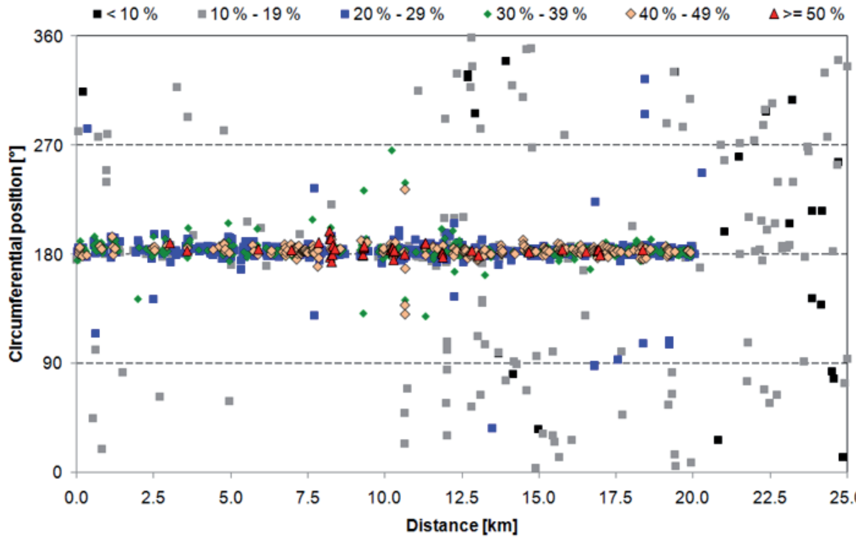

Figure 2: Distribution of internal anomalies

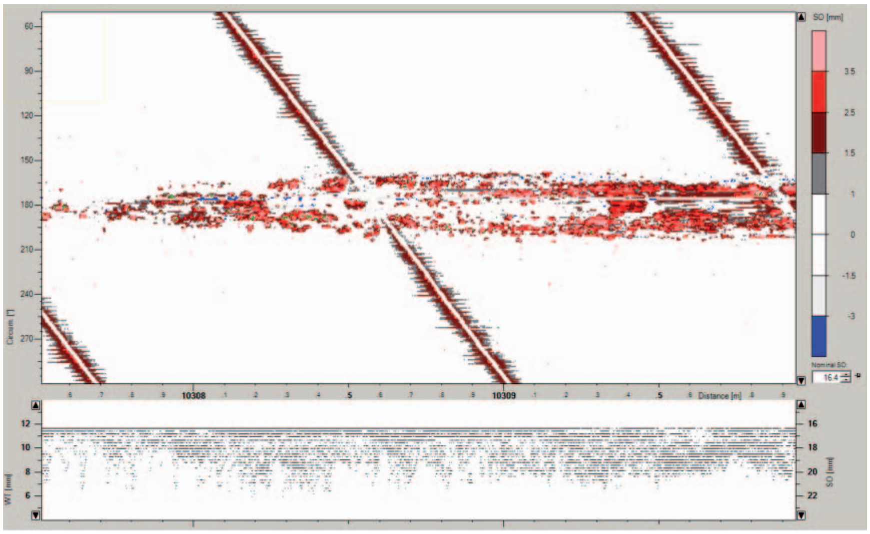

Figure 3: UT ILI data representation of bottom channeling

4 FITNESS-FOR-PURPOSE ANALYSIS

4.1 Corrosion Assessment in Terms of Immediate Integrity

A typical example of the channeling corrosion with an uneven depth profile is given in Figure 3. Among the published defect assessment methods, the most appropriate method for assessing the significance of corrosion reported in this pipeline is the RSTRENG , effective area method which takes into account the river-bottom profile of each metal loss anomaly. The river-bottom profile is a two-dimensional representation of the corrosion along the pipe joint based on the high-resolution ultrasonic wall thickness measurements with an axial sampling distance of 0.75 mm.

An iterative effective area analysis is performed to determine the most critical subsection of the anomaly profile that yields the lowest safe operating pressure. This procedure accounts for the local reinforcing effects

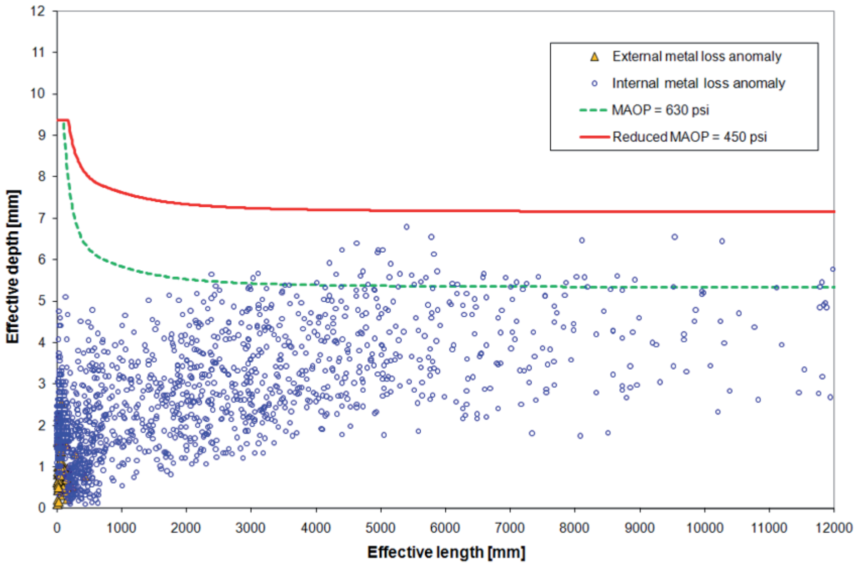

Figure 4: MAOP curve

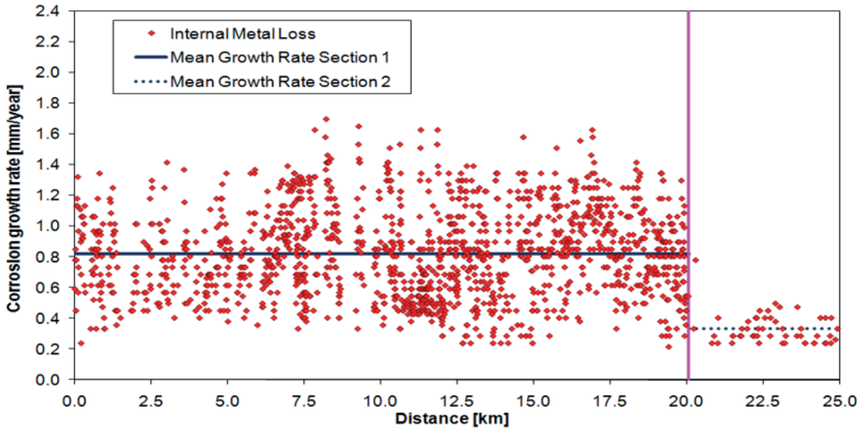

Figure 5: Distribution of corrosion growth rate

due to the varying local wall thickness along the defect profile. Therefore, this RSTRENG method results in more precise and less conservative predictions for the safe operating pressure compared to standard methods such as the B31G criterion which considers only the maximum depth and the total length of a defect.

The RSTRENG safe operating pressure of each corrosion anomaly was compared to two different assessment pressures (MAOP of 630 psi and reduced MAOP of 450 psi).

The safe operating pressures of around 60 anomalies (all of them are characteristic of internal channeling corrosion) are below the MAOP of 630 psi. In terms of pipeline integrity these features are therefore not acceptable at 630 psi and would require immediate repair. Using the simple B31G criterion, four times more anomalies would be unacceptable at 630 psi.

Considering the reduced MAOP of 450 psi, no immediate repairs are required, as the safe operating pressures of all anomalies are above 450 psi. An overview of the anomaly acceptance is given in the assessment chart of Figure 4. The dashed green line represents the acceptance curve at the MAOP of 630 psi and the red line the curve at the reduced MAOP. Anomalies located above a certain curve are not acceptable at the corresponding assessment pressure, e.g. the anomalies requiring repair at the MAOP are located above the dashed green line.

4.2 Integrity of the Pipeline in the Future

The target is to investigate the potential effect of external and internal corrosion growth on the future pipeline integrity. Analyzing corrosion growth and conducting an integrity assessment enables the operator to prioritize repairs and to develop a rehabilitation program. Corrosion growth rates can be determined based on the comparison of consecutive inspection runs. As the 2009 ILI is the only inspection conducted so far, the growth rates need to be determined in a different way.

A common approach for estimating corrosion growth rates is to assume that the corrosion anomalies have been active for a given proportion of the pipeline life. For example, it can be assumed that corrosion growth initiated right after the date of commissioning in 2005 or at the half life of the pipeline anytime in 2007. The half-life approach (corrosion is active between 2007 and the date of the inspection in October 2009) leads to higher growth rates than the full-life approach (corrosion is active between 2005 and October 2009) and is therefore more conservative.

Corrosion initiation and corrosion behavior is influenced by many factors. Internal corrosion depends for example on the product composition (water content), the flow rate or the use of inhibitors. The pipeline has been transporting sour crude oil since the date of commissioning in 2005. The product or product composition has not been changed during life time. Due to the low flow and velocity of the sour crude, it is very likely that the internal corrosion process started quite soon after commissioning the pipeline. Therefore, the full-life approach was applied for the estimation of internal growth rates. The resulting distribution of the internal growth rates is illustrated in Figure 5.

The severe internal channeling corrosion occurs in the first 20 km of the pipeline. Most of the internal anomalies in the section after 20 km are manufacturing-related anomalies. Therefore, the pipeline was divided

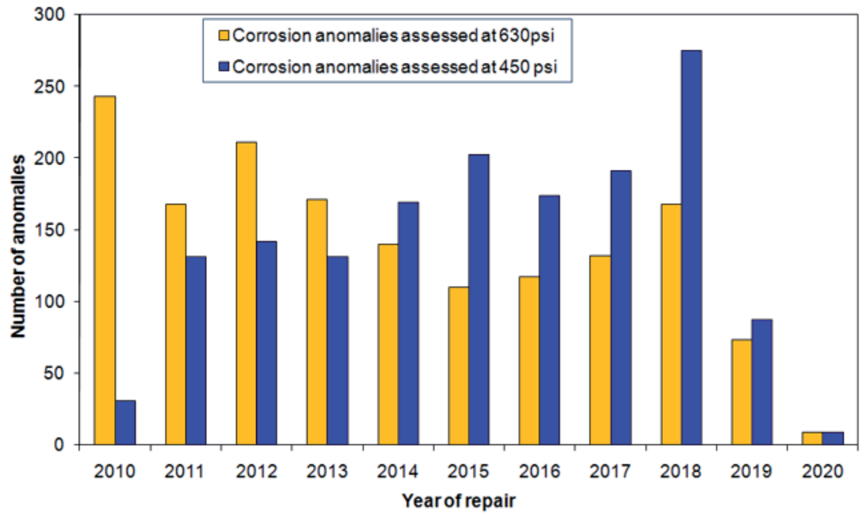

Figure 6: Anomalies requiring repair in each year

into two internal growth rate sections as illustrated by the vertical line in Figure 5 at distance 20 km. Despite the manufacturing characteristics of the metal loss in the 2nd section, the anomalies that are not explicitly reported as manufacturing-related were conservatively considered as growing anomalies for the estimation of repair dates. According to the internal corrosion growth behavior of the two sections, the mean and the maximum growth rates were determined separately. In the first 20 km of the pipeline, the mean internal corrosion growth rate is just over 0.8 mm/year and the maximum value is 1.7 mm/year. Although the corrosion rates have been determined according to the full-life approach and not to the half-life approach, the resulting growth rates are very high. It is therefore obvious that the corrosion growth behavior of the sour crude oil in this section is very aggressive.

In the section after the 20 km distance, the average rate is around 0.3 mm/year and the maximum rate is close to 0.8 mm/year. The mean growth rates of each section are illustrated by the different horizontal lines in Figure 5.

4.3 Calculation of Repair Dates

In order to determine future repair dates of each corrosion anomaly, the anomaly depths as reported by the 2009 inspection are extrapolated and the anomalies are assessed using the RSTRENG approach. Different options for the application of growth rates are feasible:

1. local growth rate of each anomaly
2. maximum growth rate of each section used for all anomalies within that section
3. mean growth rate of each section used for all anomalies within that section

Option 1 is not the most appropriate one as anomalies that have grown at lower rates so far may show higher rates in the future. Using the maximum rate to all anomalies (option 2) is over-conservative and using the mean rate (option 3) not conservative enough. In order to be not too conservative on the one hand but to minimize the risk of failure on the other hand, a combination of option 1 and 3 was applied. The maximum of the local corrosion growth rate or the calculated mean value of the respective section was used for the depth extrapolation of each anomaly.

The estimated future repair date of a corrosion anomaly was obtained by calculating the time when its dimensions exceed the values not tolerable at the two assessment pressures or its maximum depth exceeds 80 % of the wall thickness. The earlier of the two calculated repair dates of each metal loss anomaly has been taken as result for the future repair plan. The annual numbers of anomalies recommended for repair until 2020 are illustrated in Figure 6.

At the time of the inspection at the end of October 2009, around 60 metal loss anomalies were unacceptable at the MAOP of 630 psi according to the immediate integrity assessment. In addition to those anomalies, approximately 100 more anomalies require immediate repair although they were acceptable at the time of the UM inspection. However, applying the estimated corrosion growth rates, the anomalies have been growing since October 2009 and they were unacceptable at the time of the report delivery in June 2010.

Looking at the reduced MAOP of 450 psi, all metal loss anomalies were acceptable at the time of the UM inspection. Applying the estimated corrosion growth rates, the anomalies have been growing since October 2009 and, at the time of the report delivery (in June 2010) slightly over 10 anomalies were unacceptable. For the reduced MAOP of 450 psi, the annual number of repairs until 2013 is much lower than for 630 psi.

5 Repair Plan

In order to outline a repair plan appropriate for this pipeline and to reduce the upcoming repair costs, it is recommended to define so-called repair areas. A repair area consists of an anomaly requiring repair at an appointed date and anomalies requiring repair at a later date but located in a pipe spool next to the previous one. Repairing several anomalies in one mobilization is more cost-efficient than to repair them separately, e.g. an anomaly is repaired now and the one in the adjacent pipe spool with a recommended repair date of July 2012 will be repaired two years later.

Since the number of repairs required at the MAOP is much higher than at the reduced MAOP, all anomalies due for repair until the end of 2011 at the reduced MAOP are selected as basis for the suggested repair plan. If pipe spools with channeling corrosion due for repair until the end of 2012 are located next to those, repair areas are developed. As a result, approximately 300 anomalies can be combined to around 40 repair areas consisting of 2 to 20 pipe spools each.

6 OTHER INSPECTION AND STUDIES

6.1 In-Ditch Inspection

Since 2008 there have been several opportunities to carry out thickness measurement and ultrasonic scanning at different locations along the pipeline length.

The discovery of internal corrosion was from thickness measurement at 14.3 km as discussed in the introduction. Thereafter, during manifold inspection program in 2008, all accessible locations like isolation valves, branch connections etc. which are provided with concrete pits were inspected and ultrasonic thickness measurement/scanning was carried out on the pipeline sections in the pits.

For verifying the ultrasonic ILI findings of 2009 the pipeline was excavated at 10.3 and 14.0 km. External ultrasonic wall thickness measurements confirmed the internal corrosion sites as reported by the ILI. Further to this, 10 locations were excavated and inspected in 2011 in order to investigate the growth of the internal corrosion. Again internal corrosion was found at all locations as reported by the ultrasonic ILI results. However, the corrosion growth rate was found to be negligible and not as calculated in the FFP report. This is due to the implementation of a rigorous cleaning pigging program and the increase in flow velocity.

6.2 Internal Corrosion Direct Assessment

In order to find out the root cause of the severe internal corrosion and to determine the best possible solution for eliminating further corrosion, KOC decided to carry out an Internal Corrosion Direct Assessment as per NACE SP208 . The assessment was carried out by Allied Engineers, India and Broadsword Corrosion Engineering ltd., Canada. Though it was known that internal corrosion has occurred due to very low product velocity, the study threw further lights on how water wetting and solid accumulation is affecting pitting corrosion. The study served as a corrosion investigation for the entire pipeline. A technical paper is presented on this study at NACE 2012, Utah, USA.

6.3 Corrosion Monitoring

Two corrosion monitoring stations were constructed on the pipeline. One at distance 7.5 km and another one at 14.3 km based on the profile of the pipeline available at that time. Flush disk coupons were installed on the bottom and top of the pipeline at both locations. The first monitoring service took place in Dec'09. The corrosion coupons at the top of line positions at both locations showed low to moderate corrosion rates but the corrosion rates at the bottom of the line positions showed very severe general and pitting corrosion rates (30 mpy general corrosion rate and 38 mpy pitting corrosion rate).

On the fluid samples collected from the corrosion monitoring fittings a bacteria analysis was carried out in May 2010. SRB counts were found to be on higher side indicating likelihood of bacterial corrosion.

6.4 Cleaning Pigging Sample Analysis

A cleaning pigging program was initiated in 2009 after the detection of internal corrosion. Debris/liquids brought out during cleaning pigging were collected and analysed for iron based compounds, organic matters and salts. Initially, the cleaning pigging started with 3 months frequency. The analysis showed a decreasing trend of internal corrosion. Since August 2011 no corrosion product has been detected. This confirms the effectiveness of the applied cleaning program. It also gave KOC confidence that the corrosion growth rate has been contained and will not reach critical dimensions as predicted in the FFP analysis.

7 RECOMMENDATIONS

7.1 Repairs

Based on the ultrasonic ILI results, the FFP study and the in-ditch inspection findings, a detailed repair program was recommended. The infrastructure available with KOC, operational needs, repair contractors capability and limitations were also considered. Following is the summary of the recommendations.

1. The pipeline MAOP was reduced to 289 psig with immediate effect.

2. Since the number of repairs for a MAOP of 630 psig was considerably higher than for a MAOP of 450 psig and a higher MAOP was not required for the intended operational crude oil throughput, it was decided to do all required repairs for restoring the pipeline MAOP to 450psig.

3. It was also decided to repair anomalies due for repair at the end of 2011. Thereafter a re-inspection is planned to revise corrosion growth rate, as it is seen (during in-ditch inspection in 2011) that the corrosion has been contained with the help of cleaning pigging and increased oil flow.

4. Several anomalies were predicted (by FFP study) to reach 80 % wall metal loss by Dec. 2010 and hence, it was recommended to carry out all required repairs (for 450 psig MAOP) by Dec. 2010.

5. Accordingly, 52 locations, totaling 3 km length were recommended to be cut out and replaced before Dec. 2010.

This repair is still considered a significant work for maintenance contractors particularly the procurement of pipe material needed for repairs before Dec. 2010. At the same time, it was not possible to drain the pipeline and keep it shut down for a long period of time till pipe material is procured and repairs are carried out. It was then decided to inspect anomalies which were expected to reach 80 % wall thickness loss by Dec. 2010. At the same time, the pipeline was taken out of service at the end of Dec. 2010 as a precautionary measure. These anomalies (10 nos.) were excavated and inspected in early 2011 and found to be dormant. Also, result of analysis of product samples collected during cleaning pigging and data from internal corrosion monitoring devices (installed at two locations) gave us confidence that the internal corrosion growth has reduced considerably.

Based on this analysis, the rigorous cleaning pigging and the increased flow in the pipeline, it was concluded that the pipeline can continue to operate at 289 psig beyond Dec 2010 without the required repairs being carried out. The pipeline was put back to operation and continued till Dec 2011. By the time, the pipeline material was procured and repairs are carried out.

7.2 Control of Internal Corrosion

Based on the findings of UT ILI and ICDA study, two major steps were taken to control internal corrosion which has threatened the integrity of the pipeline in a short life span. The first one was carrying out rigorous cleaning pigging backed up by analysis of debris. The frequency of pigging was optimised based on analysis of debris. The second step was to increase crude oil flow and hence velocity. To achieve this, crude oil from other gathering centers were diverted to the subject pipeline at MF/TB-1. It was not possible to achieve recommended minimum flow of 496,00 bpd (as per ICDA report), which would have resulted in low flow in other pipelines. Nevertheless, crude oil flow was increased to the extent possible which was substantially higher than transporting only Wafra crude oil.

8 CONCLUSIONS

The pipeline was designed for a much higher flow rate but later developments in oil production resulted in much lower flow and hence low velocity in the pipeline. Early detection of internal corrosion enabled KOC to implement comprehensive inspection and mitigation measures. Further analysis using Fitness-for-Purpose methodology ensured that the required repairs are kept to a minimum which can be carried out in time. Cleaning pigging program and internal corrosion monitoring ensured that the pipeline continued to remain in operation while new pipe material is procured and repair work is planned.

Ultrasonic intelligent pigging and Fitness-for-Purpose analysis carried out by NDT Systems and Services helped KOC to sustain crude oil production and avoid costly repairs while ensuring safe operation without leak incident.

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CHALLENGES IN THE CONSTRUCTION AND INSTALLATION OF PIPELINES GATHERING SYSTEM - REFINERY ABREU E LIMA, BRAZIL

Flavio Alexandre Silva, Ulisses Dias Amado

1 INTRODUCTION

This work has as objective describe the main construction methodologies as well as their points of care, best practices, constraints and assumptions adopted in the construction of pipelines that will compose the gathering system of Abreu e Lima Refinery S/A, linking the vessels oil and refined product and major distribution companies located in the port complex of Suape, Ipojuca - State of Pernambuco - Brazil.

2 CONSTRUCTION OF ABREU E LIMA REFINERY

With the growing economic development of Brazil, associated with an increase in fuel consumption, it becomes increasingly necessary to ensure the fulfillment of the national market.

PETROBRAS aligned to this goal, decided since 2007, starting the implementation project of the Abreu e Lima Refinery S/A, whose main product is its diesel. This refinery whose investment is $12 billion dollars, with a nominal capacity of 230,000 bpd processing, will produce about 90% of diesel oil as its end product. This derivative will cater mostly to the North and Northeast.

The Abreu e Lima Refinery, located in the port complex of Suape in Pernambuco, northeastern Brazil, is now in the final stages of construction. A feature of this refinery stands out the possibility of oil processing in 02 distinct production lines and can therefore process oil from 02 different characteristics. The processing units now under assembly process is characterized by a low degree API oil (less than 16 º), thus enabling a higher profit return for the final product.

[1]3 Pipelines

Aiming at the service gathering system products of the refinery, pipelines were designed with the following features:

Quantity	Duct	Material	Diameter Inches	Nominal flow m³/h	Coating	Length m
1	Petroleum	API5L X60	46	7080/ 8400	3LPE	7000
1	OCREF/ GOPK	API5L X60	24	1670	PP	7000
2	Diesel (Ship)	API5L X60	24	2800	3LPE	7000
2	Diesel (company)	API5L Gr B	12	500	3LPE	7000
1	Nafta Petroq.	API5L X60	20	1670	3LPE	7000
1	Sulfuric acid	AISI 316L	10	180	3LPE	7000
1	Water waste	PEAD	18	550	HDPE	7000
1	LCO	API 5L X60	12	550	PU	7000
1	SLOP	API 5L Gr B	10	205	3LPE	7000
1	LPG	API5L X60	8	200	3LPE	7000
1	Optical cables*	PEAD	4	N/A	N/A	42000

Table 1: Characteristics of pipelines dispatch / receipt of Abreu e Lima Refinery[1]

[1]LEGEND: PP- polypropylene; 3LPE – Triple layer polyethylene; HDPE-High density polyethylene; PU-Polyurethane

Figure 3: Right of way lay out between Refinery and Suape port

Based on the demand presented, the Company held EPC contract for the construction and installation of the whole system. In phase monitoring and execution of the work, we highlight some aspects of great importance, which could enable the execution of services:

Logistics of materials and equipment;
Environmental licenses and permits:
Planning the sequencing of implementation of field activities;
Specific solutions for construction and assembly;
Actions and results of safety, health, environment and social responsibility.

4 LOGISTICS

4.1 Positive points:

Activities carried out in the industrial area with easy access to all parts of the work. Work close to the harbor, and ship transport a great alternative for delivering materials and equipment, as well as modal inland. Tropical climate encourages and enables the execution of works throughout the year, being necessary only care rainy season, which occurs from March to July.

4.2 Difficult points

A series of works carried out at the same time to build the refinery, and other large works that are underway in the region, generate an internal competition for resources of qualified personnel (Skilled Labor in the areas of industrial assembly). Infrastructure supplies and skilled labor less than the required demand, causing a lack of supplies, consumables and personnel.

Because of the detailed design to be hired along with the supply and construction (EPC), environmental per-

Figure 1 and 2: Location and Refinery lay out

Figure 4 and 5: Logistics equipment through containers and overview of the port of Suape

mits of special works (road crossings, water crossings and vegetation removal) occurred during the execution of the work, causing unforeseen delays by regulators.

5 Planning activities for construction and assembly

Because of the pipelines are in an area beyond the fences of the refinery, there was the need to obtain specific licenses for removal of mangrove areas, brench of the river crossing , roads and highways crossings and pipelines in operation.

The assembly of 13 pipelines in parallel in a ROW of 45 m width, was necessary to establish the following sequence of execution:

Surveying, clearing and preparing the ROW;
Ditching and preparation of background of quota ditch;
Stringing, welding, NDT and coating;
Backfilling and rebuilding the track.

6 Solutions and assumptions for the construction and assembly

6.1 Avoid flooded stretches;

When studies indicated a water level above the limit of buoyancy control, has been done a landfill on the pipelines assembled. When this was not possible, we con-

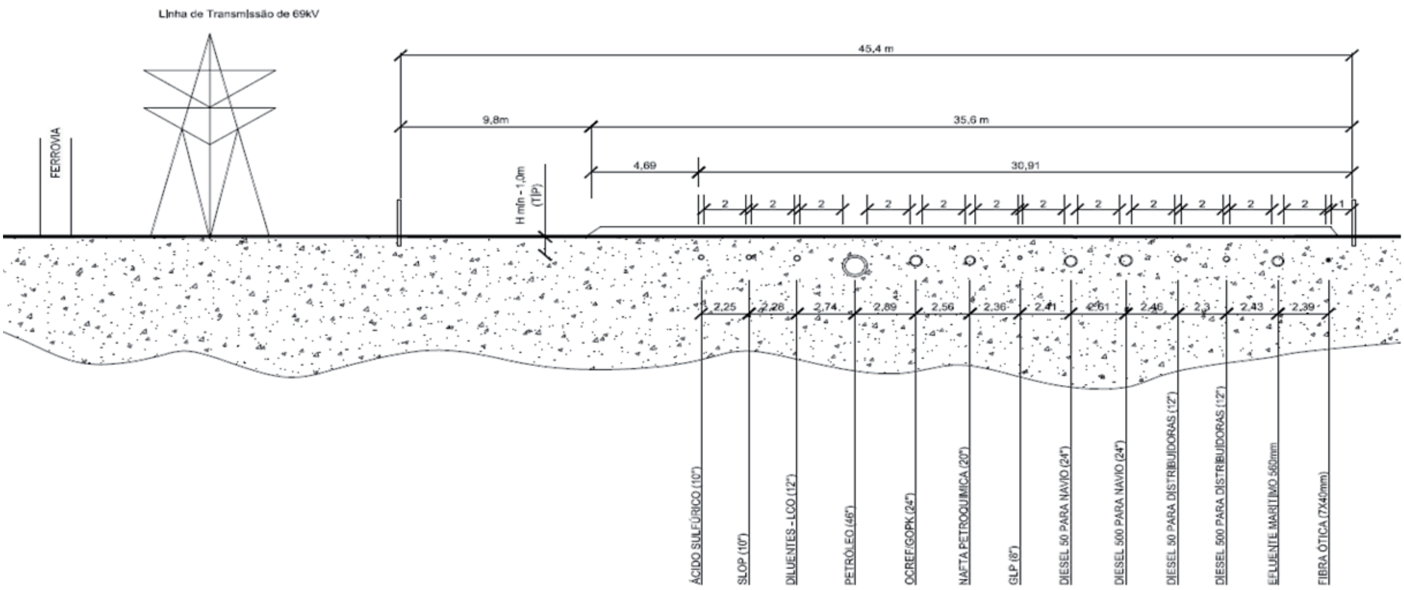


Figure 6: Typical cross section of the range of pipelines

Figure 7 and 8: Bags, concrete coating and saddle on weight

trol the buoyancy through concrete coating, saddle on weight or BAGS.
Obviously, factors such as soil type and devices to containments were considered and evaluated.

6.2 Avoid opening simple trench

With the concept of working with all personnel and equipment at an elevation of bottom of ditch, attempted to avoid the risk of collapse, facilitate the movement of equipment and machinery.

With the assembly work being done already at the bottom of the trench, there is no need for lowering the pipeline column. Therefore we use a small working range area, as well as cranes and side boom had optimized their capabilities.

6.3 Evaluate the methodology of the following crossings:

6.3.1 Pipelines in operation

In this case, the crossings were performed one at a time in order not to cause risks to the pipeline in operation. Because of the depth of excavation is below the water level, we used the aid of lowering system groundwater. With this device can work safely avoiding collapse of the embankment excavated and the perfect visualization of the bottom of the trench to avoid damaging the operating pipeline and the new pipeline. We tried to perform the excavation work in the period of low tide, as it influences the water level due to proximity to the sea.
Roads and Highways

For the crossings with roads, we use HDD (horizontal directional drill), whose technique despite being known, requires some special care such as drilling fluids and the need for geotechnical studies.

Figure 9 and 10: Excavating the trench bottom and pipelines under construction

Figure 11, 12 and 13: Brench of the river before, during and after

An important fact that we highlight is that due to the large number of pipelines in parallel, the angles of entry holes were performed in alternate quotas, thus eliminating any damage to the column to be mounted in case of change of course of the pilot hole.

Water Crossings

In the case of branch of the river crossing, was done a special design, because running a crossing with conventional pull, would not guarantee the distance between the pipelines. The use of non-destructive technique like HDD or microtunneling were also uncertain about the execution time, assembly costs and the success of its completion, due to the large number of pipes in parallel, and the type of terrain that characterized by soft soil, sandy soil and compacted with little gravels.

The excavation in the riverbed would also be difficult to implement due to the constant change of direction of the currents caused by tides. Moreover, surveys of the detailing design identified the occurrence of approximately 33,000 m³ of soft soil on the shores of the crossing.

Based on geotechnical studies, was chosen the option of replacing this stretch of soft soil by sandy terrain. After that, a landfill was performed with the quota fund trench for the entire ROW length of the crossing. However, the interconnection between the mangrove and the branch of river was preserved through several equalization ducts.

With the landfill, the pipelines were assembled in the conventional manner, enabling the assurance of the spacing between pipelines as well as the backfilling. In this case, it was necessary to implement a special work, using rocks on both sides of the ROW to form a containment slope, due to variation of the tide and the proximity of the sea, avoiding loss of material from the landfill run.

With the implementation of equalization ducts and interconnection between the two sides of the ROW, we sought a balance between the integrity of the pipes and the preservation of the mangrove vegetation that was cut off.

6.4 Consider the 46-inch oil pipeline as a separate work

Due to its large diameter, preserve the quota backfilling design among 1.2 m to 1.5 m was almost impossible to avoid the flooded sections, which meant in most cases, the installation of buoyancy control devices. The coat concrete proved to be unfeasible due to the approximate weight of 36 ton per tube 12m long. The adopted technique was the placement BAGS filled with gravel maintaining negative buoyancy.

At highway crossings, where it was not appropriate to do the work by the open cut method, because of the sandy soil with low compression and below the water table, the methodology employed was the implementation of tunnels by utilizing „Microtunneling". For a wide range diameter (60 inch) and till 120 meters long, this technology has more agility, security and guarantee of success for implementing the crossing.

In this service we highlight the need to complete the launch shaft for Microtunnelling, whose depth was around 7m. Prior to the digging, it was necessary to protect the excavation of water ingress and the vertical excavation. So it was specified sheet piles, installed with vibrating pile drivers.

Figure 14: Launch shaft preparation

6.5 Surveys:

Before the excavation of trench, several percussion and rotary soundings were performed, so it was clear to identify areas in need of special care, mainly the incidence of soft soil along this region. These regions could cause deformations not acceptable to pipelines installed and therefore cause unexpected leaks with damage to the environment.

For this we used the following methods:

- Landfill in the affected region over quota coverage project;
- Use of horizontal drains;
- Monitoring repression through piezometric plates.

In some situations, due to the shallowness of the soft soil, landfill has proven to be efficient. But we took care of performing it gradually in order to not cause an abrupt ruputure of the soft soil layer.

However, an area 200m long located at km 02 of the ROW, had occurrence of soft soil at great depths, so the landfill was not enough, requiring the installation of horizontal drains and piezometers. After that, the settlement of the land was monitored for 6 months for the subsequent release of the pipelines assembly.

Another similar event also came at km 03, but a length of 96m, in this case we opted for installation of piles of sand and gravel along the entire stretch affected, whose piles had the dimension of 30cm X 3.5 m and 1.8 m between them. This methodology is more expensive, however the advantage of this method is the ability to install the pipe immediately after the conclusion of the service, which lasted about 04 days.

Figure 15 and 16: Vertical drains on km 02 and sand and gravels piles on km 03

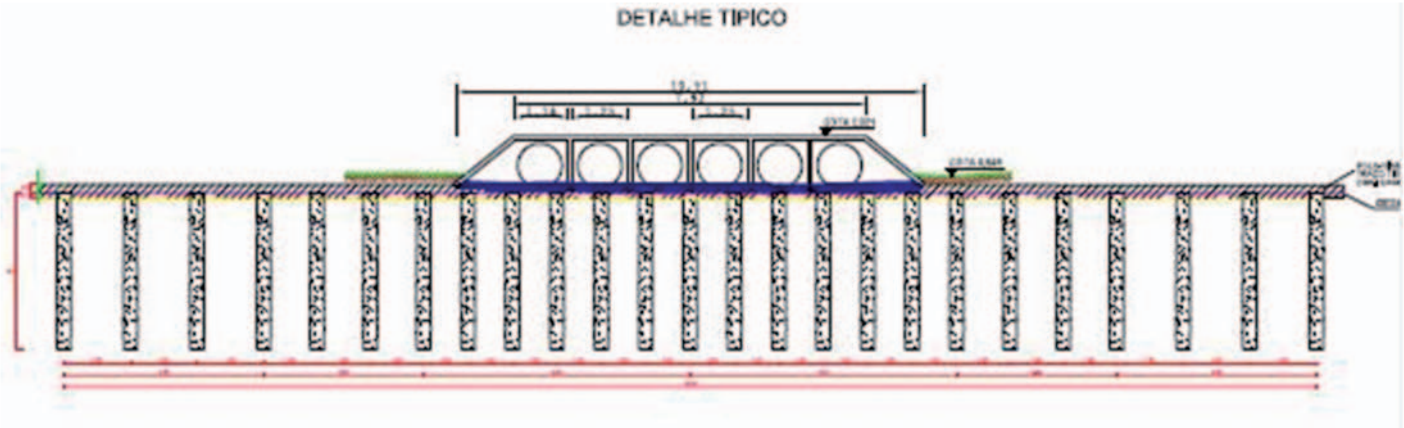
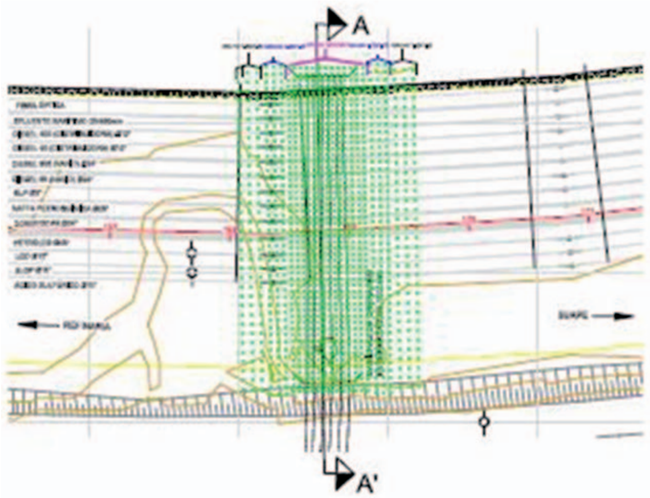


Figure 17 and 18: Sand and gravel pile drawing



6.6 ACTION AND RESULTS IN SAFETY, HEALTH, ENVIRONMENT AND SOCIAL RESPONSIBILITY

Over 20 months, the installation of pipelines had a total of 6 million man hour, in which we obtained the following results as shown in Table 02. We also monitor the environmental restrictions discussed and determined by the environmental license. This is the result of an intensive program where each employee receives a wide range of training, in addition, there were several continuous actions that were performed on the fronts of services such as safety daily dialogues and behavioral audits, seeking preventively avoid damaging the health of employees and the environment.

Regarding the social responsibility campaigns, activities were done with monthly periodicities, promoting the preservation of the environment for residents near the areas of influence of the work, as well as disease prevention campaigns and raising the educational level of the employees.

7 Conclusion

A more detailed study of the terrain and the level of aquifers prior to beginning of the works is essential to anticipate the solution of the problems with soil (eg existence of soft soil) and the definition of special methodology works.

Assemble both sets of pipelines in parallel required a specific and individualized assessment of restrictions and conditions imposed by assembling different materials and diameters of the pipes. This required the project, the use of unconventional ways of assembling pipelines due to exceptional design.

2010	2011	2012	Summary
0	0	0	0
0	3	3	6
0	25	10	35
12	51	15	78
1.120	1.435	3.274	5.829

Table 2: Accident data represented by Frank Bird pyramid

VALUE ENGINEERING APPROACH TO INCREASE COST EFFICIENCY

Tobias WALK,
ILF Consulting Engineers, Germany

ABSTRACT

Nobody would argue that investment and operation costs are a key element for any industrial plant project nowadays. However, has this fact properly considered during the initial design phase of a project? Are the identified solutions selected and opti-mized accordingly? This point is essential during the design phase in order to in-crease cost efficiency during the entire lifetime of the plant. Utilizing a structured engineering approach would guarantee to identify and classify all potential oppor-tunities in order to select the most appropriate ones for the project.

From a general aspect the "Value" of a plant or system can be increased by either improving its adequate functionality or reducing the required capital expenditure (CAPEX) and operational expenditure (OPEX).

In order to optimize the "Value" of a plant its essential functionalities needs to be properly defined and analyzed. This needs to be done in a systematic structured approach. This practice identifies and removes unnecessary functions. Achieving these essential functions at the lowest life-cycle cost would clearly improve the "Value" of a system. The necessary steps for that approach are briefly explained and examples from various projects will be provided for this Value Engineering Ap-proach. These are not limited on Greenfield projects only as this approach can be also applied to Brownfield or Revamp projects. OPEX savings of 40% and more are possible as identified within resent projects. Furthermore the Value Engineering Approach can be also utilized within pre-defined Engineering Technical Practices which can be used as company standards.

The general steps of the Value Engineering Approach will be explained and supported by various examples.

1 Introduction

The financing of large investments for industrial plants (like Pipeline Infrastructure or their dedicated storage and export facilities) is a critical element for the success of a project. A responsible allocation of the required resources is therefore essential and the cost efficiency needs to be optimized. The "Value" of a plant can be used to measure the cost efficiency already during the early design phase. The "Value" of a plant can be defined as the reliable performance of "functions" to meet customer needs at the lowest overall "costs".
In mathematical terms the "Value" of a plant or system can be reflected within the following simple algorithm:

Value = Function / Cost

The "Value" is derived from the ratio between the provided "Functions" and "Cost". Within this respect a "Function" is the characteristic action performed by a plant or system and the "Cost" is the expenditure (CAPEX & OPEX) which is necessary to realize, construct and operate a plant or system.

From a general aspect the "Value" of a plant or system can be increased by either improving its functionality or reducing the required capital expenditure (CAPEX) and operational expenditure (OPEX).

In order to optimize the "Value" of a plant its essential functionalities needs to be properly defined, analyzed and improved. This needs to be done in a systematic structured approach within an interdisciplinary and experienced team. This practice identifies and removes

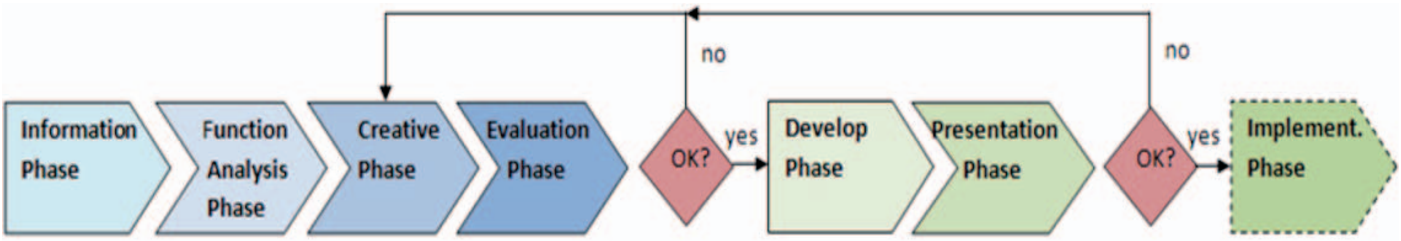


Figure 1: Value Engineering Workflow

unnecessary functions. Achieving these essential functions at the lowest life-cycle cost would clearly improve the "Value" of a system which forms the basis of the Value Engineering approach.

2 Methodology

The Value Engineering methodology is based on a multistage job plan, sometimes also called as "value analysis job plan". The required stages depend on the applica-tion, but in general the following 6-step approach (Figure 1) is very typical and forms the basis.

The individual workflow steps do contain the following activities:

Information Phase

Within this initial task it is required to gather information about the proposed plant/system and its required main functions for a better understanding of the pro-ject.

Function Analysis Phase

During the Function Analysis Phase the project will be analyzed in order to clarify the required functions. It tries to identify what functions are important and which performance characteristics are required for these functions.

These function analysis activities are typically performed during a workshop exer-cise with an interdisciplinary experienced team. The individual experts will provide input from their areas of expertise as relevant for the project (e.g. system designer, senior engineers, plant manager, operation expert). This thought process is based exclusively on "function" (e.g. what something "does" and not what it "is"). Also ini-tial alternative ideas might be already generated, registered and compared during that workshop for the next phase as shown within Figure 2. This exercise is an open discussion of further improvements rather than a quality evaluation of the de-sign.

Creative Phase

Within the Creative Phase it is required to generate ideas on all possible ways to achieve the required functions. It is looking for various alternative solutions to achieve the identified requirements. Ideally this would be a process without any re-strictions or limitations in order to pick-up also the possibilities of new technologies or unconventional solutions.

Evaluation Phase

The Evaluation Phase is assessing the ideas and concepts derived from the Crea-tive Phase. It will cross-check and verify if these alternatives do meet the required functions. During that Phase the feasible and most promising ones are selected for further steps.

Development Phase

The identified best ideas / alternatives from the Evaluation Phase are selected and further developed during that phase. In order to improve the value of the plant a special focus would be on their impact, what are the costs and what performance can be expected?
Presentation Phase
The identified and developed alternative solutions are presented to the project stakeholders. The presentation shall provide all pros and cons of the alternative solutions and convince the stakeholder to follow the recommendations to improve the value of their project or plant. With the approval of the stakeholders the alternative solutions will be granted a form part of the project implementation phase.

	Item	Function (verb)	Function (noun)	Function is provided?	Alternative 1	Does it fulfill function?	Does it reduce cost?	Alternative 2	Does it fulfill function?	Does it reduce cost?
1	Cooler in station recycle line	allow	performance test	y	Locate cooler in main stream (potentially with by-pass)	y	n (n)	No cooler	n	y
		allow	high compression rates	n		y			n	
		allow	steady state unit recycle	n		y			n	
		avoid	pressure drop (in main line)	y		n (y)			y	

Figure 2: Example for the Function Analysis

Figure 3: Oil Transportation Modelling

3 Examples

The Value Engineering Approach is possible within various types of projects and not limited to Greenfield project plants only. It can be used also for Brownfield / Re-vamp projects and it's getting more and more popular within this area. Furthermore the Value Engineering Approach is also not limited to (re-)construction of real in-dustrial plants only as it is also possible to utilize it for the update of company standards. The following examples are derived from recent projects within ILF and shall provide a flavour of the variety and it's possibilities to utilize the Value Engi-neering Approach.

Greenfield Projects

Within the Burgas – Alexandroupolis Crude Oil Pipeline project (in Bulgaria and Greece) an Oil Transportation Model has been developed to reflect all required functions and boundary conditions. It defines the amount of oil supply at No-vorossiysk and Sheskharis Terminals, the required black see shuttle traffic via ves-sels to reach Burgas, the pipeline transport capacity and it provides the required fig-ures to optimizes the tank farm storage capacity as well as the marine facilities (see also Figure 3). The derived key parameters have been further used to determine the optimum pipeline diameter and the required number of pump stations.

The approach is based on a simulation model which equips organizations with the ability to ask "what-if?" when making strategic decisions. Simulation's unique time based approach, in conjunction with the ability to reflect the factors that vary, enab-les models to accurately mimic the complexities of real life systems. As a result, de-cision-makers can be sure that they have found the solution that strikes the right balance between capital costs and service levels.

Brownfield Projects / Revamp Projects

In 2011 ILF has been involved as an Engineering Contractor responsible for Re-Engineering and Infrastructure Optimization Study of the Samotlor field which is the biggest oil field in the history of the Former Soviet Union and one of the biggest in the world. The Samotlor field is in operation since 1969 and has produced some 2.3 billion tons of crude oil until now.

The Purpose of the Re-Engineering and Infrastructure Optimization Study was:

- to ascertain options for infrastructure development of the Samotlor field in its mature stage of production, allowing for improvement of economic indicators of field operation;

- to optimize expenses for infrastructure maintenance in safe mode and with-out loss of production throughout the remaining period of operation (estimated till 2030)

Within this respect the Value Engineering Approach has been utilized in this project and the required steps performed accordingly (see also Figure 4):
Due to the magnitude of the Re-Engineering Project in total 143 sub-options could be identified during the Creation Phase of Value Engineering Approach. In order to better structure and handle this big amount an additional Screening & Condensing Phase (see also Figure 5) has been introduced which reduced it to 10 strategic sub-option packages and finally identified 3 strategic options, which are based on each other. The Base Case was further developed and investigated in detail.

Due to the identified Base Case it was possible to identify about 40% of OPEX sav-ings and to increase the revenue gains (see also Figure 6).

4 Conclusion

Utilizing a structured engineering approach would guarantee to identify and classify all potential opportunities in order to select the most appropriate ones for the project. The Value Engineering Approach can be utilized within various project types to in-crease significantly the cost efficiency of a plant. Therefore it is an essential meth-odology to increase the value of a plant or system at an early stage of a project. The approach is not limited to Greenfield projects and can be adapted also for Brown-field revamp projects or the development of company standards.

Literature

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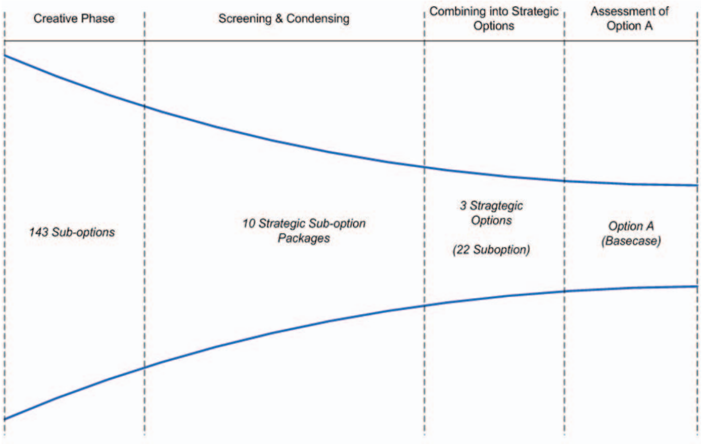

Figure 5: Screening & Condensing Phase

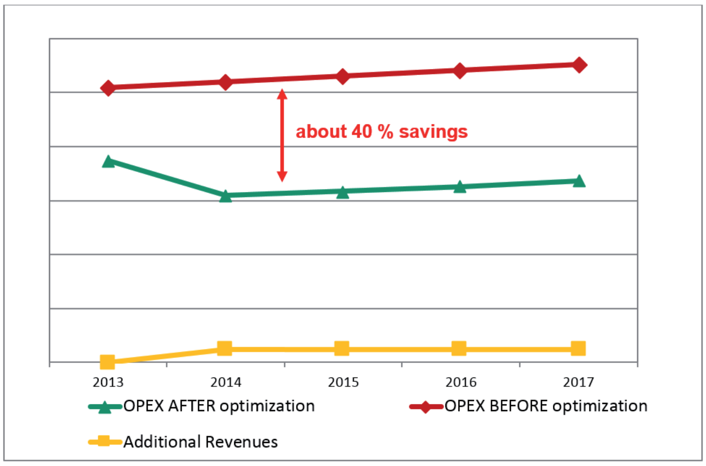

Figure 6: OPEX savings and Revenue Gains

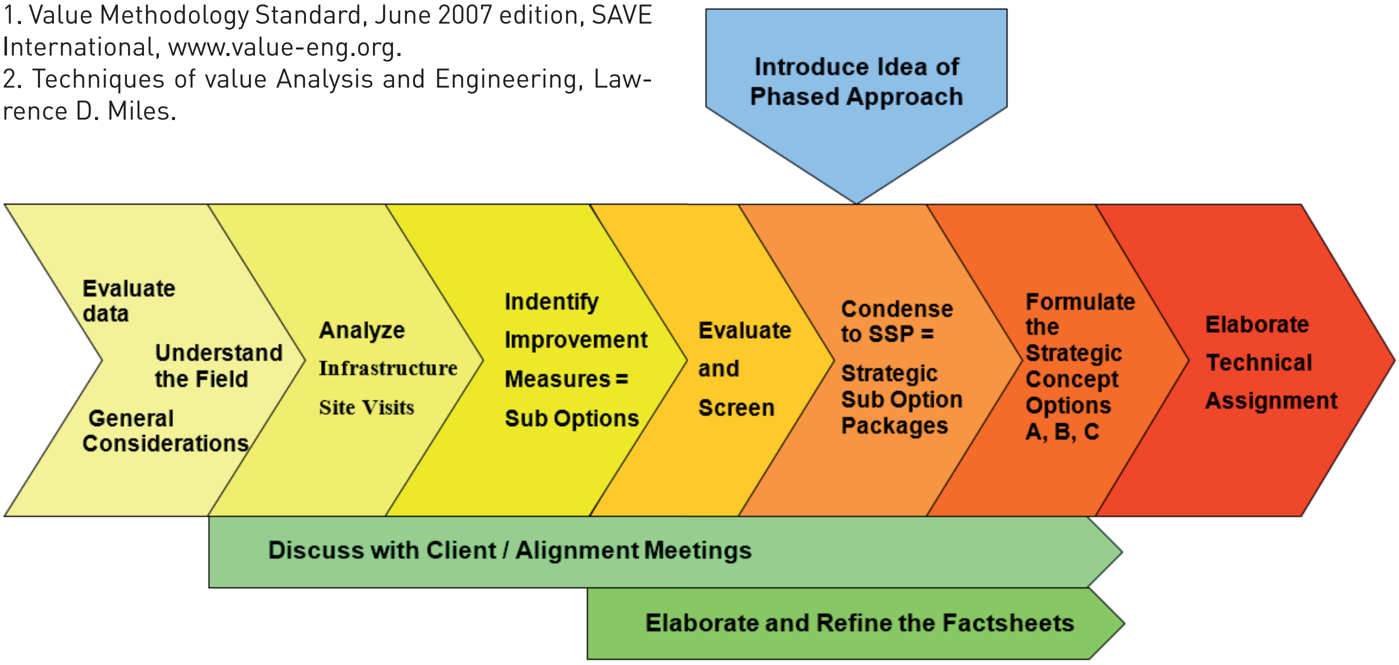

Figure 4: Value Engineering Workflow within Re-Engineering Project

THE DEVELOPMENT TENDENCY OF PIPELINE STANDARDS BASED ON QUANTITATIVE AND QUALITATIVE ANALYSIS

Bing Liu, Biyuan Shui, Kaixuan Wu
PetroChina Pipeline R&D Center, 51 Jinguang Road, Langfang, Hebei, 065000, P.R.China

ABSTRACT

Standardization, as the basis of pipeline, plays an important role in the sound development of pipeline operation and ensures its safety and efficacy on technology. In recent twenty years, pipeline standards have been developed and revised significantly in the world. A growing number of engineers would like to know which standards are more relevant to them when they face massive pipeline standards from different countries and organizations. However, there is no such a method that can objectively analyze the development tendency of pipeline standards for the whole world.

This paper developed a new method and discussed the technical basis of the procedures. Firstly, the general methodology of bibliometrics and content analysis was reviewed. The bibliometrics and content analysis are important tools to estimate the development direction of pipeline standards. Then the national standards of 7 countries, including China, the United States, Britain, France, Germany, Japan and Russia, as well as the standards of international standardization organizations, including ISO, IEC, and EN, were collected and analyzed. In this stage, more than 18 thousands standards were taken into account and the wide coverage would represent the world development tendency of pipeline standards as much as possible. Finally, four development trends of oil and gas pipelines standards were found in this study.

1 INTRODUCTION

1.1 Background

Standardization, as the basis of pipeline, plays an important role in the sound development of pipeline operation and ensures its safety and efficacy on technology. In recent twenty years, pipeline standards have been developed and revised significantly in the world. A growing number of engineers would like to know which standards are more relevant to them when they face massive pipeline standards from different countries and organizations. However, there is no such a method that can objectively analyze the development tendency of pipeline standards for the whole world.

1.2 Outline of the work

This paper determined the quantifiable content of standard data and the adopted data analysis methodologies based on standard features first, and then confirmed the scope of standards analyzed in this paper on oil and gas pipelines, and studied and determined the schemes and methods for data processing and data retrieval, and established standard data set for data processing; and finally carried out analysis for the development trend of oil and gas pipeline standards and drew a conclusion.

2 THE METHODOLOGY OF BIBLIOMETRICS AND CONTENT ANALYSIS

Through combining the qualitative analysis and quantitative analysis, this paper applied the LIS research methodologies, mainly including bibliometrics and content analysis methodology and literatures survey methodology, in this study and analysis of standard literature data for the first time.

2.1 Bibliometric methodology

Bibliometrics is a branch discipline of library and information science, which describes, evaluates and predicts the status quo and development trend of science and technology with mathematical and statistical methods assisted with the quantity of various features of literatures. This paper carried out analysis for „quantifying" features of standard literatures, that is performed analysis and collation of data which can be quantified, such as quantity of standards, year of publication, age of standard, adoption rate, adoption degree, adoption and time performance, etc, to reveal and explore the development status quo of standards and the generality and difference between various types of standards.

2.2 Content analysis methodology

The content analysis method is a research method carrying out description and analysis of literature content in an objective, systematic and quantitative way and has been widely used in social science research. The content analysis is mainly used in statistical analysis of library science, information science, science and technology, economy and society, etc, to understand its development status and predict development trend.

The basic features of content analysis methodology are objective, systematic and quantitative, in which quantitative is the most significant feature and is a necessary mean to achieve „accurate“ and „objective“. In quantifying process, in addition to a lot of literature samples, the statistical analysis must also be carried out for knowledge content contained in sample literature.

The content analysis in this paper was based on two basic analysis methodologies, word frequency statistics analysis methodology and co-word analysis methodology. This paper mainly used subject word frequency statistics analysis methodology, the subject word field in standard database was marked according to ISO descriptors, revealing the technology development process with year distribution of word frequency. This paper segmented subject words based on the data item of subject word (A837) in standard database, and carried out natural language clarifying (merging synonym, conjugate, singular and plural words) for the data, and performed uniqueness treatment of subject words (one subject word should appear once at most in one standard; if not, remove the excess one), remove generic words manually, and generate a co-occurrence matrix with many subject words appeared in highest frequency, and then standardize the co-occurrence matrix and generate relationship diagram accordingly to reveal the focus and development trend for natural gas and pipeline standards.

2.2.3 Literatures survey methodology

In this paper, the national standards of seven countries, including China, the United States, Britain, France, Germany, Japan and Russia, the standards of three international organizations ISO, IEC, EN and the websites of eight professional standard organizations including API, ASME, NACE, AGA, NFPA, ISA, IEEE, ASTM, as well as conference paper, theses and dissertations, journal papers, books, technical reports related to long-distance oil and gas pipelines were collected and analyzed, to understand the overall development situation of standards organizations and their related standards.

3 Establishment of data set for natural gas and pipeline standards

This paper required to set-up a data set for standards in the field of long-distance oil and gas pipelines, mainly related to standards established and published by 18 standards organizations including ISO, IEC, EN, GB (China), ANSI (USA), BSI (Britain), AFNOR (France), DIN (Germany), JIS (Japan), GOST (Russia), API, ASME, NACE, AGA, NFPA, ISA, IEEE, ASTM. During the process to establish the appropriate standard data set, it is required to go through a series of working processes, including determination of data sources, data extraction, data normalization processing, data duplication checking and special data retrieval.

3.1 Data Sources

National Library of Standards of CNIS has completed the translation of standard titles into Chinese and their Chinese classification processing. German Perinorm database has the characteristics of complete field items and complete standard data, through retrieving required data from context of two databases respectively and then carrying out merging, standard number format unification, data duplicate check processing can guarantee that the data retrieval is comprehensive and accurate, providing a reliable data base for this research. Therefore, we selected above two databases as data sources.

3.2 Scope of data

According to the content and objectives of this research, the data range of standard data set is as follows:

- 3 international and regional standards: ISO, IEC, EN;
- 7 national standards: GB (China), ANSI (USA), BS (Britain), NF (France), DIN (Germany), JIS (Japan) and GOST (Russia);
- 8 professional standards: API, ASME, NACE, AGA, NFPA, ISA, IEEE, ASTM.

3.3 Data extraction

This paper analyzed and determined applicable Chinese classification for standards and international classification for standards according to the professional field range required by Party A, and extracted standard data from Chinese standard database and German standard database for 18 standard organizations, including ISO, IEC, EN, GB, ANSI, BS, NF, DIN, JIS, GOST, API, ASME, NACE, AGA, NFPA, ISA, IEEE and ASTM.

3.4 Data processing

The data items are not exactly the same between the Chinese standard database and the German standard database, to merge and de-duplicate the data extracted from two databases, it is required to unify and standardize the structure of two databases. After analysis of the two databases, the data items required to be unified and standardized include publication organizations and Standard No. The unification and standardization method is to carry out standardized processing for data items in the German standard database according to the descriptive rules of the Chinese standard database.

3.5 Data merging

After standardized processing for data items in the German standard database, we determined the data items required by this research after analysis and study of data items between the Chinese database and German database according to the data content needed in the research.

3.6 Data de-duplication and transfer

After merging the data extracted from Chinese standard database and German standard database, it is required to carry out de-duplication and transfer processing for merged data for the purpose of keeping uniqueness of each standard data and absorbing characteristics and advantages data content from two databases.

3.7 Establishment of a data set for long-distance oil and gas pipeline standards

After keyword retrieval, classification retrieval with above retrieval program and data de-duplication, the primary database for long-distance oil and gas pipeline standards is formed, but if we want a more actuate databases for current standards, draft standards and withdrawal standards for long distance oil and gas pipelines, it is required to carry out screening and manual processing for different kinds of data. Since the primary database for current standards, draft standards and withdrawal standards of long-distance oil and gas pipeline may still contain irrelevant data after above processing and retrieval of computer program, and to ensure the accuracy of the data in above primary databases, manual data screening is required. After manual screening, the data set of oil and gas pipeline standard is set. The total number of standards in oil and gas pipelines standard data set is 18,904, in which, the current standard is 11,234; withdrawal standard is 6408 and draft standard 1312, as shown in Table 1.

Standard type	Quantity (number)
Current standard	11,234
Withdrawal standard	6,358
Draft standard	1,312
Data quantity	18,904

Table 1: Data Quantity in the Data Set of Long-distance Oil and Gas Pipeline Standards

4 ANALYSIS OF THE DEVELOPMENT TREND OF LONG-DISTANCE OIL AND GAS PIPELINE STANDARDS

4.1 Comparative analysis of standard quantity

Carrying out a comparative analysis of standard quantity of various standard establishment organizations can start from understanding the similarities and differences in quantity. The quantity of standards of published by 15 standard establishing organizations (including 7 countries and 8 professional standard establishing organizations in the USA) is 9332, the comparison of standard quantity of different organizations is as shown in Figure 1.

According to Figure 1, the quantity of standards issued by national standard organizations is greater than that issued by professional standard organizations in the United States. In professional standards organizations, the quantity of ASTM standards alone exceeds some national standards organization, ranking 4th in all standard organizations

4.2 Comparative analysis of year of publication and age of standards

According to the comparative analysis of year of publication and age of standards, we can understand the timeliness as well as applicability of standard establishment and revision, providing a basis for standard establishment work. We performed statistics for year of publication of standards from 15 standard establishment organizations and for standard quantity issuing each year, and please refer to Figure 2 and Figure 3 for statistical results by standard quantity and by ratio respectively. The ratio refers to the quantity of standards publishing by one organization in one year to total quantity published in that year. According to the statistics of Figure 2 and Figure 3, we can see that: DIN standard has developed rapidly since 2000, reaching peak of standard establishment in 2010 (245), accounting for 15.63% of the total quantity of the organization. GB standards has also developed relative rapidly, especially in 2005-2010, with annual average establishment of over 100 standards, and 95 standards was established in 2008 alone. The AFNOR standard had been in significant growth trend since 1990s, reaching peak in 2007 (121), accounting for 9.36% of the total number of the organization, but thereafter the quantity of standards establishment has been declining slightly.

4.3 Comparative analysis of age of standards

We carried out statistics of age of standards published by various standard establishment organizations respectively, the statistical comparison diagrams by quantity and by ratio are as shown in Figure 4 and Figure 5. According to Figure 4 and Figure 5: for standards of age of 1-year, ASTM ranks first in quantity (166), followed by DIN (113); NFPA ranks first in ratio (15.67 %), followed by ASTM (15%). For standards with age of 2-year, DIN ranks first in quantity (245), followed by ASTM (160); NFPA ranks first in ratio (23.53%), followed by ASME (16.05%). For standard of age of 1 to 5-year, DIN ranks first in quantity (722), followed by ASTM (606), BSI comes third (555) and China fourth (461). For standard of age of 6 to 10-year, BSI ranks first in quantity (514), followed by AFNOR (423).

If comparing by ratio, the standards of age of 2-year rank first (15.63%)in DIN, the standards of age of 5-year rank first in BSI (8.71%), AFNOR (9.35%) and GOST (9.34%); the standards of age of 3-years rank first (13.87%) in ANSI; The standards of age of 4-year rank first in GB (17.8%) and JISC (13.67%).

4.4 Comparative analysis of technical fields

Comparing the standard establishment situations in various technical fields by various standards organizations can compare and analyze the difference between different countries in technical fields of standards, providing a basis for the rational establishment of standards. The technical field comparison adopted ICS for division of technical fields. Except for ISO, IEC and EN, the quantity of current standards on oil and gas pipelines published by 15 standard establishment organizations with ICS is 7168 in total. Overall comparative analysis of technical fields is to compare and analyze the standard distribution in various technical fields of different standard establishment organizations, and to carry out statistics of standard quantity of various agencies in various technical fields, the results of the ICS statistics are as shown in Figure 6.

According to Figure 6, among national standard organizations, BSI basically has the maximum standards quantity in various technical fields while JISC has the minimum, GB has less standard in fundamental discipline and measurement. All professional standard establishment organizations rank first within their respective professional fields, such as API in petroleum field, IEEE in electronic field and NFPA in fire field. We carried out detailed secondary classification for standards in petroleum and related technology fields to understand the distribution of standards in various professional fields in petroleum industry, the statistical results are as shown in Figure 7.

According to Figure 7, standards on fuel field(75.160) have maximum quantity, in which ASTM come first in quantity (2145), followed by DIN (134); NFPA ranks first in ratio (100%); In the field of oil and gas industry equipments (75.180), API ranks first (199) in quantity, followed by BSI (54); In integrated areas of petroleum products(75.080), ASTM ranks first in quantity (104), followed by BSI(72) and DIN comes 3rd (67), while JISC ranks first in ratio(40%). In the field of petroleum, petroleum products and natural gas storage and transportation, BSI ranks first in quantity, followed by AFNOR, ANSI comes third, GB fourth, JISC the last.

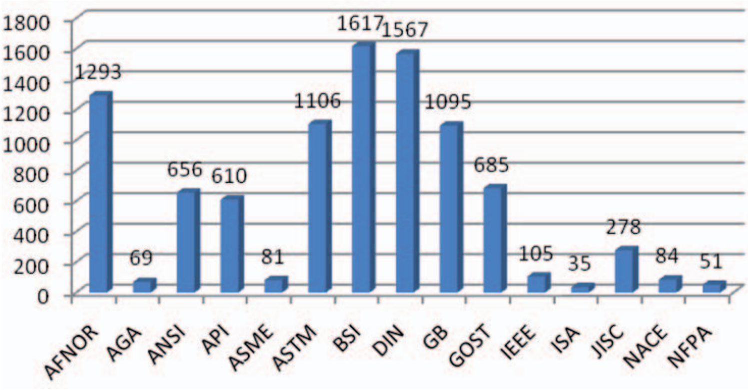

Figure 1: Comparison diagram of standard quantity

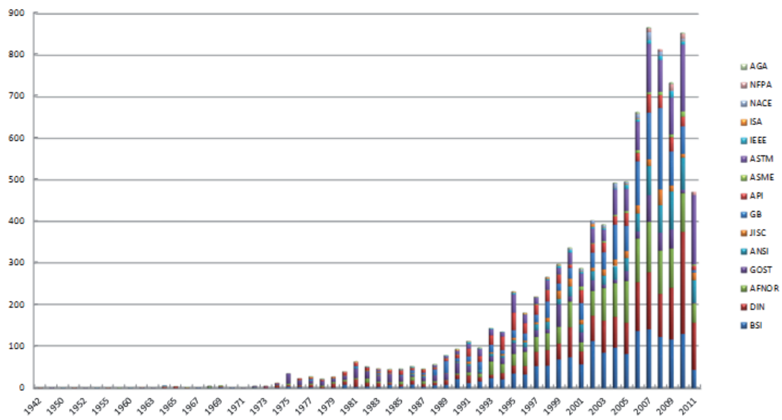

Figure 2: Comparison diagram of year of publication of standards (by quantity)

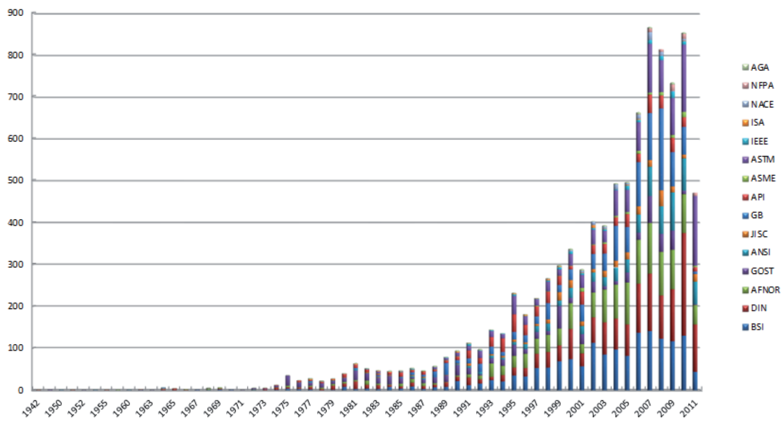

Figure 3: Comparison diagram of year of publication of standard (by ratio)

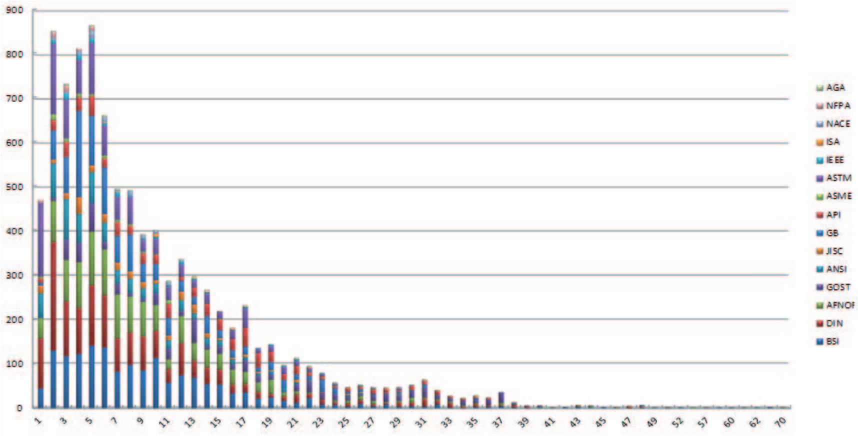

Figure 4: Comparison diagram of age of standards

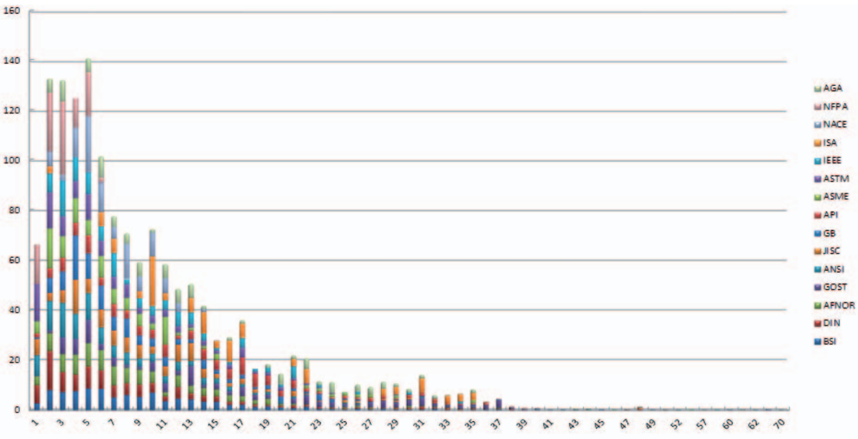

Figure 5: Comparison diagram of age of standard age

4.5 Analysis of the development trend of long-distance oil and gas pipeline standards

4.5.1 General development trend

The analysis was based on the data of all current standards, analyzing the general development trend of long-distance oil and gas pipeline standards through segmenting and processing of subject words of all current standards. We selected 200 high-frequency words to generate a general development trend diagram of long-distance oil and gas pipeline standards as shown in Figure 8.

According to Figure 8, the long-distance oil and gas pipeline standards shows the following general development trends:

- Pipe and inspection or test are the key fields of standard development, which have close relations to each other, that is to say, the pipeline inspection and test are focus of standard development.

- Design, measure and content are relative important fields of standard development, and design has close relation not only with inspection or test, but also with pipes, that is to say, the standards on design and inspection or test are in coordinated development, the pipeline design standard is one of development priorities. While measure standards are closely related to the standard on inspection or test, which should be in coordinated development. The standards on content are rela-

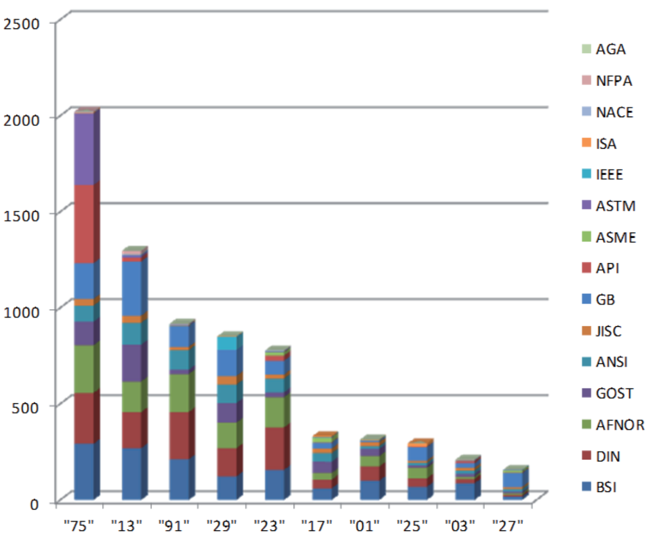

Figure 6: Comparison diagram of technical field distribution

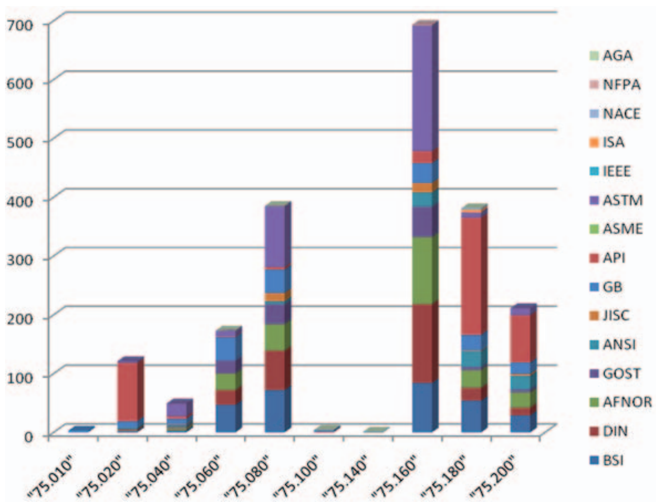

Figure 7: Comparison diagram of technical field distribution in petroleum industry

tively independent, only related to composition, pollution and other special indicators.

- Pipeline standards are related with industry, accessories, plastic, metal, valves, identification, etc, that is to say these standards are standards often involved in pipeline standards.

- Standard on safety requirements is a relative hot field, but not directly related with the pipeline, and mainly associated with inspection or test and electrical engineering, showing that special safety standards for pipelines have not specially developed yet, and electrical safety, and inspection and testing safety are the focus of development.

- Standards on electrical equipments and electronic devices are separated with general standards, showing that this kind of standards have no direct relation with pipeline standards.

4.5.2 Technical fields of new development standards

The analysis was based on the standards newly established in recent three years, the data screening conditions was the standards that publishing after 2009 and without data in "Replaces" (A462) data item . It analyzed the newly developed technical fields of oil and gas pipeline standards through segmenting and processing of subject words of these standards. Through data retrieval and screening, 1337 new standards were established in recent three years; please refer to Table 2 for the new standards established by various standard establishment organizations in recent three years.

According to above table, the quantity of standards of age of 3-year is maximum, and of age 1-year is minimum. For various standard organizations, ASTM ranks first in quantity of standards established in recent 4 years (328), followed by GB (186), ISA the last (1), followed by AGA (10). ASTM standard of 1-year is maximum in quantity, showing that its revision speed is very fast and standard update is timely. GB standards of age of 4-year is maximum, showing that its reversion should speed up.

4.5.3 Technical fields of new developed standards

After processing of subject words for all new standards with content analysis methodology as mentioned in section 2.2, 250 high-frequency words were selected to generate a technical field diagram for new developed standards, as shown in Figure 9. According to Figure 20, the technical fields of newly developed oil and gas pipe-

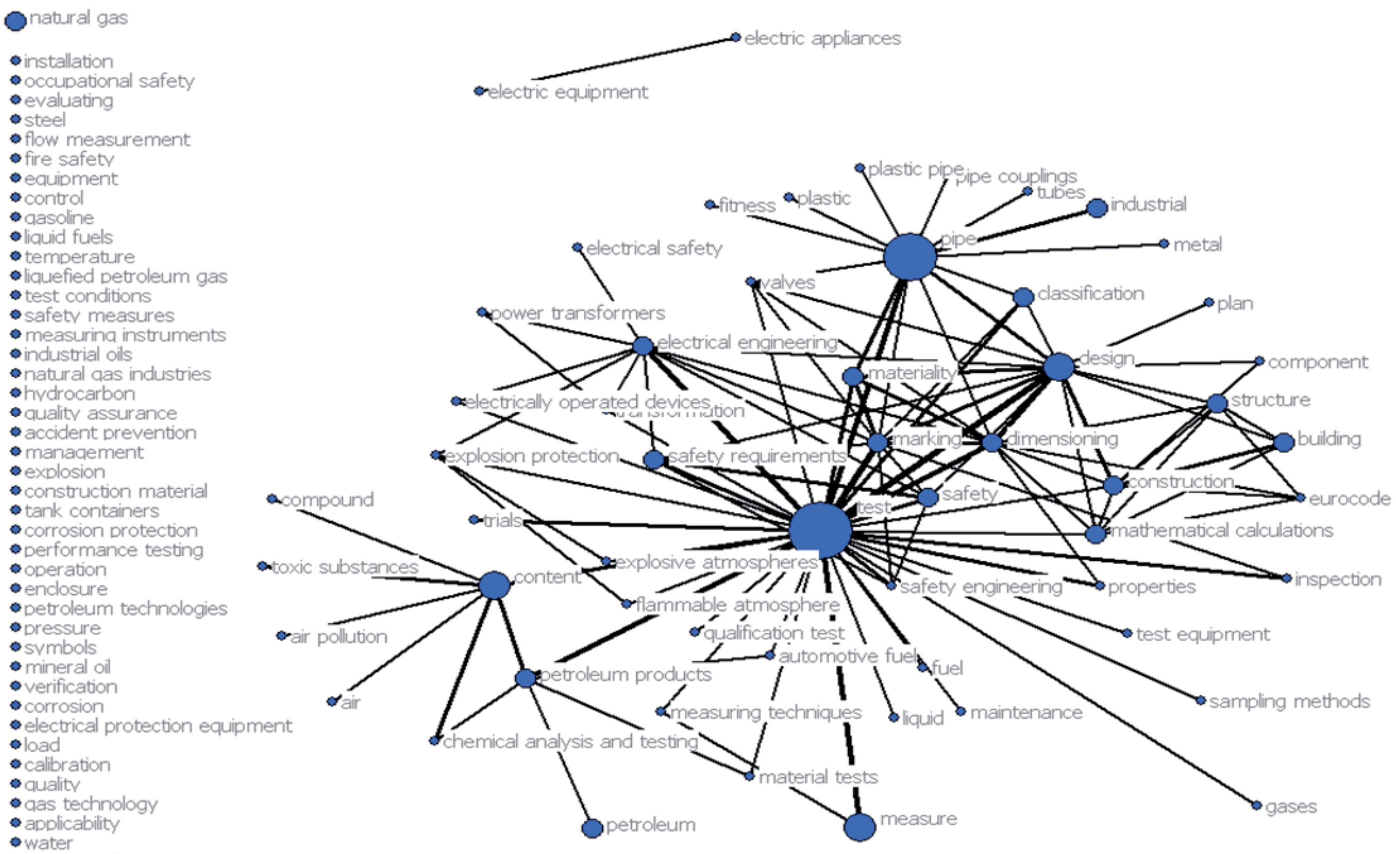

Figure 8: General development trend of standards

Standard organization	Standard age of 1-year	Standard age of 2-year	Standard age of 3- year	Standard age of 4-year	Total
ISO	2	6	15	18	41
IEC	2	4	8	10	24
EN	2	6	12	8	28
BSI	18	36	39	35	128
DIN	7	18	46	32	103
AFNOR	20	43	48	49	160
GOST	2	8	41	34	85
ANSI	18	26	29	20	93
JISC	9	2	6	29	46
GB	5	50	55	76	186
API	3	11	16	11	41
ASME	2	2	4	7	15
ASTM	108	115	60	45	328
IEEE		3	6	4	13
ISA		1			1
NACE		5	2	10	17
NFPA			12	6	18
AGA		4	6		10
Total	198	340	405	394	1337

Table 2: Age and quantity of standards newly established by different standard organizations

lines standards and its related fields are wide in range, including pipes, fittings, design and construction, inspection, non-destructive testing, operation and maintenance, etc. The new technology shows the „cluster" trend, the standards of the new technology are focused in the following fields according to Figure 9:

- The quantity of new standards related to pipelines is maximum, including steel pipe, plastic pipe, fittings, joint piece, piping systems, piping installation, and so on.

- The quantity of new standards related to inspection and testing is relative great, including inspection, quality verification tests, safety, and security requirements, electrical engineering, explosion protection, etc, inspection and testing standards are most closely associated with pipe design.

- Standards in design include specifications, construction, structure, classification, performance, mathematical calculations, pavement marking, etc and design standards more closely associated with pipes and detection. In addition to the above-mentioned fields, a few new standards are also appeared in petroleum products and transportation.

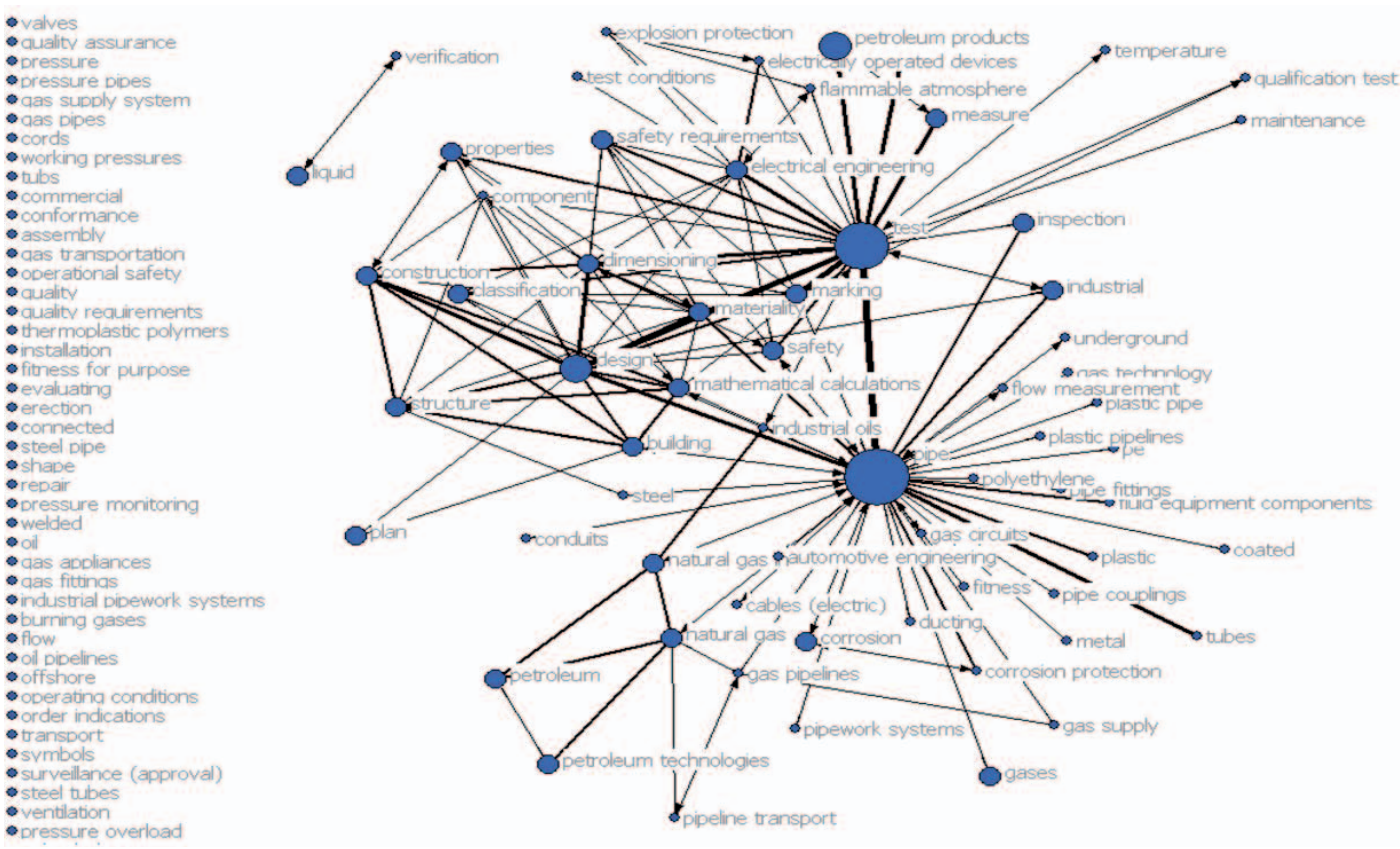

Figure 9: Technical fields of new development standards

4.5.4 Technical fields of standards under continued development

The analysis was based on current standards of average reversion cycle less than 3 years, the data screening condition was the standards with data in replaces (A462) data item, segment the standards in history version (A900) data item to calculate the time difference between the various versions of the standard, and screen the standards of average reversion cycle of 3 years from it. Through segmenting and processing of subject words of these standards, we can analyze the technical fields of long distance oil and gas pipeline under continued development.

According to data retrieval and screening, the quantity of standards with revision cycle of three-year is 2094 in total. Generally speaking, if sorting by quantity of standards of establishment cycle less than three years, DIN comes first (482), followed by BSI (286), EN third (228) and GOST the last (14).

Eight standard establishment organizations, including ISO, EN, DIN, BSI, ANSI, GB, API and ASTM have standards of revision cycles less than 2 years. In which, for the quantity of standards of revision cycle of 1-year, EN ranks first (91), followed by DIN (51) and ISO third (39); for the quantity of standards of revision cycle of 2-year, DIN ranks first (61), followed by ISO (49) and EN (48). In professional standards organization, ASTM performance is more prominent, with 20 standards of revision cycle of one year and 38 standards of reversion cycle of 2-year. Chinese GB standards have 10 standards of revision cycles of 2-year, which are slower in update speed than that of DIN, BSI and ASTM.

After processing subject words of all standards of reversion cycle of 3-year, we selected 250 high-frequency words to generate a technical field diagram of standards under continued development, as shown in Figure 10. According to Figure 10, the standards in continuously updated are concentrated in three major fields: (1) inspection and test; (2) pipeline, including plastic pipe, corrosion inhibitor, gas line, pipeline transport, valves, pressure test, etc.; (3) design and construction, including mathematical calculations, pavement marking, structure, mechanical properties, components, applicability, etc. So, in inspection and test, pipeline design and construction field of subject field of said current standards, there are some standards under continued reversion, reflecting that these fields adopt more new technology to continuously improve the level of standardization.

4.5.5 Technical fields of future developed standards

The analysis was based on draft standards proposed in recent 4 years, that is excluding drafts of revised standards, and data screening condition was the standards without data in replaces (A462) data item in draft standard database. Through segmenting and processing of subject words of these standards, we can analyze the technical fields of long distance oil and gas pipeline standards to be developed in the future. According to data retrieval and screening, the quantity of draft standard proposed in recent 4 years is 283 in total. Refer to Table 3 for standard establishment organizations and the quantity of draft standards.

As the data for draft standard was difficult to obtain, the new proposed draft standards screened from the database only included the draft standard of ISO, IEC, EN and DIN. In which, ISO ranked first both in total draft standard quantity and draft standard quantity proposed in 2011, followed by DIN.

After processing of subject words for all draft standards with method mentioned in section 2.2, 250 high-frequency words were selected to generate a technical field diagram for standards to be developed in the future, as shown in Figure 11. According to Figure 11, there are two main fields that new standards may be established:

- New standards related to pipelines: standards in this respect are more concentrated, involving more detailed subjects, including plastic pipes, corrosion and corrosion inhibition, gas line, physical properties, mechanical properties, sleeve, gaskets,

Standard organizations	Standards of age of 1-year	Standards of age of 2-year	Standards of age of 3-year	Standards of age of 4-year	Total
ISO	21	37	24	25	107
IEC	0	5	6	2	13
EN	9	23	19	14	65
DIN	19	32	23	24	98
Total	49	97	72	65	283

Table 3: Draft standard proposed in recent 4 years

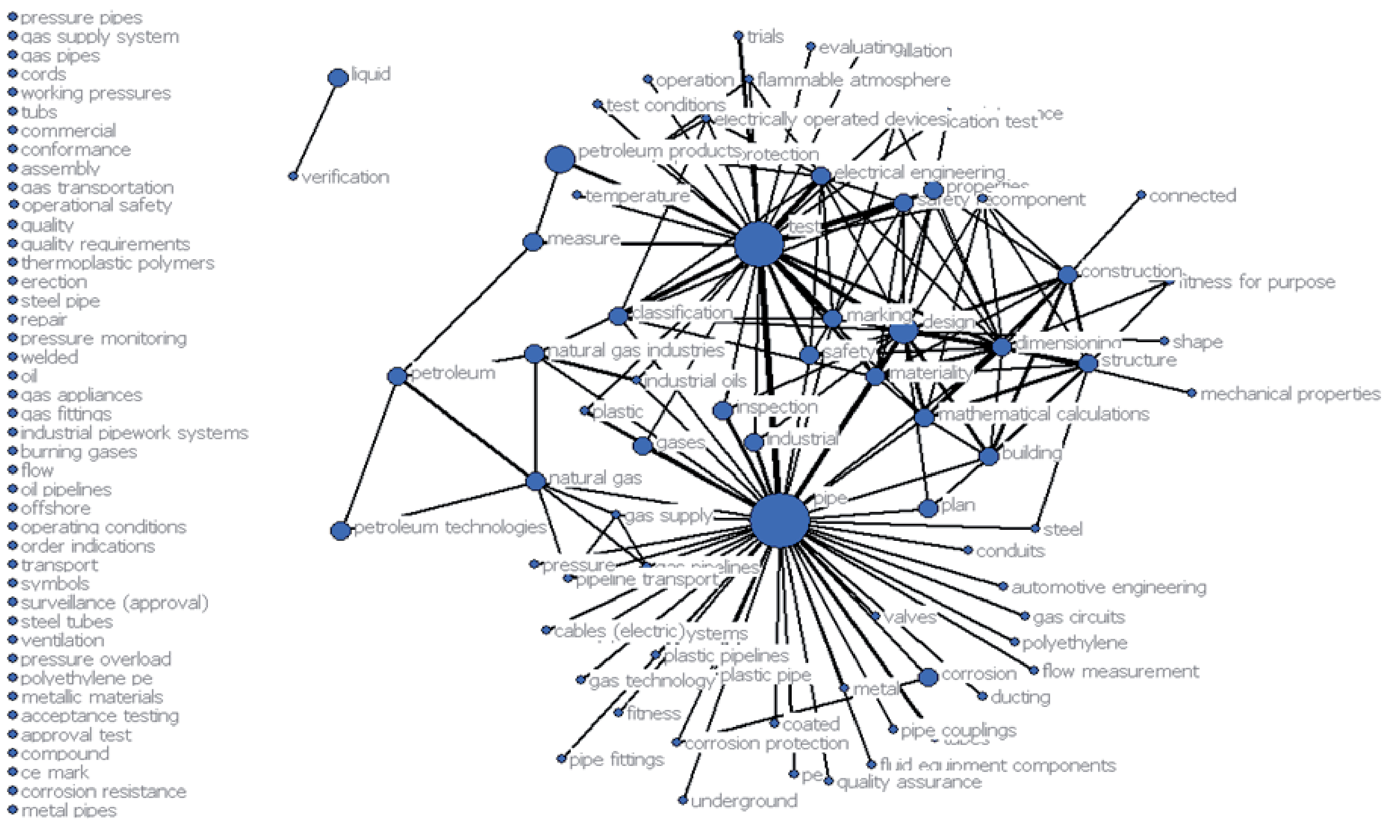

Figure 10: Technical fields of standard under continued development

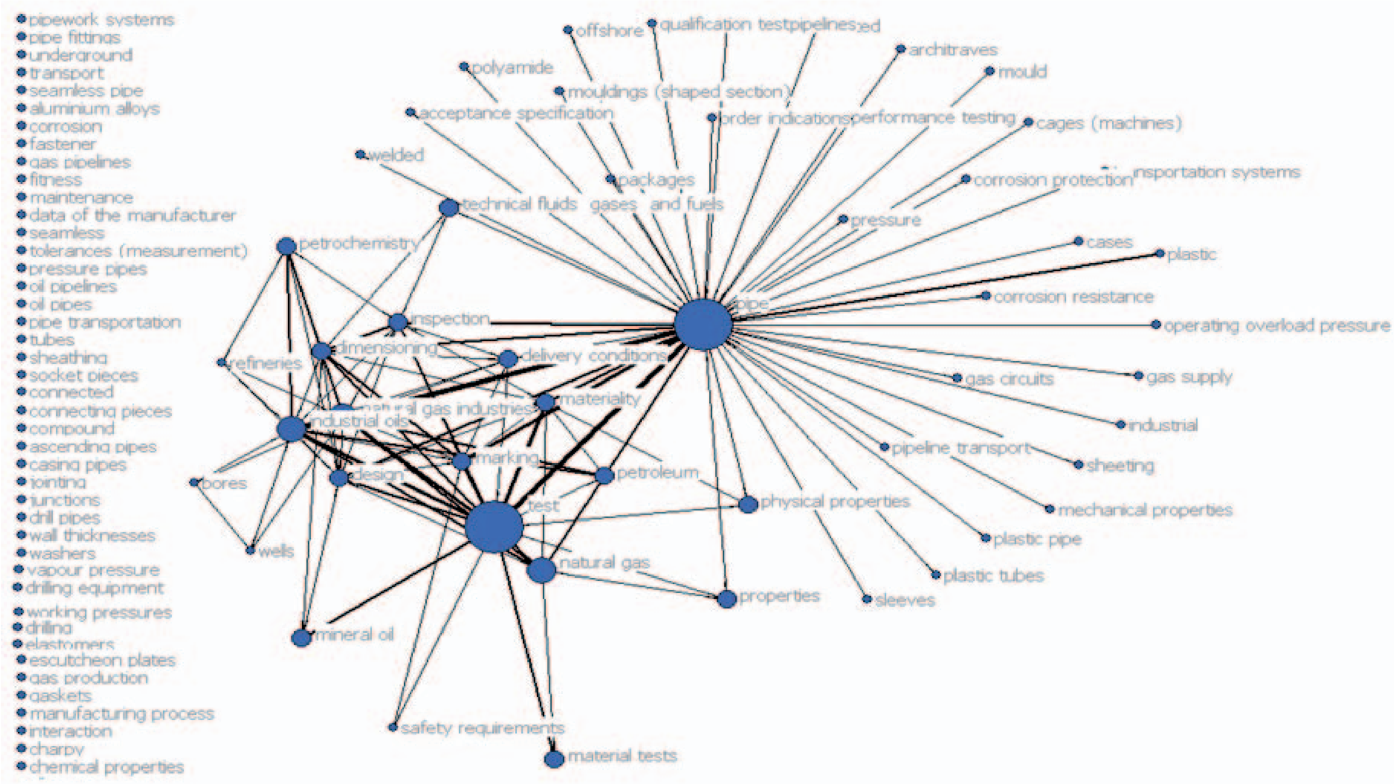

Figure 11: Technical fields to be developed in future

pipeline transport, offshore transport, transport conditions, pressure test, etc. With the increase of wide application of new materials in the oil and gas pipelines, the standards in this field will continue to increase;

- New standards related to inspection and test, including materials testing and safety requirements, etc. With the development of chemistry and chemical process and the application of new inspection and testing instruments and means, new standards in inspection and test field are expected to be established. In addition, new standards in natural gas, mineral oil, industrial oil, petrochemical and other fields are also likely to be established.

5 CONCLUDING REMARKS

This paper carried out analysis and research for general development trend of long-distance oil and gas pipelines with bibliometric and content analysis methodology, performed comparative analysis of standard developments between the various standards organizations, and the following conclusions were obtained:

- Joint and coordinated development of standards on pipelines, inspection or test, design, accessories and materials is focus and hot spot in standard development, that is to say, standards on inspection, design, accessories, materials are major development fields of standards; the standards on safety and electrical equipment are also hot points of standard development, but not directly related with standards of pipeline yet, that is to say there is still no standards on safety and electrical equipment specially established for pipelines.

- The standards developed relative actively are concentrated in pipeline, detection, and design, in which, pipeline involves with steel pipe, plastic pipe, fittings, joint piece, piping systems and pipe installation, corrosion and corrosion inhibition, gas line, pipeline transport, valves, pressure tests, etc; test involves with inspection, qualification tests, safety, and security requirements, electrical engineering, materials testing, explosion protection, etc.; design involves with specification, construction, structure, classification, performance, mathematical calculations, pavement markings, structure, mechanical properties, applicability, etc.

- The standards under relatively stable development are relatively professional technical standards which are relative independent and not associated with other aspects of standards, including pipeline standard related with fluid measurement, and inspection and test standards related to special technology, such as explosion index, oil quantity, sampling methods, explosion protection, and standard in petroleum products and measurement, as well as standards in fuel inspection and test, content inspection and test.

- Test standard is the hot spot of development, and also the field that technology is updated very fast, such as test standard natural gas, fuel oil, crude oil, gasoline, hydrocarbons and other oil and gas. In addition, the test standards in safety requirements and safety engineering, hazardous materials, environmental health, occupational safety also show the same trend.

6 FURTHER WORKS

The greatest difficulty facing in this research is data retrieval problems of various professional fields, and the data accuracy is directly related to the correctness of research findings. Moreover, the content analysis method is a method based on a large number of data analysis; the greater the amount of data, the more accurate analysis results. According to this research, the test, design, safety, and electrical equipment are major and hot point fields of standard development. What is the development trend of these standards? Which can be used in the field of natural gas and pipeline? How to control the consistency of these standard application? These issues should be addressed through a more deeper targeted research.

7 ACKNOWLEDGMENTS

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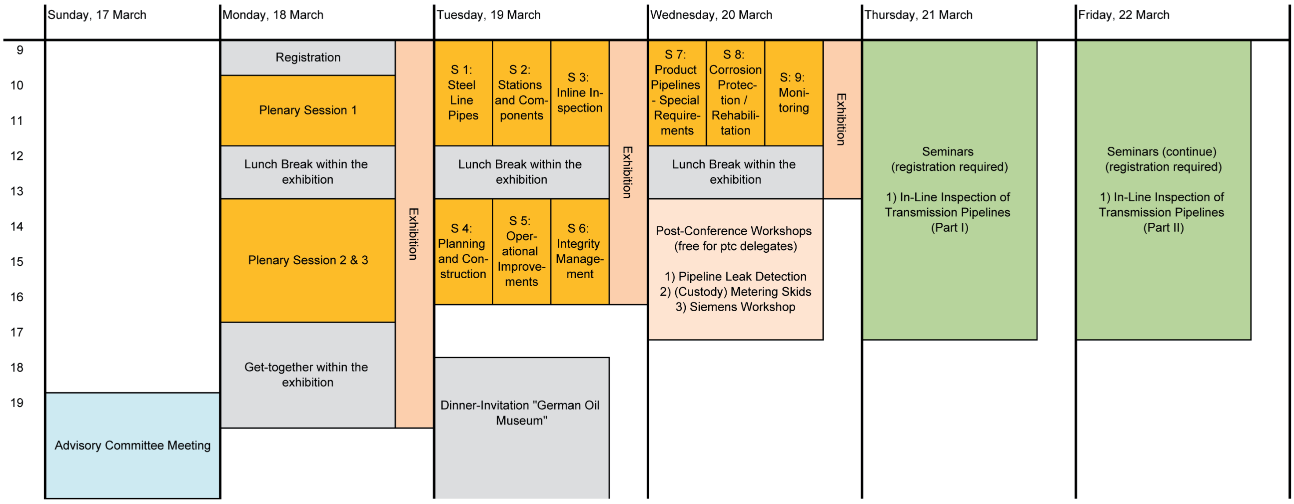
Conferences | Sem

inars | Exhibitions

8[TH] PIPELINE TECHNOLOGY CONFERENCES 2013

18-20 March 2013
Hannover Congress Centrum, Hannover, Germany

Time Schedule



Conference Program - Monday, 18 March 2013

(all abstracts available online)

	OPENING AND PLENARY SESSION (Niedersachsenhalle B)
10:00-10:30	• Welcome by Dr. Klaus Ritter, President, Euro Institute for Information and Technology Transfer • Keynote Speech by Heinz Watzka, Managing Director Technical Services, Open Grid Europe
	PLENARY SESSION I (Niedersachsenhalle B) Session Chair: to be announced
10:30-12:00	• "The German Safety System for Gas Infrastructure (tbc)", NN , DVGW - German Technical and Scientific Association for Gas and Water, Germany • "Enhance Pipeline Safety", Stephen Klejst, Director, Office of Railroad, Pipeline and Hazardous Materials Investigations, National Transportation Safety Board (NTSB), USA • "The Development Tendency of Pipeline Standards Based on Quantitative and Qualitative Analysis", Dr. Bing Liu, Chief Engineer of Division of Standardization, PetroChina Pipeline R&D Center, China • "Overall simulation of German natural gas transmission systems", Steven Hotopp, Research associate, Clausthal University of Technology, Institute of Petroleum Engineering, Germany
12:00-13:30	Lunch Break within the Exhibition
	PLENARY SESSION II (Niedersachsenhalle B) Session Chair: to be announced
13:30-15:00	• "Illegal tap repair applications", Adem Dincay, Maintenance Planning & Corrosion Control Manager, Botas International Ltd., Turkey • "Third party damage prevention: the human factor and the Integrity of Pipeline Installations, an urbanization proposal", Mauricio Terada Vaz, Pipeline Right-of-Way Maintenance Coordinator of São Paulo Region, PETROBRAS TRANSPORTE SA - TRANSPETRO, Brazil • "Integrated approach to risk and safety – MTO: Including human, organizational and inter-organizational factors", Dr. Babette Fahlbruch, Coordinator in the field of Human Factors / Human-Technology-Organization, TÜV NORD Systems GmbH & Co. KG, Germany • "Pipeline Leak Detection Technologies and Emergency Shutdown Protocols", Prof. Dr. Gerhard Geiger, Westphalian University Gelsenkirchen, Germany
15:00-15:30	Coffee Break within the Exhibition
	PLENARY SESSION III (Niedersachsenhalle B) Session Chair: to be announced
15:30-17:00	• "Pipeline Inspection Technology - What we've achieved and where we need to go", Trent van Egmond, TransCanada, Canada • "Pipelines Integrity Management Plans: an Initiative toward Collaboratively Managing Pipelines Integrity", Yaser S. Al-Qahtani, Integrity Management Engineer, Saudi Aramco, Saudi Arabia • "Integrated PIMS supporting an offshore pipeline system", Peter Baars, Asset Manager Pipeline Systems, GDF SUEZ E&P Nederland B.V., The Netherlands • "View of a Pipe Manufacturer to the Developments for Linepipe Material", Dr. Christoph Kalwa, Senior Manager Sales, EUROPIPE GmbH, Germany
from 17:00	Get-together Party within the Exhibition

Conference Program - Tuesday, 19 March 2013

(all abstracts available online)

TIME	STEEL LINE PIPES	STATIONS AND COMPONENTS	INLINE INSPECTION
09:00-10:15	X80 Pipelines in Arctic Environment: Prediction of the Long-Distance Ductile Fracture Propagation/Arrest Alexey Gervasyev, Russian Research Institute of the Tube and Pipe Industries, JSC, Russia	Metering selection approach Andreas Hausmann, ILF Consulting Engineers GmbH, Germany	UT-ILI and Fitness-for-Purpose Analysis for Severely Internally Corroded Crude Oil Pipeline Shabbir Safri, Kuwait Oil Co., Kuwait
	High Strength Large Diameter UOE Line Pipes Optimised for Application in Remote Areas and Low-Temperature Service Dr. Charles Stallybrass, Salzgitter Mannesmann Forschung GmbH, Germany	Compressor Station Considerations Matt Lubomirsky, Solar Turbines Inc., USA	Reliable sizing of complex metal loss through combined ILI data sets for internal & external anomalies in gaseous & liquid Johannes Palmer, ROSEN Technology & Research Center GmbH, Germany
		Integrated maintenance practices for rotating equipments Alberto Rostagno, GE Oil and Gas, Italy	On the Application of Statistical Methods in Inline Inspection – An Overview Dr. Gerhard Kopp, NDT Systems & Services GmbH & Co. KG, Germany
10:15-10:45	Coffee Break within the Exhibition		
10:45-12:00	HAZ Physical Simulation of API5L X80 Pipeline Steel Prof. Ivani de S. Bott, Pontifical Catholic University of Rio de Janeiro/PUC-Rio, Brazil	Four Ultra Large Surge Relief Systems for an Asian 40" Crude Oil Pipeline Project – A Case Study Trilochan Gupta, Daniel Measurement & Control Business Unit of M/s Emerson Process Management Asia Pacific Pte Ltd, Singapore	Apply Non Destructive Testing for Assessment Hydrogen Cracking in Joining Procedure of Split Tee to Pipeline in Hot Tapping. Meysam Rasooly, National Iranian Gas Company, Iran
	Axial strain capacity of line pipe subjected to combined loading conditions - An experimental approach in full-scale dimension: LiSA S. Zimmermann, Salzgitter Mannesmann Forschung GmbH, Germany	Custody transfer flow metering systems for the oil and gas Industry Ralph Kwaaitaal, KROHNE Oil & Gas, The Netherlands	EMAT for detection of axially aligned cracks at girth welds Stephan Tappert, GE Oil & Gas - PII Pipetronix GmbH, Germany
		Total Drag Reduction Solutions from Opportunity to Operation Dr. Yung N. Lee, Phillips Specialty Products, Inc, USA	Mechanical Damage Assessment Using Multiple Data Sets in Inline Inspection Abel Lopes, T.D. Williamson, United Kingdom
12:00-13:30	Lunch Break within the Exhibition		

Conference Program - Tuesday, 19 March 2013

(all abstracts available online)

TIME	PLANNING AND CONSTRUCTION	OPERATIONAL IMPROVEMENTS	INTEGRITY MANAGEMENT
13:30-14:45	Challenges in the Construction and Installation of Pipeline System of Dispatch of Refinery Abreu E Lima Northeast - Petrobras Flavio Alexandre Silva, PETROBRAS S/A, Brazil	Example of the Effect of Sudden Overpressure in Piping System Ahmed R. AlMutairi, Saudi ARAMCO, Saudi Arabia	Application of risk based methodology to onshore & offshore pipelines Dr. Gundula Stadie-Frohbös, Germanischer Lloyd SE, Germany
	Pipeline Seismic Design and Potential Mitigation Measures Dr. Prodromos Psarropoulos, National Technical University of Athens, Greece	A comprehensive approach to integrity of DN 400 high pressure pipeline Ales Brynych, CEPS a. s. , Czech Republic	Qualitative pipeline risk assessment principles using Geographical Information Science and Remote Sensing Emil Bayramov, British Petroleum (BP), Azerbaijan, Azerbaijan
	Pipe Express® - An innovative method for environmentally friendly and economical pipeline installation Andreas Diedrich, Herrenknecht AG, Germany	MAC MEC Pipeline project: advantages and challenges of the concept Dr. Andreas Helget , Siemens, Germany	Prioritizing threats in gas pipeline systems - An example related to transporting renewable and unconventional gases Martin Hommes, DNV KEMA Energy & Sustainability, Netherlands
14:45-15:15	Coffee Break within the Exhibition		
15:15-16:30	Efficient application of the Horizontal Directional Drilling technology in pipeline construction Dr. Hans-Joachim Bayer, TRACTO-TECHNIK GmbH & Co. KG, Germany	Crude Oil Network Modeling, Simulation & Optimization – Novel approach and Operational Benefits Mohamed Rizwan, Kuwait Oil Company, Kuwait	Pipeline Integrity Analysis Using a 3D Laser Scanner Method Pierre-Hugues Allard, CREAFORM, Canada
	Applying Offshore Pipe-in-Pipe Technologies on Onshore Projects Christian Geertsen, ITP InTerPipe SA, France	Integrated Cyber and Plant Security Supports Operational Safety Jochen Frings, ILF Consulting Engineers GmbH, Germany	Reasons to implement an enterprise Work Management solution for proving auditing acceptability Jens Focke, GEOMAGIC GmbH, Germany
	CoiFlatLine - A game changing approach to ultradeepwater pipeline Philippe Nobileau, MARINOVATION, France	Smart solutions for pipeline safety after a natural disaster Dr. Gillian Kendrick, Ubisense, United Kingdom	FBG Optical Sensing for Pipeline Structural Health Monitoring Dr. Daniele Costantini, Micron Optics, Inc., USA
from 17:00	Bus transfer from "Congress Hotel am Stadtpark" for Dinner Invitation "German Oil Museum"		

Conference Program - Wednesday, 20 March 2013

(all abstracts available online)

TIME	PRODUCT PIPELINES - SPECIAL REQUIREMENTS	CORROSION PROTECTION / REHABILITATION	MONITORING
09:00-10:15	**Risks of Underground Pipelines Transporting Chemicals** Dr. Margreet Spoelstra, RIVM (National Institute for Public Health and the Environment), Netherlands	**Analysis of Microstructure and Mechanical Properties Patching Result on Flowline Pipe** Ari Antono, Kondur Petroleum S.A, Indonesia	**realSens Remote Sensing of Liquid Hydrocarbon Leaks from Pipelines** Adrian Banica, Synodon Inc., Canada
	Field Experience with Interior Pipe Coatings from High Performance Polyurethane Elastomers Dr. Michael Magerstädt, Rosen Swiss AG, Switzerland	**Composite Repair Performance at Elevated Temperatures** Jim Souza, Pipe Wrap LLC, USA	**Fiber Optic Based Pipeline Monitoring** Alexander Rauscher, PiMON GmbH, Germany
	Internal Corrosion Mitigation Strategies for Naphtha Transportation through Pipelines Cherian P. Varghese, Indian Oil Corporation Limited, India	**Maximizing Transportation Capacity of an Aged Crude Oil Pipeline** El Sayed Abdel Maaboud Mohamed Bayoumy, Egyptian General Petroleum Corporation (EGPC), Egypt	**Remote Sensing based automated Change detection of Oil and Gas Pipeline corridors** Santanu Sur, Tata Consultancy Services, India
10:15-10:45	Coffee Break within the Exhibition		
10:45-12:00	**FRP-reinforced Liner Pipes for the Safe and Reliable handling of corrosive media in chemical industry and metallurgy** Dr. Mirko Lotz, Quadrant EPP AG, Switzerland	**New building blocks for rigid polyurethane pipe coatings** Andreas aus der Wieschen, Bayer MaterialScience AG, Germany	**Continous Real-Time Pipeline Deformation, 3D Positioning and Ground Movement Monitoring Along The Sakhalin-Khabarovsk-Vladivos** Adrian Garrow, Omnisens S.A, Switzerland
	Requirements for safe and reliable CO2 transportation pipeline (SARCO2-A) – Project Update Stefan Jäger, Salzgitter Mannesmann Forschung GmbH, Germany	**SCC Direct Assessment on 16"gas line and considering the coating defect as primary factor to determine SCC** Shamsedin Shamsaee, TWI Persia, Iran	**Performance of the ThreatScan™ system in different operational and environmental conditions** Thierry Romanet, PII Pipeline Solutions, United Kingdom
	Status of National and International Standardization in CO2 Transportation Dr. Achim Hilgenstock, E.ON New Build & Technology, Germany	**Polypropylene coating system with improved low temperature performance** Norbert Jansen, Borealis Polymere GmbH, Germany	**Custody Transfer Measurement on the World Longest Heated and Insulated Pipeline – A Case Study** Neelesh Purohit, Cairn India Limited, India
12:00-13:30	Closing Lunch Break within the Exhibtion		

Venue

The Pipeline Technology Conference takes place at
HCC - Hannover Congress Centrum • Theodor-Heuss-Platz 1-3 • 30175
Hannover • Germany • www.hcc.de

The HCC provides sufficient parking space and is well-connected to highway A 37, Hannover Airport and Hannover Central Station. Name of the closest tram stop is "Hannover Congress Centrum" (Line 11).
For further information: www.pipeline-conference.com/venue

Possibilities of Participation:

As Exhibitor

Equipped standard booth
6 sqm (5 1-meter walls, 1 table, 2 chairs) 3,900 € + VAT
8 sqm (6 1-meter walls, 1 table, 2 chairs) 5,000 € + VAT
12 sqm (8 1-meter walls, 2 table, 4 chairs) 7,000 € + VAT
More information: www.pipeline-conference.com/stand-booking

included services for all packages: power supply, wastepaper basket, 1/4 page advertisement within conference proceedings, 3 free-of-charge conference registrations, logo + link + profile on conference website, logo + short profile in conference program

As Delegate

Fee: 580€ + VAT
Participation fee includes: entrance to conference and exhibition, printed proceedings, lunch, beverages, snacks, tickets for get-together and dinner invitation
You can register on our website. www.pipeline-conference.com/registration

In case of questions, contact Ms. Claudia Quatz on +49 511 90992 20 or email to ptc@eitep.de

PTC SEMINAR: IN-LINE INSPECTION OF TRANSMISSION PIPELINES

After the regular Pipeline Technology Conference Dr. Michael Beller and Dr. Konrad Reber will offer a seminar on Inline inspection of Transmission Pipelines.

The course will provide an in-depth introduction into the subject and importance of pipeline inspection and integrity management. Delegates will learn about the need for pipeline inspection and the use of inspection for the analysis of the pipelines integrity and fitness-for-purpose.

The course will introduce the flaws and anomalies observed in pipelines. Suitable external and internal inspection technologies will be introduced including the strength and weaknesses of the non-destructive testing principles applied. The material cover details on a pipeline inspection operation, including pipeline preparation, cleaning, gauging.

Final Reports, Reporting Formats are discussed. The course also includes a short introduction into integrity assessment.

Target group:

Managers responsible for pipeline integrity, Pipeline Engineers, Technicians or other interested personnel from operators. Engineering Consultants active in the field of NDT and Integrity Assessment. Personnel from the authorities or certification bodies involved with pipeline inspection and assessment and licensing.

Course Content:

1 Introduction
1.1 Pipelines: Why is Pipeline Integrity Management important?
1.2 Introducing Integrity Assessment and Fitness-For-Purpose
1.3 Pipeline Integrity Management
1.4 Safety Aspects and International Approaches

2 Defects in Pipelines
2.1 Pipeline materials
2.2 Types of pipelines
2.3 Coating Flaws
2.4 Corrosion and Metal Loss
2.5 Cracks and Crack-Like Defects
2.6 Leaks

3 Pipeline Inspection
3.1 Hydro- and Stress testing
3.2 In-Line Inspection
3.3 External Inspection Methods

4 Non-Destructive Testing Technologies
4.1 Magnetic Flux Leakage Technology
4.2 Ultrasonic Technology

5 Pipeline Inspection Tools
5.1 Free swimming In-Line inspection tools
5.2 Tethered and cable operated tools
5.3 Automated external inspection tools

6 Pipeline Inspection Procedures
6.1 Planning an inspection
6.2 Preparing the Pipeline for an Inspection
6.3 Pipeline Cleaning
6.4 Performing the Inspection

7 Reporting
7.1 Data Evaluation
7.2 Final Report
7.3 Introducing POF
7.4 Integrity Assessment: MAOP
7.5 Run Comparison
7.6 Data Management and archiving

The course also includes a workshop session and exercises covering the following topics:

Which Tool Does What?
How to read Tool Data and Defect Specification Sheets
Preparing an Inspection Project
Data Analysis and MAOP

Lecturers:

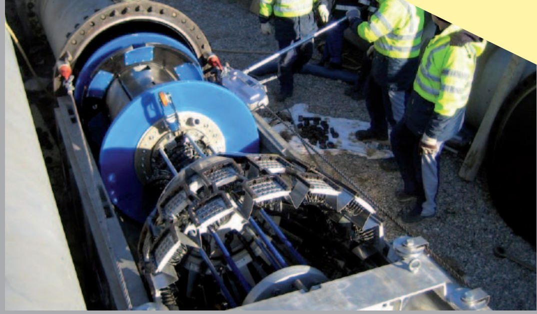
Dr. Michael Beller, Landolt AG, Switzerland
Dr. Konrad Reber, Innospection GmbH, Germany

Minimum number of participants: 8
Registration Deadline: 11 March 2013

The registration fee is 1,400 Euro per person (1,200 Euro for already registered delegates of Pipeline Technology Conference 2013)

In case of any further inquiries or for registration please contact:

Mr. Dennis Fandrich: Tel. +49 511 90992-22,
E-mail fandrich@eitep.de



Special Focus on Pipeline Technologies

INFRASTRUCTURE
NORTH AFRICA

NORTH AFRICAN STATES DISCUSS THE DEVELOPMENT AND RENEWAL OF THE TECHNICAL INFRASTRUCTURE AS PART OF INA 2013 IN TUNIS, TUNISIA

Final Report

The Arab Spring that begun in Tunisia in January 2011 led to far-reaching changes in North Africa. The upheavals triggered in politics and administrations have not yet ended. Nevertheless, outstanding infrastructure projects must be tackled as a matter of urgency in order to maintain links with international competition and attract investments to the country. The improvement in general living conditions, the creation of jobs and the involvement of the local population in decisions about the future are now the top priorities.

With this in mind, the Infrastructure North Africa, INA, (21-22 January 2013) was organized by the Germany-based Euro Institute for Information and Technology Transfer, EITEP, and its Tunisian partner, Circina, together with the Tunisian government.

Attendance by top players in politics and business in the North African states was very good, with around 140 people taking part. Western industrial states were represented with 20 exhibitors and around 60 attendees. However, even at the opening of the conference and exhibition, 4 ministers/secretaries of state highlighted that an increase in democracy and human rights will only take place by improving the living conditions of the people; the top priority here is to improve infrastructures.

During the opening event and the two subsequent plenary sessions, a total of 18 ministers, secretaries of state, deputy ministers and CEOs from major publicly owned enterprises reported on the status of development and planning in all areas of the infrastructure in the countries of Tunisia (primarily), Algeria, Morocco, Libya and Mauritania. These reports will soon be made available to the public online www.infrastructurenorthafrica.com.

During 3 parallel sessions, a total of 35 talks discussed tried-and-tested technical solutions for use in North

Africa with participants from 16 nations. These presentations will also be published on the aforementioned website.

The exhibition enjoyed good attendance during breaks from the conference, especially as the coffee breaks all took place in the exhibition. The booth staff from the US construction equipment company, Vermeer, described their impressions as follows: "We didn't have very many visitors - but those who came were highly qualified and very motivated. It was great to be here."

During the event, an information platform was set up on which information could be provided about new projects between the conferences, and a preliminary agreement was signed on the qualification of Libyan engineers from all areas of the infrastructure.

Infrastructure North Africa 2013 enjoyed a great deal of attention from the national press and will be enhanced further in 2014 with additional infrastructure topics. The next INA will provisionally take place again in Tunis from 17 to 19 February 2014.

You can find more information and images at
www.infrastructurenorthafrica.com

Contact:

EITEP – Euro Institute for Information and Technology Transfer
Am Listholze 82
30177 Hanover, Germany

Dr. Klaus Ritter
Tel. +49 (0) 511 90992-10
E-mail: ritter@eitep.de

PPIM
Pipeline Pigging and Integrit Management
25th YEAR 2013

SILVER YEAR FOR PPIM EVENT PROVES SOLID GOLD

Celebrating its 25th year in Houston, the 2013 Pipeline Pigging & Integrity Management Conference and Exhibition (PPIM) was a sell-out success, attracting 1940 attendees and smashing 2012's record attendance by more than 37%.

Organised by Clarion Technical Conferences and Tiratsoo Technical (a division of Great Southern Press), the PPIM Conference and Exhibition was held from 11–14 February 2012 at the Marriott Westchase Hotel in Houston. Participation included 1940 people from 30 countries, with 116 companies represented in the commercial Exhibition.

The event was supported by Platinum Sponsor Rosen, Gold Sponsor RCS, and Silver sponsors A.Hak and N-Spec Pipeline Services.

Key industry experts gathered at the event, which is the only conference and exhibition in the world tailored specifically to the pipeline pigging industry. Over its 25 years, the event has grown to accommodate the needs of pipeline owners and operators, and manufacturers, product and service providers – ensuring that the whole of industry is gathered in the one place.

In-depth training courses precede the conference and exhibition, providing attendees with the technical knowledge required to ensure the safest pipeline infrastructure. Following these, the two-day conference programme and exhibition allows delegates and exhibitors to meet to discuss the latest developments in technology and services.

A world-class technical programme

Papers presented in the conference programme covered a range of new inspection and assessment technologies, case studies, and management systems. A panel session chaired by BP's Stephen Gower and David Whitman discussed the benefits and importance of striving for successful first-runs with ILI services, and the newly developed Pipeline Operators Forum Guidance Document. Panellists included members of prominent pigging vendors – GE/PII Pipeline Solutions' Geoff Foreman, Rosen's Holger Hennerkes, Baker Hughes' Kirk Langford, and NDT Systems' Ulrich Schneider. Each explained how they worked with owners/operators to achieve the best ILI results possible, before the microphone was opened up to questions from the attendees.

Forming new partnerships at the exhibition

Featuring all of the latest pipeline inspection, rehabilitation and maintenance equipment, including cleaning and many other types of utility pigs, ILI tools, non-destructive testing, and more, the Exhibition allowed delegates and trade visitors one-on-one contact with pipeline pigging and inspection equipment manufacturers and suppliers. Attendees were able to form new partnerships by speaking directly with company representatives who provided tailored advice to specific queries.

Get involved in 2014

More than two-thirds of this year's exhibitors have already signed up for PPIM 2014, which will take place from 10-13 February, 2014.

Contact:

Clarion's BJ Lowe for further
information: bjlowe@clarion.org
Tel. +1 713 521 5929.

IMPORTANT PIPELINE EVENTS IN 2013

Pipeline Technology Conference

18 - 20 March 2013 – Hannover, Germany
Visit event website www.pipeline-conference.com

17th International Conference & Exhibition on Liquefied Natural Gas (LNG 17)

16 -19 April 2013 - George R. Brown Convention Center in Houston, Texas, USA
Visit event websit ww.lng17.org

China international pipeline exhibition

23 - 25 April 2013 - Langfang International Exhibition Center(Beijing, China)
Visit event website www.pipechina.com

Unpiggable Pipeline Solutions Forum

15 – 16 May 2013 - Houston, Texas
Visit event website www.clarion.org

Rio Pipeline 2013

24 – 26 September 2013 - SulAmérica Convention Center, Rio de Janerio, Brazil
Visit event website www.ibp.org.br

Best Practices in Pipeline Operations & Integrity Management

20 – 23 October 2013 - Gulf International Convention & Exhibition Centre,Bahrain
Visit event website www.clarion.org

Did we miss an important event or do you want your event to be registered here?

Contact us: ptj@eitep.de

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President: Dr. Klaus Ritter
Register Court: Amtsgericht Hannover
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Editor in Chief
Dr. Klaus Ritter
E-Mail: ritter@eitep.de
Tel.: +49 (0)511 90 99 2-10

Editorial Board
Advisory Committee of the Pipeline Technology Conference

Editorial Management & Advertising
Claudia Quatz
E-Mail: ptj@eitep.de
Tel.: +49 (0)511 90 99 2-20

Designer/Layouter
bl;visign | Benjamin Linden
URL: www.bl-visign.de
E-Mail: info@bl-visign.de
Tel.: +49 (0)511 90 99 2-20

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D-76297 Stutensee
Germany
Phone: +49 (0)72 44 7415-0
Fax: +49 (0)72 44 7415-97
www.ndt-global.com
info@ndt-global.com

NDT Middle East FZE
ZH-01, R/A 13, PO Box 261651
Jebel Ali Free Zone, Dubai
United Arab Emirates
Phone: +971 4 883 77 41
Fax: +971 4 883 77 62
www.ndt-global.com
uae@ndt-global.com

NDT Systems & Services LLC
2835 Holmes Road
Houston, Texas 77051
USA
Phone: +1 713 799 5400
Fax: +1 713 799 5406
www.ndt-global.com
usa@ndt-global.com

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