May 2016

ptj

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Pipeline Technology Journal

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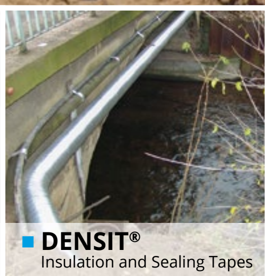

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Pipeline Planning & Construction ...

... is becoming increasingly difficult, not least due to politic changes and stronger public resistance against new pipeline projects

Dr. Klaus Ritter
Editor in Chief

Dear Reader,

Constructions of new pipelines have slowed down in North America and Europe. More residents and ecological groups are protesting against the construction of such pipelines, and their protests are succesfull. Examples for this development are the failed Keystone Pipeline in Canada / USA, which was canceled recently, and the decreasing demand in Europe, due to the energy turnaround and the increased usage of LNG. On the other hand, maintenance and reconstruction offer new possibilities as reliability, safety and longevity become more important.

Apart from this considerable developments there are a lot of reasons for planning- and constructions-companies to stay optimistic. Most important is without doubt the pipeline boom in South Asia and North Africa.

Because of this development, we will not only discuss planning- and construction-related topics in this issue of **Pipeline Technology Journal (ptj)**, they will also receive special appreciation and recognition in this year's Pipeline Technology Conference (ptc) in Berlin. The exchange of existing experiences and best practices from all over the world is necessary to create and distribute required state-of-the-art technolog to face all challanges.

This brings me to another noteworthy thought: because North Africa and South Asia are demonstrating such a potential for pipeline operators and technology and service providers, we have deceided to take a next step with our portfolio and to develop a new conference directed towards this emerging markets. In 2017, we will hold for the first time the **Pipeline-Pipe-Sewer-Technology (PPST)** Conference & Exhibition in Cairo, Egypt. This conference will enable pipeline professionals from all over the world to access an interessting and promising market and to get in touch with players and key figures in the region of South Asia and North Africa.

Furthermore, we are constantly advancing the Pipeline Technology Journal to meet the information needs of pipeline professionals worldwide. The ptj is taking another important step forward and is now available as Chinese Edition. With this edition we are selectively aiming at the constantly increasing pipeline market in the People's Republic of China. Thus, we enable international pipeline experts and companies to introduce their solutions and to promote their products and services to a great market which offers rich potentials.

As you can see, we will never get tired of pushing the pipeline community's constant exchange. Hopefully, you will make use of the extensive opportunities we created, in order to enable this constant exchange.

Yours,

> Dr. Klaus Ritter, Chairman of the ptj Editorial Board / ptc Advisory Committee

AFTERMATH OF AN INVISIBLE DESASTER

Planning and construction have always been important fields within the pipeline industry. In recent times, there were many challenges, which had to be faced by the companies. More and more resistance against the construction of new pipelines is occurring/ appearing. An example therefor is the failed Keystone Pipeline in Canada. Resistance by residents and environmental protection group makes a prudent and sustainable planning mandatory. During the constructions strict regulatory guidelines make their presence.

These are important issues that affect the entire industry. For this reason they will receive special appreciation and recognition in the forthcoming Pipeline Technology Conference (ptc) in Berlin as well as in this issue of Pipeline Technology Journal.
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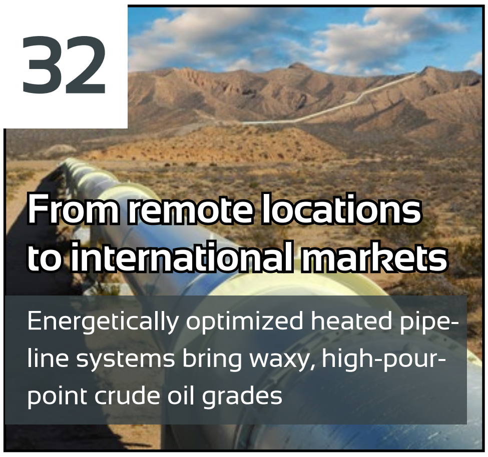

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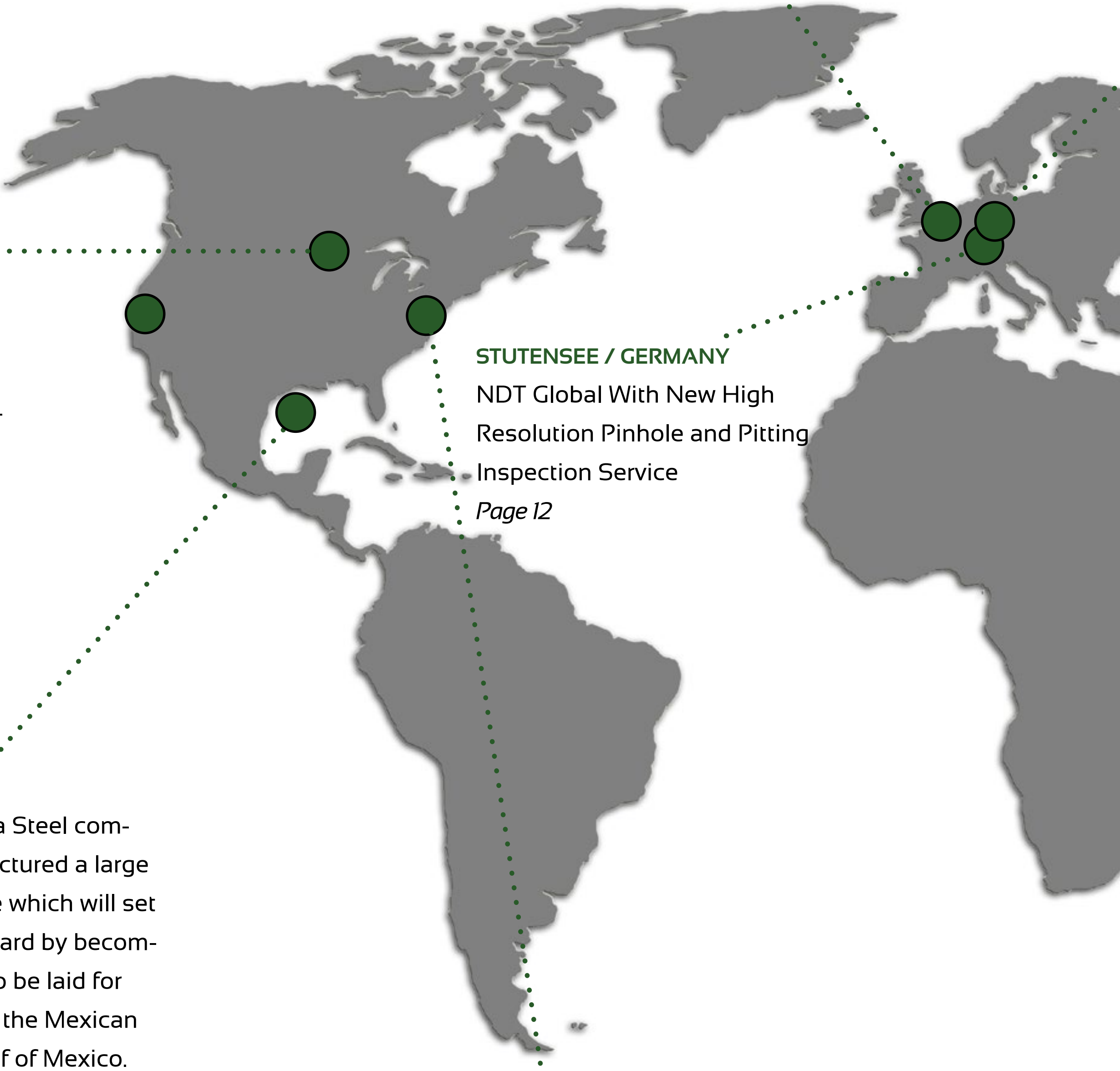

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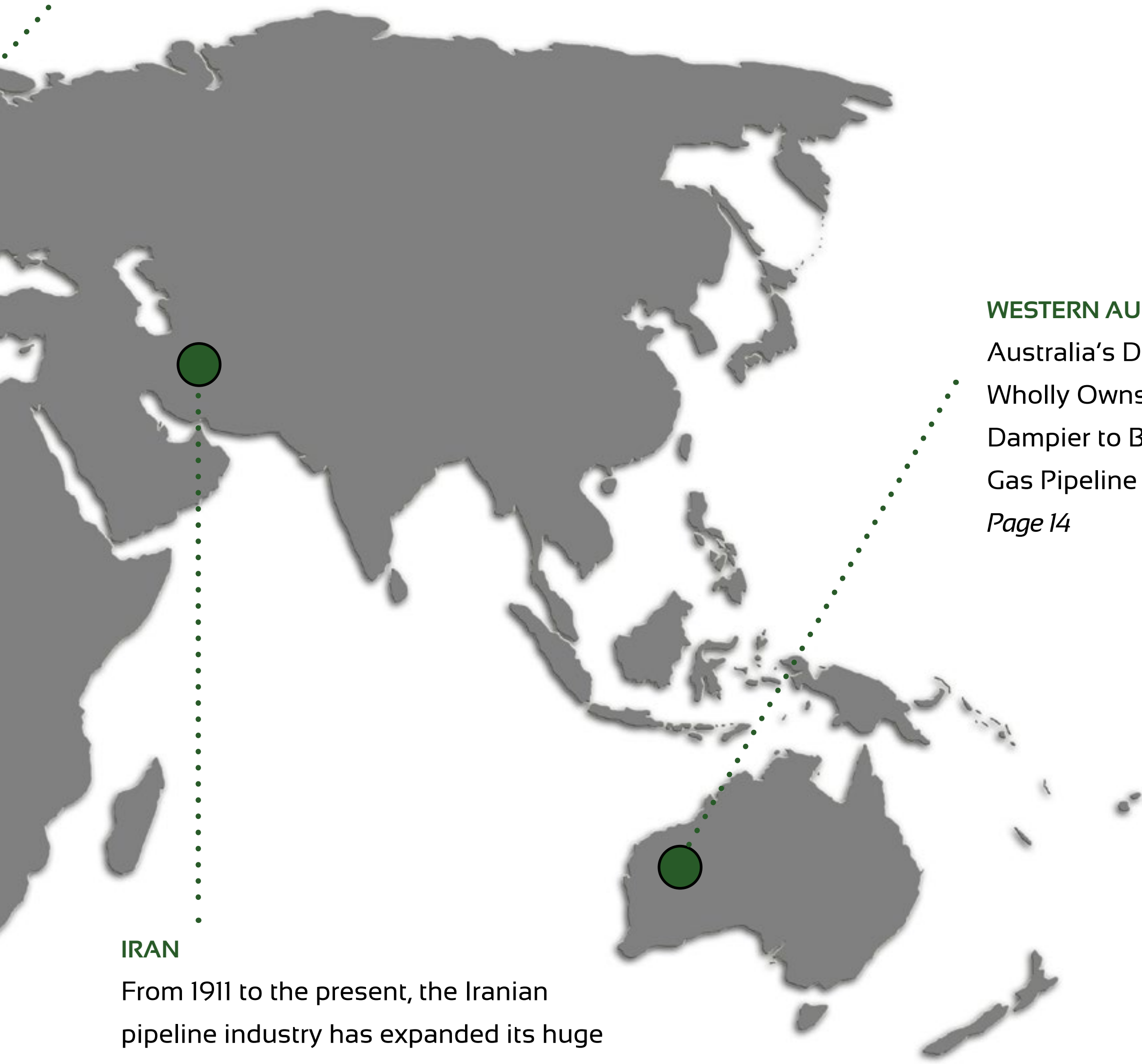

IRAN

From 1911 to the present, the Iranian pipeline industry has expanded its huge network and also improved in the technical and engineering aspects of pipeline operations. However, the impressive size and further potential growth of the Iranian pipeline industry is not well known in the international market.

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WORLD NEWS

TRANSCANADA CLEARS LAST REGULATORY HURDLE BEFORE INVESTMENT DECISION ON BRITISH COLUMBIA GAS PIPELINE

TransCanada has received the final permits from the B.C. Oil and Gas Commission for the $4.8 billion, 650 km Coastal GasLink pipeline from northeast B.C. to the west coast B.C. to serve export markets.

The Shell-led LNG Canada consortium is expected to make a final investment decision on the natural gas project in late 2016 and, if approved, TransCanada could start pipeline construction next year.

"This is a significant regulatory milestone for our project, which is a key component of TransCanada's growth plan that includes more than $13 billion in proposed natural gas pipeline projects which support the emerging liquefied natural gas industry on the British Columbia Coast," said Russ Girling, TransCanada's president and chief executive officer.

"Acquiring these 10 permits demonstrates our commitment in developing this project to the highest standards of environmental protection while delivering benefits to British Columbians and Canadians for decades to come," added Girling.

Only 4.5 million people are living in an area of nearly 1 million square kilometers. The landscape is almost unspoiled

3-KM BEER PIPELINE APPLAUDED BY CITIZENRY IN BRUGES, BELGIUM

"It all started out as a joke in 2010," says Xavier Vanneste, heir to a dynasty of beer brewers in the ancient city of Bruges, Belgium. Now six years later, laughter is turning to smiles as the De Halve Mann brewery is about to begin shipping 6,000 liters of beer per hour through a 3-km polyethylene pipeline from the brewery in the city center to the company's bottling plant outside of town.

Bruges is a medieval city that has very narrow streets. The popular brewery's trucks often clog up the roads. According to the Wall Street Journal, the owner of the brewery got the idea to create a pipeline after seeing some workmen dig up the street to lay cable.

The citywide attention gave Mr. Vanneste another idea. He'd partly fund the €4 million ($4.5 million) investment by offering lifetime supplies of beer. Attracted by the liquid returns, brew-lovers sank some €300,000 into the project.

They were offered three options. The most expensive "gold" membership, which costs €7,500, entitles the holder to an 11-ounce bottle of Brugse Zot beer (retail price, €1.70) every day for life, along with 18 personalized glasses.

One of the 21 people who signed up for that was Philippe Le Loup, who runs a restaurant on the scenic Simon Stevin square, a few hundred yards from the pipeline. Mr. Le Loup, whose establishment serves about 1,850 gallons of Brugse Zot a year, said he would have preferred a direct tap into the pipeline. "It would have saved me a lot of keg-dragging," he said.

Halve maan brewery launches crowdfunding campaign for beer pipeline (© 2016 Halve maan)

TATA STEEL WITH INDUSTRY FIRST IN 140-KM DEEP SEA PIPELINE PROJECT IN GULF OF MEXICO

Indian-based Tata Steel company has manufactured a large diameter 42” pipe which will set an industry standard by becoming the deepest to be laid for 140 kilometers in the Mexican section of the Gulf of Mexico.

The company was awarded a contract to supply 457mm OD x 28.6mm WT API 5L PSL2 X65MO line pipe from its large diameter 42” Double Submerged Arc Welded (DSAW) mill in Hartlepool, UK for the development. The project marked the first where a pipeline had been laid at water depths greater than 3,000 feet in the Mexican section of the Gulf. Tata Steel was selected for the project due to its extensive experience in the manufacture of small diameter and thick wall deepwater line pipe.

Richard Broughton, Commercial Manager, Energy and Power, Tata Steel said: “Our investment in the DSAW mill and our continuous improvement discipline enables us to offer extremely high integrity solutions to our clients for the most challenging of offshore and onshore projects.”

He added that the overall benefit of the investments is evident in the welding quality performance achieved during the project in the Gulf of Mexico where small diameter and thick wall pipe is typically “more challenging”.

The TATA Steel tubes 84 inch mill in Hartlepool (© 2015 Tata Steel company)

PHMSA AWARDED BROAD AUTHORITY TO SHUT DOWN PIPELINES AND MANDATE LEAK DETECTION TECHNOLOGIES

In yet another legislative step to strengthen regulatory oversight of the national pipeline network at the Pipeline and Hazardous Materials Safety Administration (PHMSA), the House Energy and Commerce Committee approved a series of measures known as H.R. 5050 allowing PHMSA to issue emergency orders to shut down pipeline systems and issue emergency regulations, bring new transparency to interagency reviews, tighten standards for underground natural gas storage systems and mandate the installation of leak detection technologies.

“While an accident can happen in an instant, the damage takes years to fix, underscoring the need for strong safety laws. We promised action, and today, we passed a bill that authorizes PHMSA for five years and goes a long way in strengthening pipeline safety,” Rep. Fred Upton, R-MI, chairman of the committee, said in a statement.

The bill represents a compromise after Democrats complained at an earlier energy and power subcommittee meeting that the bill was too deferential to the oil and natural gas industry. Republicans agreed to some of the requested changes, including the attempt to add transparency to PHMSA’s regulatory process, which some Democrats think it is too slow and bogged down.

H.R. 5050 will be reconciled with similar legislation (H.R. 4937) passed by the House Transportation and Infrastructure Committee earlier this week. A comprehensive bill is expected to pass in the House of Representatives and become law.

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

CAPABILITIES, TECHNICAL-ECONOMICAL PROBLEMS & DEVELOPMENT PLANS OF THE IRANIAN PIPELINE INDUSTRY

105 years ago (in 1911), the first pipeline in Middle East was completed in Iran by Charlie Richi to move crude oil from Masjed Soleiman to Abadan. From 1911 to the present, the Iranian pipeline industry has expanded its huge network and also improved in the technical and engineering aspects of pipeline operations.

However, the impressive size and further potential growth of the Iranian pipeline industry is not well known in the international market. This is due to antiquated information and data from within the industry. For example, in the OPEC annual report at end of 2014, it is mentioned that Iran has 12,000 km pipelines (8,000 km gas pipeline and 4,000 km oil pipelines). This statistic reflects the situation in Iran some 40 years ago. Today Iran has more than 69,000 km of main pipelines (without branches) and plans to increase the number to more than 110,000 km in 2025. In the water and sewer industry, there are more than 53,000 km metallic and non-metallic main pipelines.

This paper highlights the accomplishments of the Iranian pipeline industry and describes our capabilities in design, manufacturing (factories), construction, contracting and operation. It will also explain technical challenges, economic problems in new pipeline projects, development plans as well as Iran's policy to swap and export oil and gas through pipelines.

NDT GLOBAL WITH NEW HIGH RESOLUTION PINHOLE AND PITTING INSPECTION SERVICE

Pipeline operators have long identified pinhole and especially embedded pinhole defects as a significant risk factor in their integrity management programs. NDT Global, a leading supplier of ultrasonic pipeline inspection and pipeline integrity management services, announced that it is now offering a high resolution pinhole and pitting (UMp) metal loss inspection service to help operators mitigate such risks.

The UMp service reliably detects defects and sizes as small as 5 mm (0.2 inch) which represents a two-fold improvement in the minimum sizing threshold, from the previous entry level ultrasonic service of 10 mm (0.4 inch), and it will be a standard offering in all of NDT's global markets.

While many inline inspection (ILI) providers still offer corrosion inspections these are without the resolution required to detect and size pinhole defects, with some ultrasonic services only reliably detecting features greater than 10 mm (0.4 inch) and sizing features greater than 20 mm (0.8 inch). Higher resolution inspection of features identifies the true deepest point of a pinhole morphology within a larger area of corrosion with an overall shallower depth.

Map of Iran's natural gas infrastructure (© 2015 EIA)

A.HAK TO SHOWCASE INNOVATIVE 3 INCH ULTRASOUND PIGLET AT 11TH ANNUAL PIPELINE TECHNOLOGY CONFERENCE IN BERLIN

A.Hak Industrial Services has announced that its new 3 inch pipeline and furnace inspection systems are available for projects worldwide after the first pilot projects were successfully executed. This most recent development is part of a new range of faster tools with XYZ mapping possibilities.

"Our flexible design of our tools guarantees a smooth bi-directional inspection in every pipeline configuration', says Mr. Edwin Rosier, Sales Manager Inspection Services.

The new systems will complement the existing High Resolution Piglet® tools which have been in use for years in diameter ranges between 4" and 46".

All A.Hak Industrial Services' tools are free swimming inspection pigs which can be used for all kinds of piggable and 'non-piggable' pipelines such as lines with mitered or back-to-back bends with radii (less than) 1.5D.

Innovative 3 Inch Ultrasound Piglet (© 2016 AHak)

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INDUSTRY AND PRACTICE

AUSTRALIA'S DUET GROUP NOW WHOLLY OWNS THE 1530-KM DAMPIER TO BUNBURY NATURAL GAS PIPELINE

The Australian energy infrastructure owner DUET Group has agreed to buy out Alcoa of Australia of its 20 percent share of the Dampier to Bunbury Natural Gas Pipeline (DBNGP) for US$154 million.

As part of the transaction Alcoa of Australia will maintain its current access to approximately 30 percent of the DBNGP transmission capacity for gas supply to its three alumina refineries in Western Australia.

Last July DUET purchased Energy Developments Ltd. for US$1 billion and market analysts had long predicted the eventual acquisition of Alcoa's stake in the DBNGP. DUET CEO David Bartholomew said the move would help simplify DUET's structure, given that now it would own 100 per cent of four of its five operating businesses.

Looking ahead Bartholomew has said further acquisitions which may include TransAlta Australia's stake in the Fortescue River Gas Pipeline in WA.

DENSO GROUP ANNOUNCES RELAUNCH OF CORPORATE WEBSITE

DENSO Group Germany, leading supplier of corrosion prevention and sealing technology, launches its new corporate website.

The website offers new content, optimised technology and a modern design. Oriented on the demands of the customers, the product display has undergone a restructuring and an innovative product finder helps to easily select the right product.

The new mobile-friendly website for the companies DENSO and DEKOTEC offers an intuitive navigation with a high degree of user-friendliness on any devices, such as PC/Laptop, tablet or smartphone. "When developing the new portal, our aim was to focus on the customer needs in our key markets," says Max Wedekind, Managing Director. "Therefore, we are very happy to offer a multilingual site with five languages, an easy click to find the right product and immediate contact to our sales team."

Compressor station of the DBNGP in Australia

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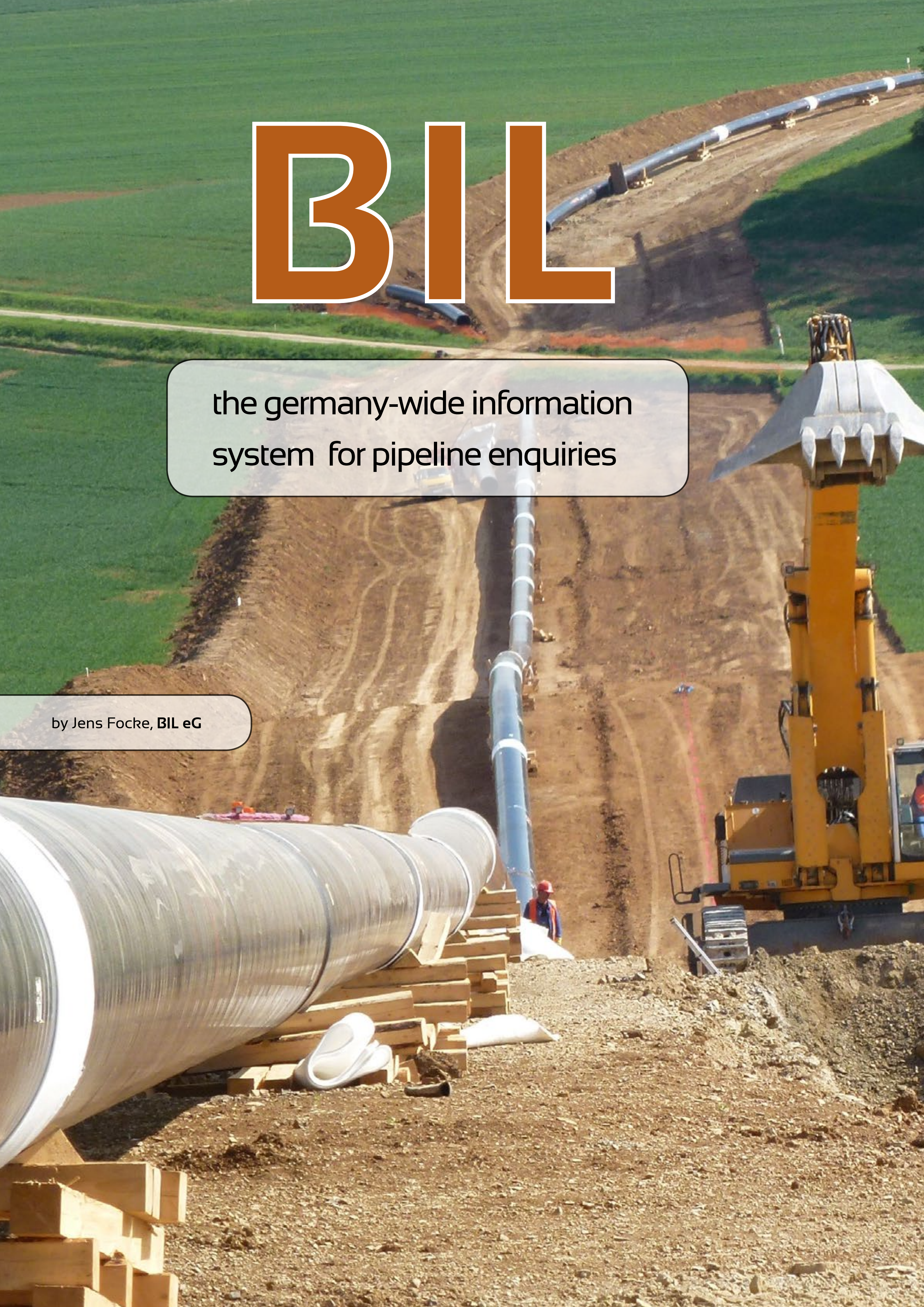


BIL

the germany-wide information system for pipeline enquiries

by Jens Focke, **BIL eG**

ABSTRACT

The foundation of BIL eG by 17 German pipeline companies from the chemical, high-pressure gas and mineral oil sectors on 15 June 2015 cleared the path for developing the national information system for pipeline enquiries, BIL. With the implementation of an internet portal and a database backend, at the start of 2016 BIL will provide the first cost- free portal for information on pipelines in Germany.

BIL-member companies (as of 03/2016)

- AIR LIQUIDE Deutschland GmbH
- ARG mbH & Co. KG
- BP Europa SE
- Covestro Deutschland AG
- Currenta GmbH & Co.OHG
- Deutsche Transalpine Oelleitung GmbH
- Fluxys TENP GmbH
- GASCADE Gastransport GmbH
- GASUNIE Deutschland Transport GmbH
- GEW Wilhelmshaven GmbH
- GRTgaz Deutschland GmbH
- IVG Kavernenbetriebsführungsgesellschaft mbH
- Mineralölverbundleitung GmbH Schwedt
- Nord-West Kavernengesellschaft mbH
- Nord-West Oelleitung GmbH
- Nowega GmbH
- ONTRAS Gastransport GmbH
- Open Grid Europe GmbH
- Oxea GmbH
- Praxair Deutschland GmbH
- PRG Propylenpipeline Ruhr GmbH & Co. KG
- Rhein-Main-Rohrleitungstransportgesellschaft m.b.H
- Rotterdam-Rijn Pijpleiding N.V.
- Stadtwerk Am See GmbH & Co.KG Friedrichshafen
- Thyssengas GmbH
- Westgas GmbH

MOTIVATION FOR ESTABLISHING BIL

BIL eG is a registered, non-profit cooperative. The organisational form (eG) provides the necessary secure legal framework. In addition, the eG legal form promotes the joint endeavours of all involved parties in making building activities safer and is intended to motivate pipeline, utility and telco companies from all sectors, who can join the cooperative as members, to support this initiative. BIL does not pursue any commercial interests and will collaborate with operating companies and system providers. BIL will provide free information on pipelines and cables to enquirers.

As pipeline operators, the founding members of BIL eG have had particular problems with the constrcution industry's lack of knowledge on the location of pipelines: often they are affected years later if damages to the subterranean pipeline infrastructure are detected during monitoring and inspection measures. In addition, undesirable costs may be incurred if civil protection operations need to be carried out, especially in rural areas, when pipelines have been hit unexpectedly by a building contractor during earthworks. At the same time name changes, organisational changes and unknown boundaries to service zones do not make it particularly easy for the building industry to identify the relevant companies and contact persons. In these times of ever increasing construction activities, it is therefore it is necessary to standardise and simplify information requests on pipeline locations. BIL provides an internet-based – and thus permanently available – process, built on digital processing of location information using IT-based work(force) management systems. BIL aims to incorporate the operators' existing planning information solutions in order to provide a standardised, lean and digital enquiry procedure to the building industry.

FOCUSSING ON THE CORE PROCESS

BIL wants to focus on the core process of the enquiry itself and access the online planning information systems of the operators without interfering with the internal workflow implemented therein. The BIL enquiry platform will enable enquiring building contractors to enter their building request with all technical details and corresponding location information as a geographical building area. The enquiry will be passed on to all pipeline companies available via BIL. By comparing the building area to the service areas of the operators (which are invisible to the enquirer), BIL checks online who is responsible for the pipelines/cables in the area and then sends the enquirer a list of the relevant operator or operators (Figure 1). The operators in charge receive the information from BIL, check whether they are affected and communicate all information via the BIL portal. This way, the task of checking if pipelines/cables are affected remains with the operator and their planning information generates the relevant information for the enquirer.

COMMUNICATION AND INTEGRATION

The main tasks and function of the BIL infrastructure are the digital check of who is responsible for a certain area and communicating this information via the portal. To this end, operators simply need to enter their geographical area of responsibility in BIL, specified as a corridor around a pipeline or as an area surrounding their service area. The data is transferred to BIL in standard graphic data formats. It comprises self-defined area polygons only, no pipeline data and pipeline routes. Operators are responsible for entering and updating their geographical areas of responsibility.

Figure 1: Core of the BIL enquiry process

If, on that basis, BIL identifies that an operator is responsible for a particular area, the operator has several options for incorporating the digital building request by BIL into its processes. The differences lie only in the way in which the system is integrated into their workflow. The operators themselves are responsible for analysing the information in their database as to which, if any, pipelines are affected:

Replying to the enquiry from the system of the pipeline company: the digital enquiry (alphanumeric information and area polygon) can be transferred via a web interface directly to the operator's system where it will be checked if their infrastructure is affected. Once it has been confirmed in the operator's system that none of their pipelines are affected, a "not affected" reply can be sent back to the BIL portal instantly and passed on to the enquirer from there. The information exchange with the enquirer takes place via the BIL portal. This process can also be used by participants who do not have their own infrastructure and where this service is outsourced to an engineer's office or a group company.

Processing the enquiry by the operator directly via the BIL portal without system connection: in this case the participating operator decides if their pipelines or systems are affected based on the coverage area stored in the system. A manually created "not affected" or "affected" reply to the enquirer, possibly with .pdf attachments, can then be entered in the BIL portal. In cases where the operator's infrastructure is affected, additional digital planning information may be sent along with the reply.

In either case BIL does not interfere with the operator's workflow for processing enquiries and checking if their infrastructure is affected. The system offers the added value of allowing the building industry to make individual requests and filter "non-responsibilities" online, and allowing pipeline operators/ utilities to make information available in a digital, standardised format.

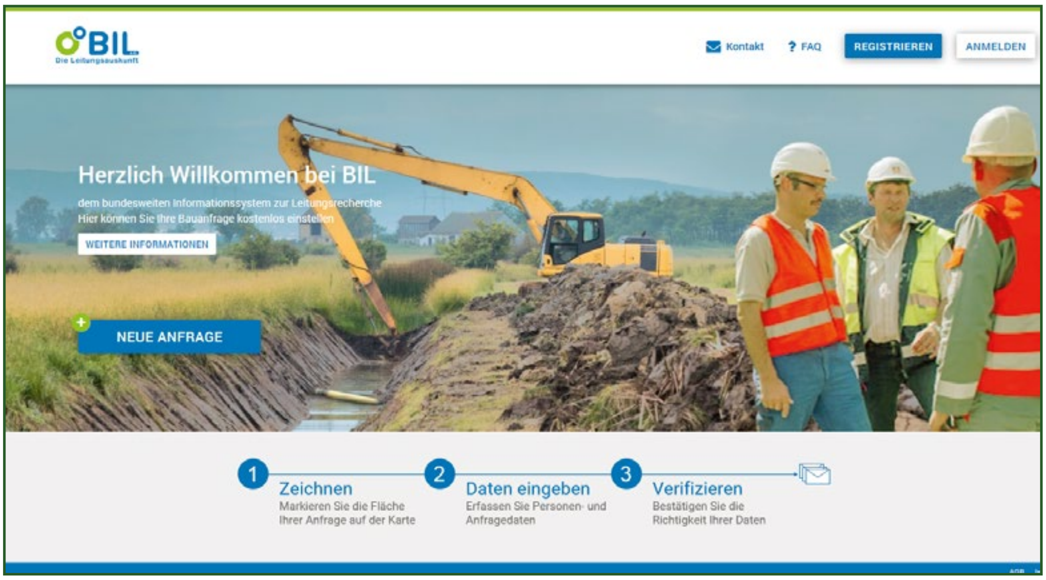
TECHNICAL SCOPE

BIL provides a web-based information solution for enquirers (e.g. building contractors, planners, authorities etc.) and participants (pipeline companies) with the following functionality:

- interface for the building industry or other enquirers to request free information regarding all types of building work,
- communication platform providing the required information and documents,
- database function with geographical reference for integrating the operator's geographical area of responsibility to analyse potential responsibilities as part of a digging request.

The overall system is made up of the following three components:

- portal solution that can be accessed as a web service via the internet,
- database-driven information system for storing the participants' areas of responsibility (geographical situation of grid areas) and related information,
- integrated Web Map Services (WMS) for providing geographical reference data and maps,
- database backend for long-term storage of enquiry and information data from enquirers and operators.
- The solution comprises the workflow between the enquirer and the participants as outlined in figure 1 with the following additional features (examples):



The BIL Portal is accessable via internet: www.bil-leitungsauskunft.de

Geographical context: BIL requires the construction area to be entered as a spatial polygon based on map material including layout plans and official maps. The coordinate system ETRS89 forms the geodesic basis.

Construction site classification: the enquirer must inform operators about the type of construction work via BIL. BIL provides a list of different types of civil engineering work for this purpose. Each type of building work generates a buffer zone of a particular size around the construction site (Figure 2). Therefore the operators' geographical areas of responsibility are affected to different degrees by the various types of construction works. Naturally, larger buffer zones must be observed for extraordinary structures than for local construction work.

Enquiries by the building industry are to be accommodated free of charge and in a technically attractive manner, with the objective of reaching more pipeline companies. Where information on the type of construction work is available from the enquirer and with a digital reply process on the operator's side, the functional aim is to consolidate enquiry and reply information in one digital workflow.

This should help overcome any potential inhibitions with respect to making enquiries at any time and from anywhere. Preventing damages and operational faults adds economic value that may also contribute to increasing the much needed acceptance for necessary infrastructure projects.

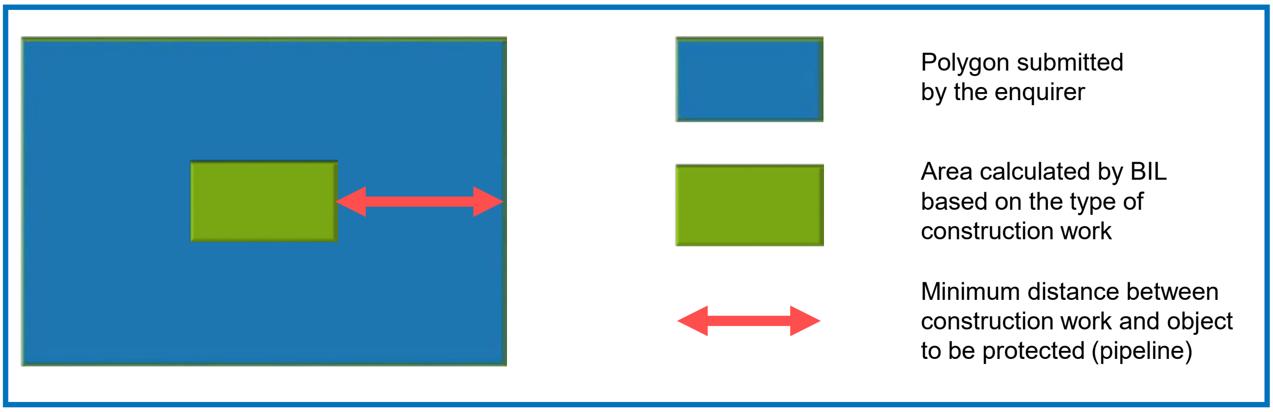


Figure 2: Handling of construction criticality by corridors

This way, operators can keep their areas relatively small without missing a relevant enquiry.

Archiving: all data and documents are archived in line with the relevant legal provisions and kept for reference. Enquirers and operators may carry out research based on the data at a later time. Based on the collected data, statistical analyses in the form of monthly and annual reports can be generated in BIL.

BENEFITS

Increasing safety in civil engineering works is the main motivation of all the founding members of BIL eG and at the same time, it is an economic necessity gladly supported by the building industry.

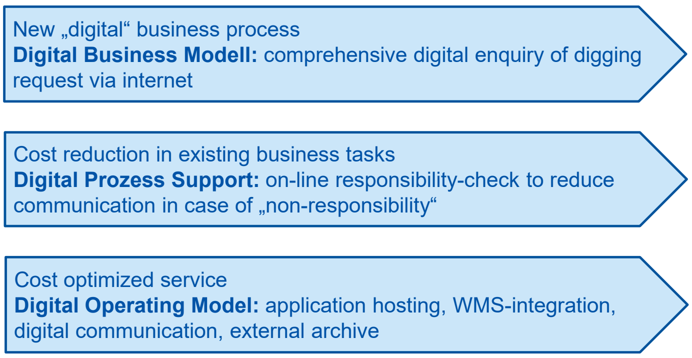


Figure 3: Digital business process support for energy industry

In the age of industrial digitisation, BIL can also help to boost the efficiency of processes that need to be optimised due to increasing construction activity, a decreasing headcount and standardised options for response. Individual operators developing their own planning information portals is a step in the right direction; it requires, however, that enquirers know which operators to address in the first place. BIL wants to solve this problem and pass on the enquiry information to the systems of the relevant operator(s).

OBJECTIVE AND OUTLOOK

It is BIL's ambitious goal to become "the go-to portal" for pipeline/cable information from operators of all sectors. The main motivational factor is to simplify the mandatory enquiry process for the construction industry with the aim of providing "complete" information. The enquiries are free of charge for private individuals, building contractors or operating companies. Implementation, maintenance and expansion of the system will be carried out by the BIL organisation in collaboration with third-party service providers and thus only requires a small set-up. Therefore the foundation of a registered cooperative was identified as the most suitable organisational structure. This way, operators of all types of pipelines and media may participate on a not-for-profit basis. Based on the experience of operators of critical media, initial implementation was carried out which fully covers the requirements for web-based building enquiries. In addition to transmission system operators, BIL wants to reach the operators of local distribution system infrastructures, in particular municipal utilities and telecommunication companies, but also operators of biogas pipelines or other media.

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CROSSING DEBRIS FLOW AREAS

> by:
> Diego D'Alberto > Saipem SpA
> Carlo Caffarelli > Saipem SpA
> Salvatore Morgante > Saipem SpA
> Agostino Napolitano > Saipem SpA

ABSTRACT

Debris Flows (DF) are one of the most dangerous of all mass wasting events.

During DF event the sliding zone undergoes morphological changes, often of considerable magnitude. The erosion due to DF is difficult to predict because there are many variables and uncertainties to consider as well as spatial and environmental conditions.

The interaction analysis of DF with the underground pipes (the erosion level at which the trench backfilling is eroded and the pipeline is exposed) is of fundamental importance for pipeline designers in order to assess the risks to which the buried pipelines undergo, identifying the areas where mitigations measures are required. This paper presents different methodologies to estimate debris flow scour depth and compares the results, providing to pipeline engineers some recommendations.

INTRODUCTION

Three main engineering tasks are required to evaluate the geohazards related to DF on onshore buried pipeline:

Task 1: Debris Flow Assessment (DFA) to determine the hydraulic parameters related to the probability of occurrence of DF;

Task 2: Soil Response Assessment (SRA) to determine potential Permanent Ground Displacements (PGD) that might result at the end of the DF event;

Task 3: Pipeline Response Assessment (PRA) to determine the structural integrity of the pipeline subject to the PGD.

The main scope of DFA is to define, from a probabilistic point of view (return time of event), the water flow rate (Q) at which DF starts and the potential discharged volume of material during one or more events. DFA can be carried out using a stochastic approach applied to deterministic formula for the description of solid transport processes in steep torrents. The solid transport processes analyzed are bed load transport during flood events and DFs. In this paper it is assumed that DFA is performed by a qualified part and inputs are provided to perform the Task 2.

The principal forms of PGD related to debris flow events that can be considered a geohazards for onshore pipelines, are surface erosion or deposition. Whether the buried pipeline fails when subjected to PGD depends, in part, on the amount and spatial extent of the PGD. The current state of technical knowledge and the assessment of the extent of the scour of the bed (excavation and localized transport) depend, in most cases, on timely feedback from the field, in order to evaluate the overall state of the riverbed. The estimation of the expected value for these phenomena is, often, a task that is largely dependent on the experience and sensitivity of the engineer, who has to rely mainly on the results of special inspections to evaluate the overall state of the riverbed, therefore an attitude of extreme caution when applying the ratios used to calculate the induced riverbed erosion shall be used taking care to apply each of them to cases similar to those for which they were obtained.

When the erosion depth and the deposition effects are estimated, PRA can be performed. This paper does not include PRA but normally stress analysis and numerical calculation will follow to model the pipeline subject to the calculated PGD.

DEBRIS FLOW ASSESSMENT (DFA)

Pasuto et al. [1] provided a geomorphological criterion to describe the prevalent solid transportation for colluvial fans classifying the activity of the analyzed basins into three behavior types:

a) bed load transport;

b) intermediate“ (debris flood);

c) DF.

The adopted morphometric indicator for DF susceptibility is Melton Index:

$$Melton \quad Index \quad = \quad A_b^{-0.5} \cdot \left(H_{\max} - H_{\min}\right)$$

Ab = area of basin;
Hmax, Hmin = maximum and minimum altitude of the basin.

Plotting Melton Index versus the slope of colluvial fan, it is possible to define the predominant type of solid transport (Figure 1).

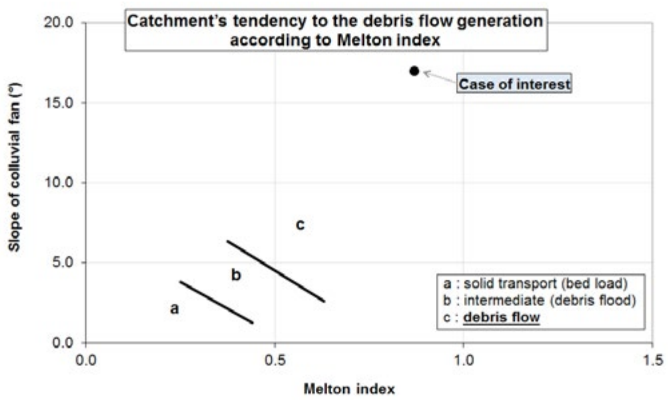

Figure 1: Example of catchment's tendency to DF generation

Once the various scenarios have been defined, the objective of DFA is the development of numerical simulations to obtain the representative parameters of DF for the subsequent SRA.

SOIL RESPONSE ASSESSMENT (SRA)

For water flow lower than the DF triggering value (established by DFA), the diameter of moved stones and the erosion scour smax can be estimated according to the classical approaches of Armanini [2] and Schoklitsh [3], respectively.

When the DF starts, the erosion rate er can be estimated through Egashira's formula ([4], [5]); the depth of erosion de is calculated multiplying the obtained value of er to the duration T of the event and then adjusted considering the effect of the final deposition height (given by DFA) along the colluvial fan.

The erosion depth induced by DF is then verified using an empirical diagram for the prediction of channel erosion (the graph is based on collected data of really happened DFs [6]).

The values obtained in the previous steps are compared to check the consistency of the methods.

The most important assumptions considered are:

1. the morphology (section and slope) of the colluvial fan does not change during DF;
2. the erosion effect of the biggest boulders is included in the calculation of erosion (inverse grading occurs during DF [7]);
3. the sediment concentration of the flow remains constant when the erosion processes occurs.

Limit diameter of transportable clasts - Armanini

Armanini's formula [2] can be used to determine the limit diameter of transportable clasts from the flood (assuming turbulent flow and the particle dimension comparable to the water height h):

$$\frac{\tau_0}{\left[0.06 \cdot \left(\gamma_s - \gamma_w\right)\right] \cdot \delta} = 1 + 0.67 \cdot \left(\frac{\delta}{h}\right)^{0.5}$$

T^O = riverbed shear stress,

Y^s = specific unit weight of particles,

Y^w = specific unit weight of water.

Considering uniform motion, T^O is obtained by expressing the condition of equilibrium to the translation, written in the direction of motion, between the component of the weight of a stretch of the watercourse and the resistance along the edges of the section:

$$\tau_0 = \gamma_w \mathrm{R\,i}$$

R = hydraulic radius;
i = riverbed slope.

Erosion depth - Schoklitsh

Schoklitsh's formula [3] is used to determine, in the section of riverbed in question, the maximum depth of the potential scour compared to the initial average depth of the floor (smax):

$$s_{\max} = 0{,}378 \cdot H^{0,5} \cdot q^{0.67} + 2{,}15 \cdot \Delta z$$

H = total hydraulic load on the section immediately upstream of the hole;

q = specific flow rate per unit of width L of the current in the riverbed (Qmax/L);

Δz = difference in the depths of the riverbed upstream and downstream the hole; z is applied depending on the geometrical characteristics of the water course, based on the local gradient of the riverbed floor, at the maximum incision, compared to a length (along the riverbed axis) equal to the water height of the flood determined.

"Egashira" Approach

Egashira erosion law ([4], [5]) is based on flume tests, numerical and dimensional analyses assuming that the bed slope is always adjusted to its equilibrium, in case of DFs travelling over an erodible bed. Applying the mass conservation law of eroded material yield, Egashira derived (Figure 2).

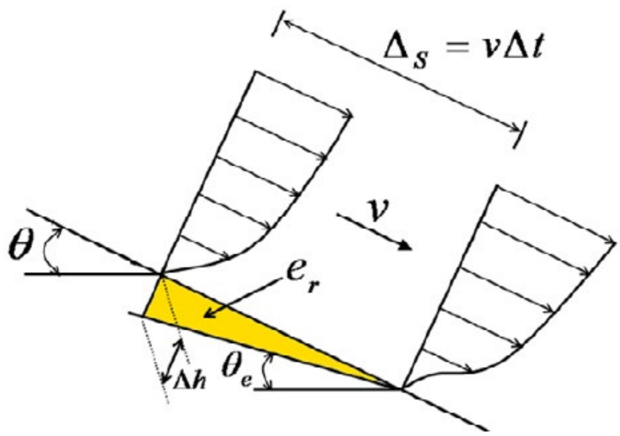

Figure 2: Definition sketch of the erosion rate

er = erosion rate;

c* = sediment concentration by volume of bed sediment (non-moving layer);

v = flow velocity;

ϴ = riverbed slope;

ϴe = riverbed equilibrium slope:

$$\theta_e = \tan^{-1}\left\{\frac{(\rho_s-\rho_w)c}{(\rho_s-\rho_w)c+\rho_w}\tan\phi\right\}$$

ρ_s = mass density of the sediment particles;

ρ_w = mass density of the water;

c = sediment concentration by volume of the DF;

ø = internal friction angle of the bed, approximated by the basal friction angle tan ø;

Experimentally, Takahashi [7] has proved that c cannot exceed the value 0.9c* (c < 0.9c*).

Blanc [8] tested Egashira law applying it to the cases of the 1990 and 2000 Tsing Shan DFs but the first results were not in accordance with the observations, since the erosion rate obtained by the Egashira law was larger than the reality. Therefore Blanc [8] proposed an empirical factor k to modify the Egashira law:

$$e_r = c_* v \tan(\theta-\theta_e)$$

For its cases of interest, suitable values of k range between 0.011 and 0.016.

To evaluate the duration T of the event, it is assumed that a DF of volume V moves downstream as an evolving, translating waveform of constant mass and density; the mass conservation gives [9]:

$$V = \int_T Q(t)\,\mathrm{d}t = \mathrm{K}Q_{\max}T$$

t = time;

Q(t) = volumetric discharge at a cross section through which the flow passes;

Qmax = maximum instantaneous or peak volumetric discharge at the same cross section (from DFA);

K = dimensionless parameter (0 < K < 1); K = 1/2 for triangular DF hydrographs (Figure 3).

Considering a triangular DF hydrograph:

$$T = \frac{V}{\mathrm{K}Q_{\max}} \approx 2\frac{V}{Q_{\max}}$$

V comes from geomorphological and stochastic considerations of DFA.

From er* and T, the depth of erosion de can be calculated:

$$d_e = e_r^* \cdot T$$

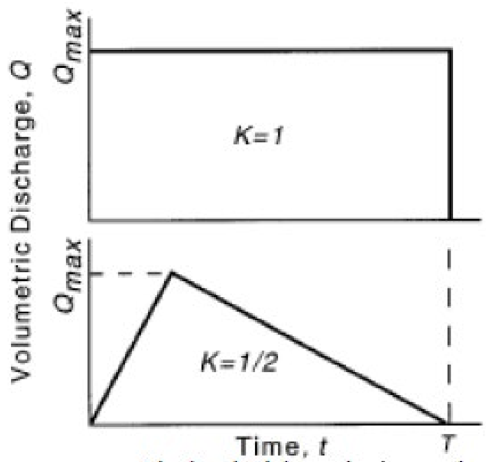

Figure 7.4: Idealized lahar hydrographs, with different shape parameters, K, defining lahar duration, T, and maximum instantaneous volumetric discharge Qmax, for hydrographs (Iverson et al., 1998)

Figure 3 – Idealized DF hydrographs, with different shape parameters (K) defining duration (T) and maximum instantaneous volumetric discharge (Qmax) [9]

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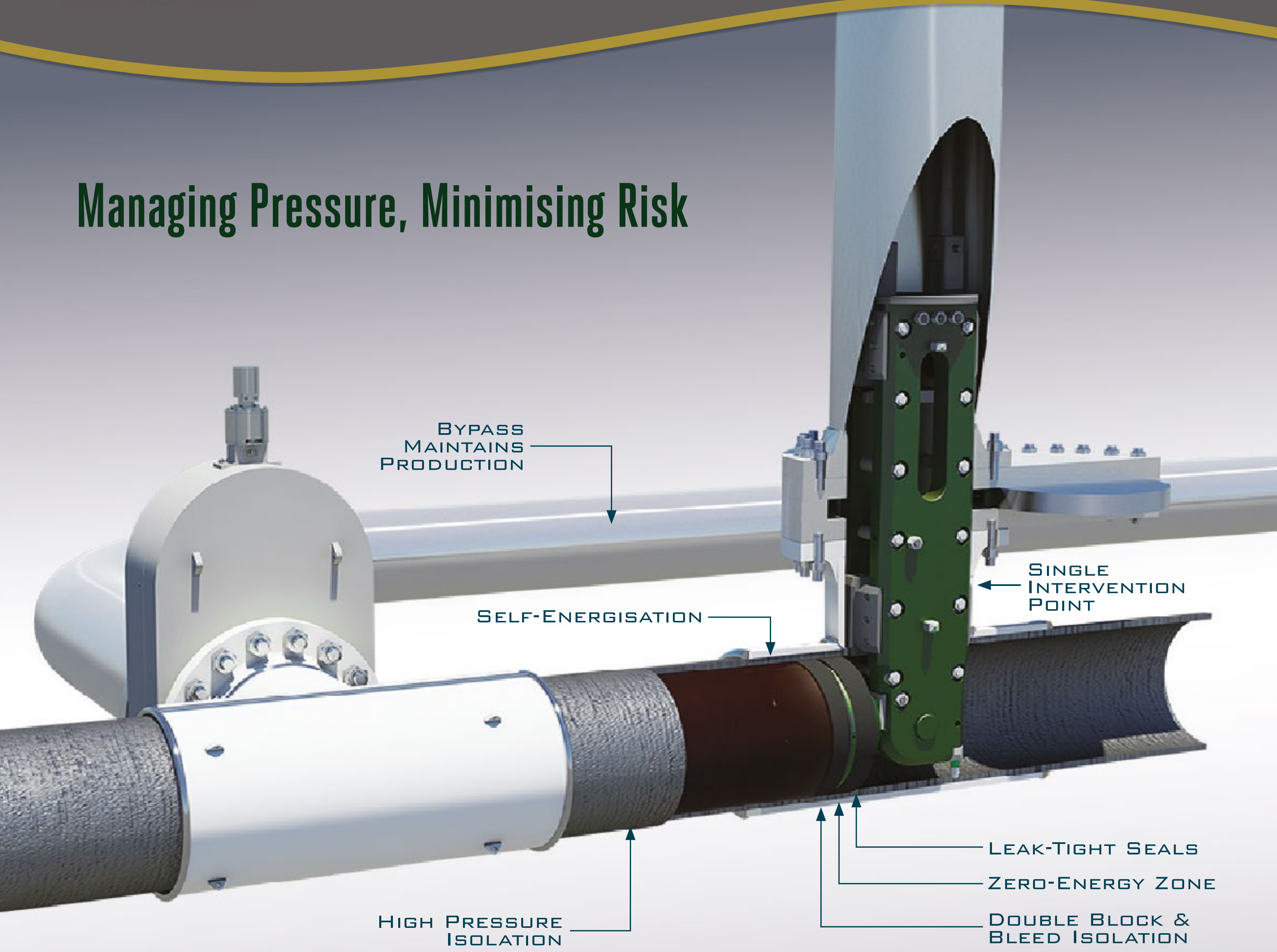

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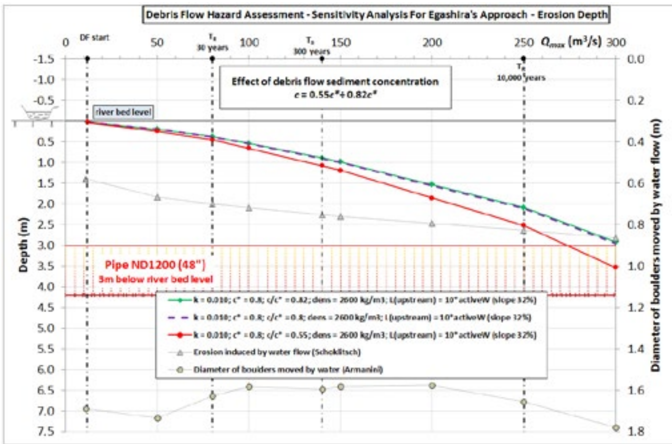
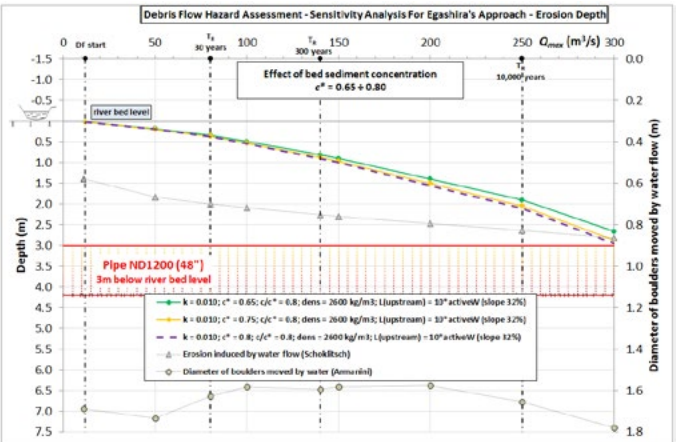
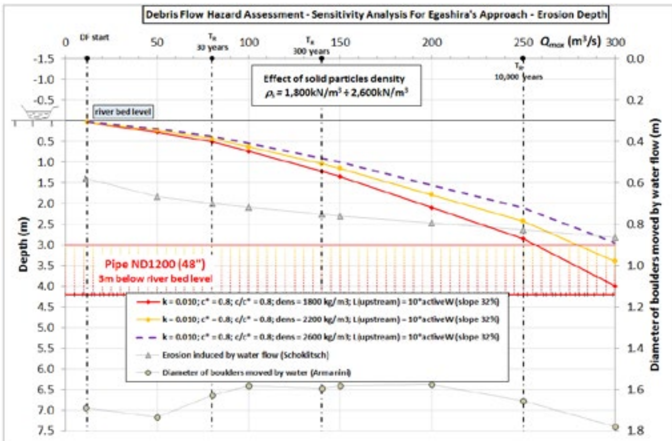
To investigate how the parameters affect the results, a sensitivity analysis shall be performed by changing one factor at a time to see the effect produced on the output (Figure 4).

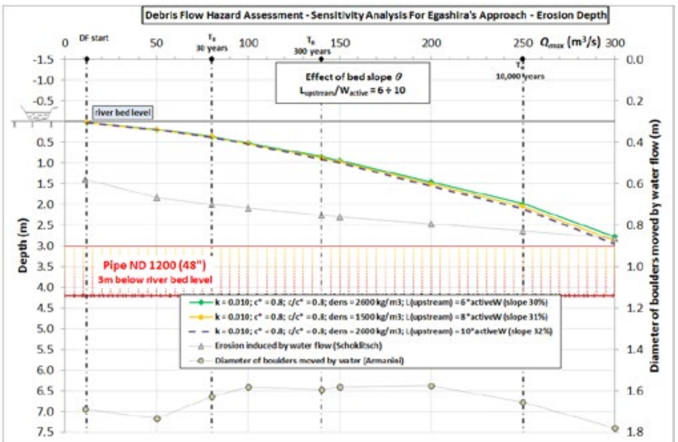
It can be observed that k and □s may have great influence on de while the other parameters (c*, c and ɵ) may normally have minor effect on the calculations.

In order to investigate, from a probabilistic point of view, the overall influence of these factors and the impact of risk, the Monte-Carlo simulation (Figure 5) can be used considering different types of variation law for the parameters of interest (k, c*, c, ɵ and p_s).









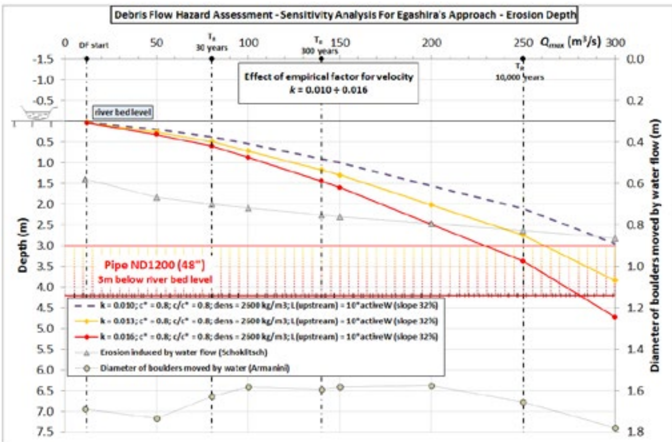


Figure 4 - Sensitivity Analysis for Egashira's Approach

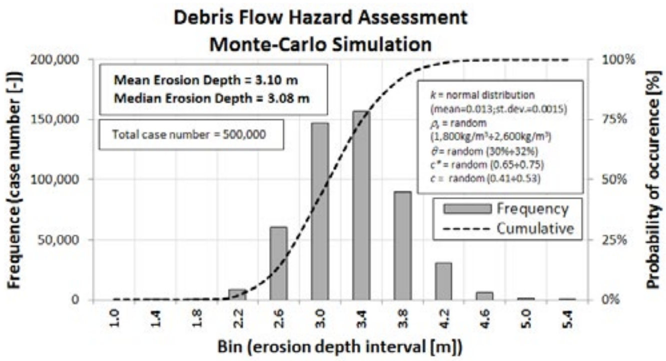


Figure 5 - Example of Monte-Carlo simulation for Egashira's approach

"EMPIRICAL (GRAPHICAL)" APPROACH

Aiming to develop a global relationship between DF scour and channel slope, the study carried out in [6] compiles data from the literature considering maximum DF scour depths, widths, and slopes obtained from detailed topographic measurements of channel cross-sections and longitudinal sections.

The study indicates that the upstream slope has the most influence on erosion and the correlations increase when the scale increases up to 6-8 times the channel width or 10 times the channel scour width.

Using a global database of debris-flow scour, scour width and upstream slope of hundreds cross-section measurements, an empirical logarithmic relationship for the prediction of channel erosion has been proposed (Figure 6).

Therefore, for a fixed (upstream) slope of the water course, a range of predictable normalized scour (depth/width) can be estimated.

Once selected the section of the channel in correspondence of the pipe crossing, one of the most important parameters to assume is the riverbed slope.

According to [6], it is useful to consider the upstream slope of the reference section calculated for an upstream length of about 8-10 times the channel active width.

COMPARISON OF RESULTS

A comparison between the three different methods can be performed. Figure 7 provides an example of comparison, from which it can be noted that the mean values coming out from the graphical approach can be used, preliminary, for a fast and conservative estimation taking into account only the slope of the channel and the width of channel interested by erosion.

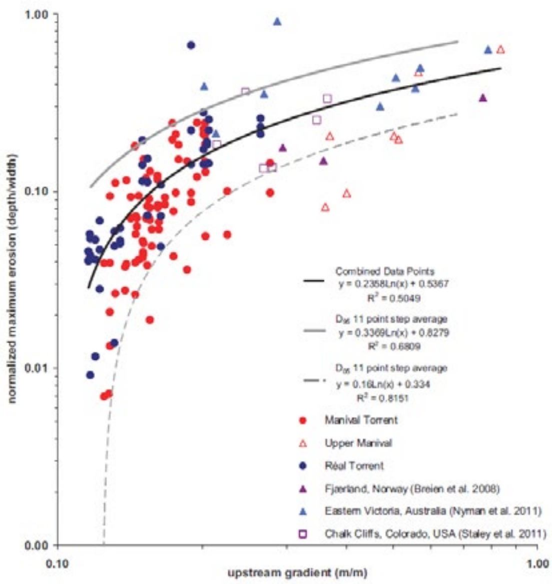


Figure 6 - Relationship of maximum erosion normalized by width and upstream slope measured by resurveyed cross sections [6].

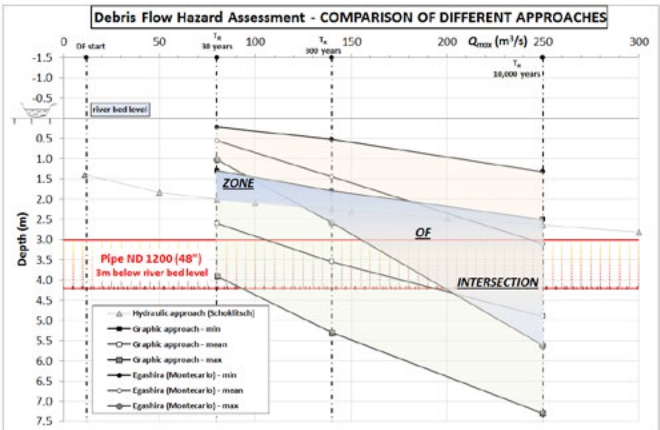


Figure 7 - SRA: comparison of results

CONCLUSION

A methodology has been proposed in order to assess the debris flow (DF) risk related to underground pipes, evaluating the magnitude of scour induced by DF conditions at which the pipeline is damaged and applying it to a real case.

Starting from a Debris Flow Assessment (DFA) that describes the solid transport processes of a channel, a Soil Response Assessment (SRA) aims to estimate the Permanent Ground Deformations PGD (erosion and deposition) associated to DF scenarios; then it is of fundamental importance the knowledge of the pipeline geometry (route and cover depth below the channel) to evaluate the associated risk.

Three different methods have been proposed within SRA to estimate the PGD:

1. calculation of the stone diameter and erosion scour due to water flow rate using the classical formula of Armanini and Schoklitsh;
2. calculation of the DF erosion depth using Egashira approach for erosion rate and final adjustment considering the effect of the colluvial deposition;
3. graphical estimation of normalized erosion depth (depth/width) using an experimental diagram based on collected data of really happened DFs.

Since they require both accurate hydraulic analyses and specific assumptions and considerations, the first and the second method are more detailed (but also more complex) than the third method which is, on the other hand, more rapid.

After the comparison, it was found that the mean values coming out from the graphical approach can be used, preliminary, for a fast and conservative estimation which takes into account only the slope and the width of the channel interested by the erosion.

Further analyses, based on real events, are required in order to validate this assumption.

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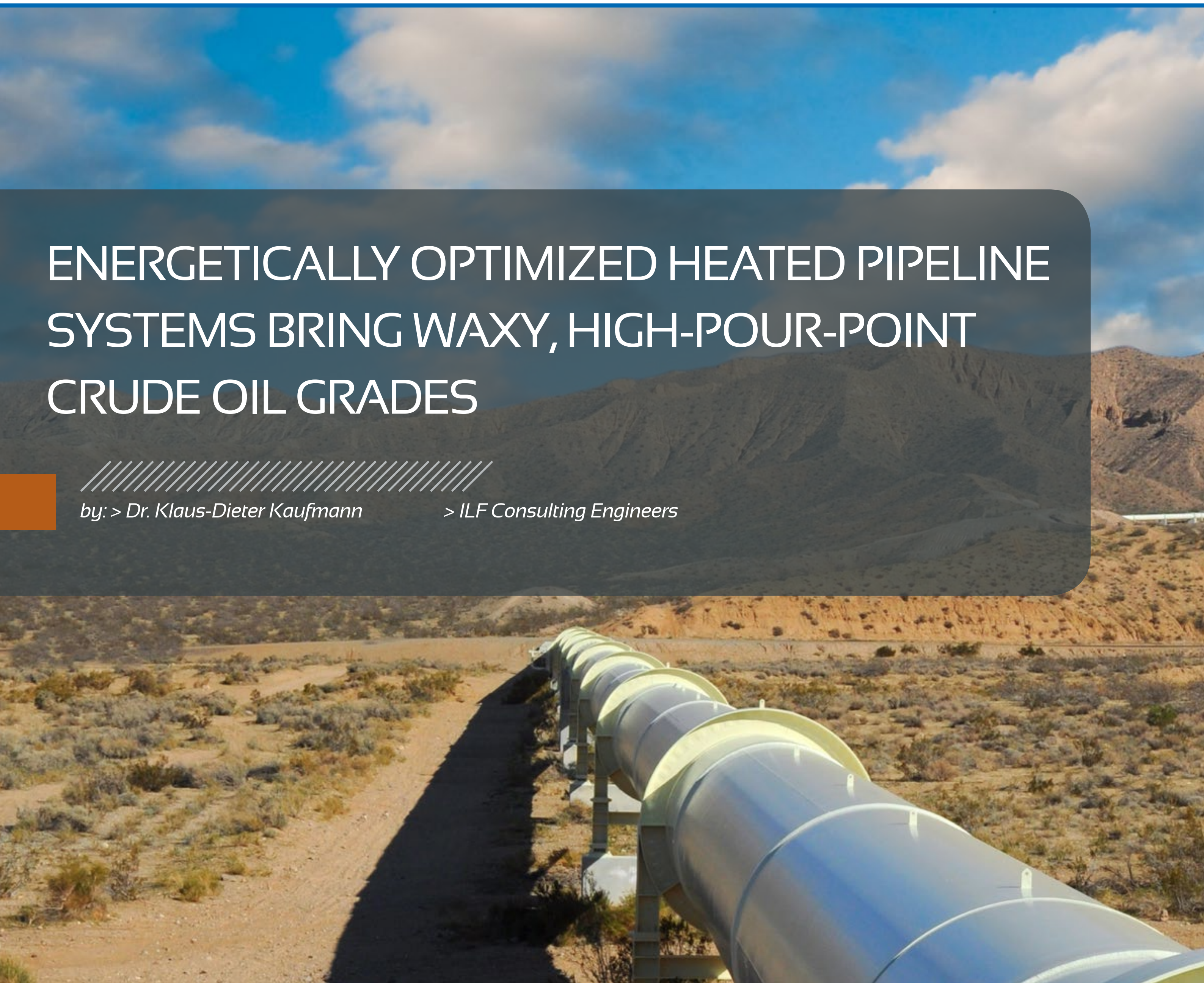

ENERGETICALLY OPTIMIZED HEATED PIPELINE SYSTEMS BRING WAXY, HIGH-POUR-POINT CRUDE OIL GRADES

by: > Dr. Klaus-Dieter Kaufmann > ILF Consulting Engineers

ABSTRACT

Heated, heat insulated pipeline systems enable transporting waxy, high pour point crude oil from remote locations to international oil markets.

After addressing the mechanical built-up of buried, heat-insulated pipeline systems (PUR compound system, steel-in-steel system), various possibilities of pipeline heating will be considered using (a) bulk heater stations, (b) skin effect trace heating, (c) resistance trace heating, (d) friction heating, (e) combined heat and power stations (CHP) and (f) heat recovery in pump stations.

A possible heating system comprises bulk heater stations installed at adequate distances along thermally insulated pipeline sections combined with electrical trace heating systems as back-up heating systems for cases of low flow or oil re-heating after operational shut-down. However, such system shows major disadvantages, e.g. higher heat losses, higher heating energy cost, high infrastructure and site related cost as well as reduced flexibility for future throughput reduction or increase.

In contrary to this system an innovative heating system is being suggested, comprising the installation of combined heat and power (CHP) stations at up to ca. 100 km distance generating electrical energy for the trace heating systems upstream and downstream of the CHP stations while additionally transferring the heat produced to a side stream of the crude oil routed through the CHP station. The advantages of this system are reduced heat losses, higher heating system efficiency, no installation requirement / cost for bulk heater stations, relatively large distances between CHP stations, higher system flexibility for throughput reduction or increase and no requirement for electrical power supply from third-party avoiding related cost and risks. Heat recovery in pump stations can be incor-porated into the design.

For minimization of environmental pollution, instead of crude oil, refined liquid products or preferentially natural gas should be used as fuel for the heating systems and pump sta-tions to be installed.

THERMALLY INSULATED AND HEATED PIPELINE SYSTEMS – OVERVIEW

INTRODUCTION

Pipeline transportation of waxy / high pour point crude oil requires maintaining the oil tem-perature at least at a certain temperature margin above the so-called pour point (PP) avoiding rapid oil solidification after intended or unintended transportation interruptions. For certain crude oil grades the PP may amount to 40°C and higher /2/.

Aiming to minimize wax built-up on the internal pipeline surface and to avoid intense op-erational measures for wax removal (e.g. frequent runs of scraper pigs) the pipeline sys-tem design may require oil transportation also above the so-called wax appearance tem-perature (WAT) which is generally expected to be 10-20°C (K) higher than the PP. A min-imum required oil transportation temperature of up to 65°C may therefore represent a re-alistic scenario.

Additionally, the oil temperature should be selected high enough resulting in related vis-cosity reduction for economic transportation. Examples for heated, heat-insulated crude oil pipelines are the (existing) Mangala MDP crude oil pipeline system in India /3/ (WAT ca. 65°C) and the intended Ugan-da-Kenya crude oil pipeline in East Africa /4/.

MECHANICAL CONSTRUCTION

Two different thermally insulated (preferentially buried) pipeline system types are consid-ered in the following (see also Figure 1):

a) A steel pipeline compound system, thermally insulated by polyurethane (PUR) foam and externally coated by polyethyl-ene (PE), as applied regarding its funda-mental construction principle since many years for district heating /5/ and

b) A steel-cased pipeline system (known also as steel-in-steel or pipe-in-pipe system) insulated by mineral wool or other special insulation material in the (preferentially evacu-ated) ring space between both steel pipes, coated externally by polyethylene /6/.

Both thermally insulated pipeline systems mentioned above can be equipped with electri-cal trace heating systems having the main advantage that the oil temperature in the pipe-line sections can be maintained independent of flow conditions like low-flow or zero flow; trace heating can even re-heat cooled-down pipeline sections after longer shut-down.

The schematics in Figure 1 show typical cross sections through both systems /1/. The trace heating elements (po-tentially more than one in each system) as well as type and number of supporting elements of the steel-cased pipeline system are indicated only schematically and may vary be-tween manufacturers.

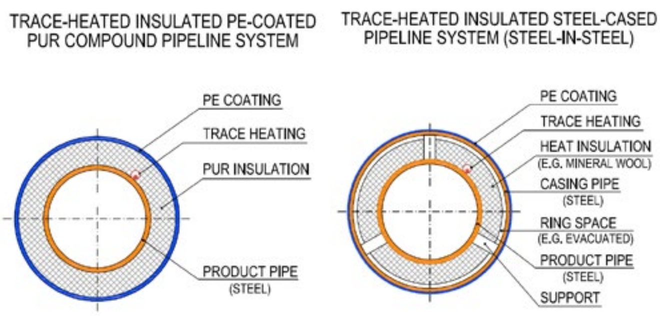

Figure 1: Schematical Cross Sections through Trace Heated and Insulated Pipeline Systems /1/

BULK HEATER STATION HEATED PIPELINE SYSTEMS

Increasing the crude oil temperature in so-called bulk heater stations installed at approxi-mately regular dis-tances along thermally insulated pipeline sections is one of the possible heating methods where the heating en-ergy from fuel combustion can be transferred effi-ciently to the crude oil. Assuming constant oil flow rate, the temperature profile is saw-tooth shaped with the highest temperature at the outlet of a heater station represent-ing the inlet temperature to the next pipeline section. Figure 2 shows related temperature profiles exemplary as a function of the oil flow rate (100 kbpd correspond to 662.5 m^3/h). The pipeline diameter was assumed to be 30" (ca. 0.76 m) and the oil inlet temperature to the pipeline section as 90°C.

Figure 2 shows e.g. that for ensuring a minimum oil tem-perature of 65°C at 100 kbpd, the distance between bulk heater stations cannot be larger than ca. 190 km.

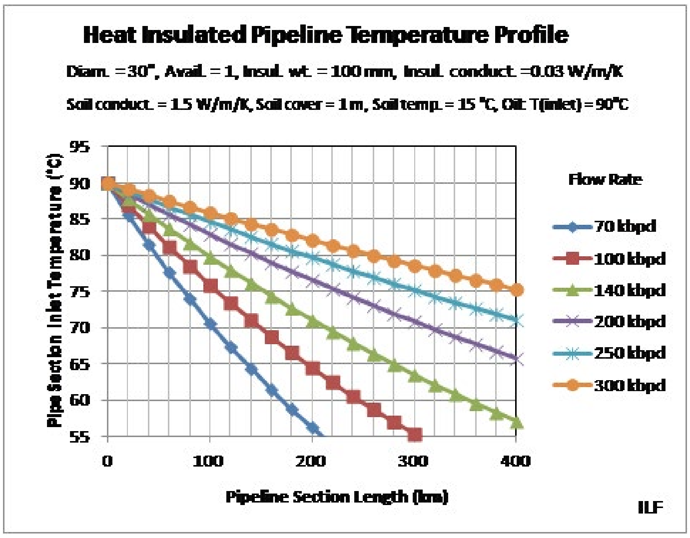

Figure 2: Influence of Oil Flow Rate on Temperature Profile and Heating Length

Despite the advantage of efficient combustion energy transferability in the heater stations to the oil transported, the heater-station heated pipeline system shows the following major disadvantages /1/:

- Increased heat losses due to higher oil outlet temperature of heater stations, com-pared to minimum required oil transport temperature
- Inability of the pipeline system to operate below a minimum oil flow rate
- Inability of the heater stations to re-heat the oil in the pipeline sections after longer shut-down phases.

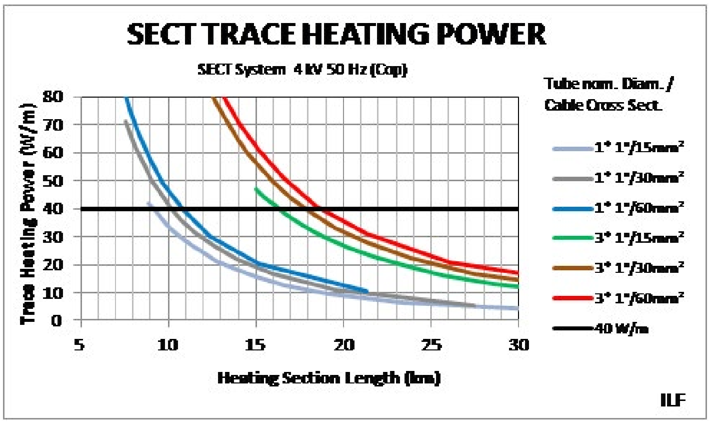

Figure 3: Specific Trace Heating Power of SECT System Depending on Number of Heating Tubes and of Trace Heating Length

ELECTRICALLY TRACE HEATED PIPELINE SYSTEM

Skin Effect Trace Heating Systems

Skin effect trace heating systems /7/, also known under different acronyms SECT, SEHTS, SEHMS or STS systems comprise one or more relatively small ferromagnetic "heating tubes" (diameter e.g. 0.5" to 1.5", i.e. ca. 20 – 50 mm outer diameter) laid usually in parallel and in thermal contact to the thermally insulated transport pipeline.

An electrically insulated conductor cable is laid inside the ferromagnetic heating tube, connected in series at the far end to the tube and is operated at AC voltage of up to e.g. 4 to 5 kV. Heat is generated by the alternating electrical current flowing through the con-ductor cable and through the heating tube near its inner surface in an approximately about 1 mm wide layer due to the proximity effect between the tube surface and the insu-lated conductor while the outside surface of the heating tube is on ground potential.

An existing crude oil transportation system operated according to the skin effect principle, providing a specific heat of up to ca. 40 W/m is the approximately 670 km long 24" MDP pipeline system in India /3/, thermally insulated by PUR foam enabling to operate the crude oil pipeline above 65°C independent of the flow rate, and also able to re-heat the pipeline system after longer standstill before resuming transportation operation. The pipe-line system disposes on generator stations located at an average distance of ca. 18 km providing the electrical energy for the SECT systems by using natural gas from a parallel 8" fuel gas line laid in the same trench as the oil transport pipeline.

Studies performed by ILF showed that increasing the distances between power supply stations for SECT heating systems in remote locations may reduce related investment and operating costs; therefore installing SECT systems with 2 or 3 heating tubes in paral-lel realizing larger heating sections can present an economically attractive alternative.

Figure 3 shows the specific trace heating power of a SECT system for 1 and 3 parallel heating tubes, respectively, as a function of copper cable cross section and of trace heat-ing length. The system voltage of each SECT system has hereby been selected as 4.0 kV, the nominal heating tube diameter as 1".

The calculation results presented in Figure 3 show e.g. that for a specific trace heating demand of 40 W/m the heating section length coverable with 1-tube- and 3-tube configu-ration will be around 10 km (1-tube-) and 18 km (3-tube) configuration, respectively. Feeding from one power supply station two SECT circuits in opposite direction, the dis-tances between neighbouring power supply stations will therefore be twice the heating section lengths shown in Figure 3.

In order to prevent water ingress into the heating tubes, especially for pipelines buried in soil with high water tables, heating tubes are joined using sleeve couplings which are typi-cally fillet welded (typical both ends) and tightness tested using nitrogen gas or com-pressed air /7/.

Resistance Trace Heating Systems

Alternatively to skin effect trace heated systems, resistance trace heated systems may be considered for pipeline heating. A typical application of such system comprises a three-phase resistance heating circuit configuration with star point connection at the far end as exemplary reported by Heat Trace /8/.

Figure 4 shows the calculated specific trace heating power of a three-phase resistance heating system. In order to reach similar protection against water ingress into the trace heating system as in case of a SECT system, three 1" heating tubes joined and tightness tested like SECT tubes are assumed to be laid in parallel in thermal contact to the transport pipeline. Each heating tube comprises an electrically insulated resistance heat-ing cable of adequate cross section whereby copper was selected as the conductor ma-terial. Further assumption was a three-phase system voltage of 5 kV.

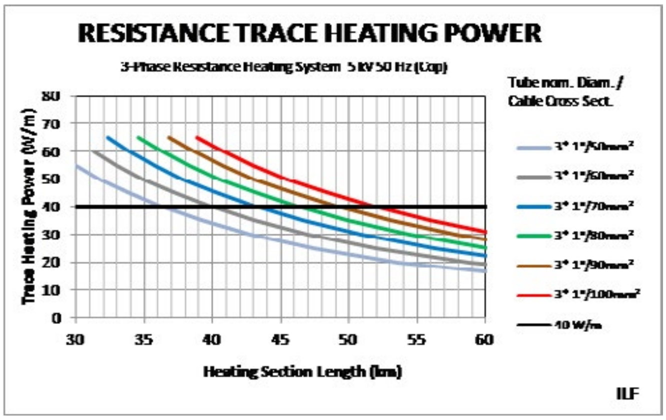

Figure 4: Specific Trace Heating Power of 3-Phase Resistance Heating System De-pending on Trace Heating Length

The calculation results presented in Figure 4 show e.g. that for a specific trace heating demand of 40 W/m the heating section lengths coverable with the 3-tube configuration will be between ca. 35 km and 50 km depending on the required conductor cross section per resistance heating cable. The possible distances between neighboring power supply stations will therefore be twice the above mentioned heating section lengths.

Economical Considerations

Due to their ability to maintain and increase the pipeline temperature at low oil flow rates and after longer shut-down phases, electrical trace heating systems may be considered to be very suitable as back-up heating systems e.g. for bulk heater heated oil transport systems. However, due the relatively low efficiency of conversion of primary fuel energy into electrical energy, electrical trace heating systems – as conventionally being installed - cannot be applied economically as the single heating method for crude oil pipelines for longer periods of application.

OIL TEMPERATURE PROFILE CALCULATION AND FRICTION HEATING

ELECTRICALLY TRACE HEATED PIPELINE SYSTEM

Oil Temperature Profile along the Pipeline

The governing equations for determination of the oil temperature profile along the pipeline incorporating contributions of heat dissipation due to friction ("friction heating") and of trace heating are presented below. For longer pipeline systems, the equations must be applied section-wise using adequate average values, e.g. of oil properties. Basic equation for oil temperature profile along the pipeline:

$$T_2 = T_{\inf} + (T_1 - T_{\inf}) \cdot \exp\left(\frac{-k \cdot L}{\dot{m} \cdot c_p}\right)$$

Specific heat transfer coefficient considering heat conductivities of insulation and soil:

$$k = \frac{2 \cdot \pi}{\frac{1}{\lambda_j} \cdot ln\left(\frac{d_j}{d_o}\right) + \frac{1}{\lambda_s} \cdot ln\left(\frac{4 \cdot h}{d_j}\right)}$$

Theoretical oil temperature reachable for infinite pipe length:

$$T_{\inf} = T_S + \Delta T_{Diss} + \Delta T_{TH}$$

Specific dissipated heat flow caused by friction energy losses:

$$\dot{q}_{Diss} = \dot{V} \cdot \Delta p_f / L = \dot{V} \cdot \frac{\lambda_f}{d_i} \cdot \frac{w^2 \cdot \rho}{2} = \frac{8 \cdot \lambda_f \cdot \dot{m}^3 \cdot \rho}{\pi^2 \cdot d^5 \cdot \rho^2}$$

Friction factor according to Colebrook-White (to be solved iteratively):

$$\frac{1}{\sqrt{\lambda_f}} = -2 \cdot \log\left[\frac{2{,}51}{\mathrm{Re}\sqrt{\lambda_f}} + \frac{k_r}{3{,}71 \cdot d_i}\right]$$

Reynolds number: $\mathrm{Re} = \frac{w \cdot d_i}{\nu}$

Formula Signs:
Page 38

Contribution of "friction heating" effect (heat dissipation) according to equation (3):

$$\Delta T_{Diss} = \dot{q}_{Diss} / k$$

Contribution of trace heating effect according to equation (3):

$$\Delta T_{TH} = \dot{q}_{TH} / k$$

According to equations (1) and (3) the theoretical oil temperature reachable for infinite pipe length corresponds to the sum of the soil temperature and of the temperature contri-butions of "friction heating" and of "trace heating" effects, see equations (7) and (8).

Temperature Effect Caused by Friction Heating

Figure 5 shows the temperature increase effect (ΔT_{Diss}) caused by "friction heating" for a buried 32" pipeline, thermally insulated with polyurethane foam (PUR) of various thick-ness. It becomes obvious that thermally insulated pipeline systems are much more prone to potential overheating by friction heating than "normal" pipeline systems.

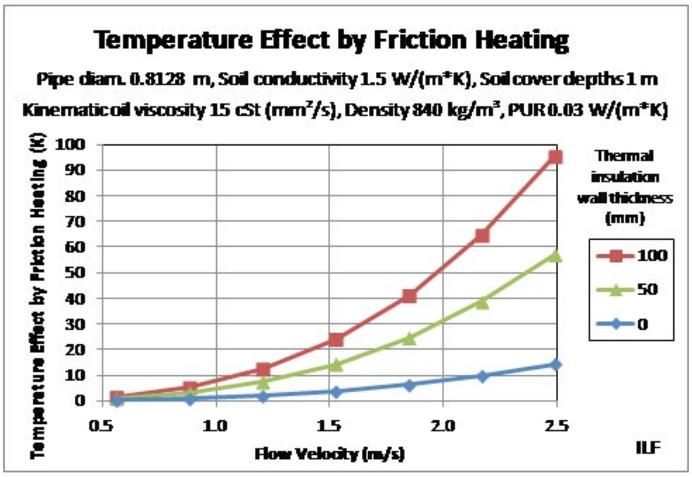

Figure 5: Temperature Effect by Friction Heating dependent on Flow Velocity and PUR Foam Insulation Wall Thickness for a 32" Pipeline System

Disadvantageous Influences of Diameter and Flow Rate on System Design

According to equations (4) and (7), the specific dissipated heat flow and temperature con-tribution caused by fric-tion energy losses are directly proportionally to the 3rd power of the flow rate and inversely proportional to the 5th power of the pipeline diameter. This combi-nation of main design variables renders, however, the system design strongly susceptible with regard to possible limitation of a future throughput increase: If the system would only be designed based on conventional optimization considering investment, energy, mainte-nance and other operating cost, a resulting smaller pipeline diameter might prevent poten-tial future throughput increase by risking exceeding the allowable oil temperature limit in the pipeline system. It may therefore be wise selecting the pipeline diameter somewhat (e.g. 2" to 4") larger than determined by the usu-al optimization process, but enabling much easier a future throughput increase.

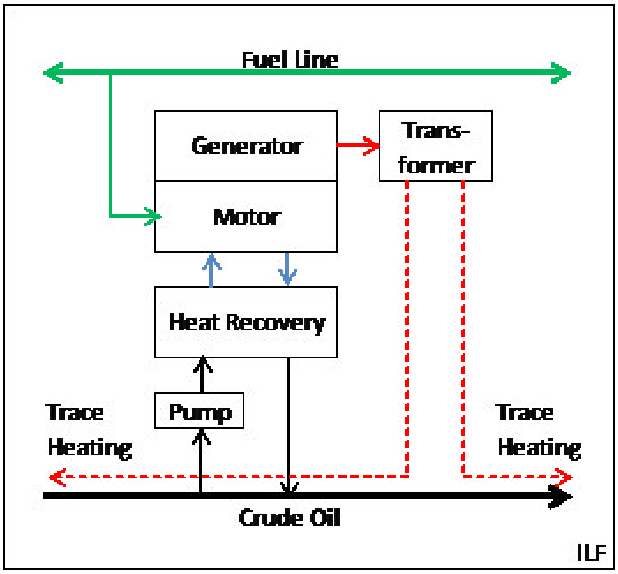

Figure 6: Simplified Sketch of Combined Heat and Power Generation Station (CHP)

SYSTEM OPTIMIZATION CONSIDERATIONS

Design for Initial Operation

Assuming that basic system design has considered po-tential future throughput increase by adequate pipeline diameter selection, the heating system must be designed ensuring to maintain the minimum required oil temperature already during the initial operation phase. As for bulk heat-er heated pipeline systems, the required distance between heater stations decreases considerably with decreasing oil flow rate (see Figure 2), a relatively high number of heater stations would be required in the initial stage of operation which would mean a high cost impact for the project.

An innovative solution to optimize the related heated pipe-line system will be presented in the following chapters.

Basic Principle

The system suggested comprises the installation of com-bined heat and power stations (CHP) located at distances of up to ca. 100 km. Figure 6 shows a simplified sketch of a combined heat and power generation station.

The CHP stations in combination with the trace heating system enable both, oil pipeline heating during normal transport operation and supplementary heating during low-flow or during oil re-heating phases after longer system shut-down.

During normal pipeline operation each CHP station pro-duces both electrical energy for power supply of the trace heating systems installed upstream and downstream of the CHP stations and additionally heat which is transferred to a side stream of the crude oil routed through the CHP station. After feeding back the heated side stream into the main stream, the mixed stream leaves the station area and enters the next downstream trace heated pipeline section.

Possible CHP heating efficiencies of up to 90% referring to the LVH of primary fuel are being expected. The fuel required for gas engine or gas turbine operation driving the gen-erator may be provided by a relatively small fuel line (e.g. liquid hydrocarbons, natural gas) buried in the same trench as the oil transport pipeline.

Formula Signs

c_p	J/(kg*K)	specific heat capacity of oil	T_{inf}	°C	theoretical oil temperature reachable for "infinite" pipe length
d_i	m	internal diameter of steel pipe	T_s	°C	undisturbed soil temperature at pipe axis laying depth
d_j	m	outside diameter of pipe insulation (e.g. PUR)	V	m³/s	oil volume flow rate
d_o	m	outside diameter of steel pipe	w	m/s	oil flow velocity
h	m	laying depth of pipe axis below ground	Δp_f	Pa	pressure loss due to friction
k	W/(m*K)	length-related heat transfer coefficient	ΔT_{diss}	K	oil temperature increase contribution by dissipated heat
k_r	m	internal pipe roughness (e.g. 0.045 mm)	ΔT_p	K	oil temperature increase in pump
L	m	length co-ordinate or length of the pipeline system	ΔT_{TH}	K	oil temperature increase contribution by trace heating
m	kg/s	oil mass flow	η_{dr}		shaft rated efficiency of driving engine referring to fuel medium LHV
P_p	W	pump shaft rated power demand	η_{el}		lectrical efficiency of CHP station referring to fuel medium LHV
q_{diss}	W/m	specific dissipated heat flow	η_{rec}		driving engine heat recovery efficiency referring to fuel medium LHV
q_{TH}	W/m	specific heat flow transferred by trace heating	η_{th}		thermal efficiency of CHP station referring to fuel medium LHV
Q_{diss}	W	dissipated heat flow in pump	η_p		mechanical pump efficiency
Q_{rec}	W	waste heat recoverable from pump driving engine	λ_j	W/(m*K)	pipe insulation heat conductivity (PUR: ca. 0.030 W/(m*K))
Q_{LHV}	W	combustion heat demand of the CHP station referred to LHV	λ_f		friction coefficient
R_e		Reynolds number	λ_s	W/(m*K)	soil heat conductivity (e.g. 0.5 – 2.5 W/(m*K))
T_2	°C	oil temperature at location downstream pipeline inlet	v	m²/s	kinematic oil viscosity (1 cSt=1 mm²/s)
T_1	°C	oil temperature at pipeline (section) inlet	ρ	kg/m³	oil density
			π		circle constant =3.14159...

Temperature Profile Calculation using CHP Stations and Electrical Trace Heating

In order to determine the temperature conditions in CHP heated pipeline sections, the fol-lowing equations have to be respected in addition to the equations presented in Chapter 3.1:

Fuel medium heating power (referring to lower heating val-ue, LHV) in a CHP station:

$$\dot{Q}_{LHV} = \frac{\dot{m} \cdot c_p \cdot (T_1 - T_2)}{\eta_{TH}}$$

Specific heat generated in the trace heating system:

$$\dot{q}_{TH} = \frac{\dot{Q}_{TH}}{L} = \frac{\eta_{el} \cdot \dot{Q}_{LHV}}{L}$$

L represents hereby the intended distance between CHP stations.

Substituting $\dot{Q}_{LHV}$ of equation (9) in (10), $\dot{q}_{TH}$ of equation (10) in (8), ΔT_{TH} of equation (8) in (3) and $T_{\inf}$ of equation (3) in (1), temperature T_1 can finally be calculated as a function of the minimum allowable oil temperature T_2.

Oil Temperature Profiles: Bulk Heater versus CHP Heated Pipeline Sections

For the following comparison it is assumed that electrical trace heating installations along the pipeline system are required in any case for supplementary heating during low-flow or during oil re-heating phases after longer system shut-down. In order to minimize the num-ber of power sup-ply points for trace heating, the installation of resistance trace heating systems (see Chapter 2.4.2) combined with the installation of CHP stations (see Chapter 4.2) has been considered. For the investment cost comparison with bulk heater stations, only the differential cost for heat recovery equipment in the CHP stations would have to be respected.

Figure 7 below shows the oil temperature profiles for bulk heater heated and CHP station / trace heated pipeline systems. The distance between bulk heater stations was assumed as 300 km, the distance between CHP heater stations as 75 km. For the assumed mini-mum crude oil temperature of 65°C (WAT e.g. 60°C) and assumed maxi-mum oil trans-portation temperature of 90°C, the oil flow velocity in the 32" pipeline systems has been determined as approximately 0.66 m/s, corresponding to a flow rate of ca. 179 kbpd (1,183 m³/h). The electrical (η_{el}) and thermal (η_{TH}) efficiencies of the CHP station instal-lations were assumed as 30% and 60%, respectively.

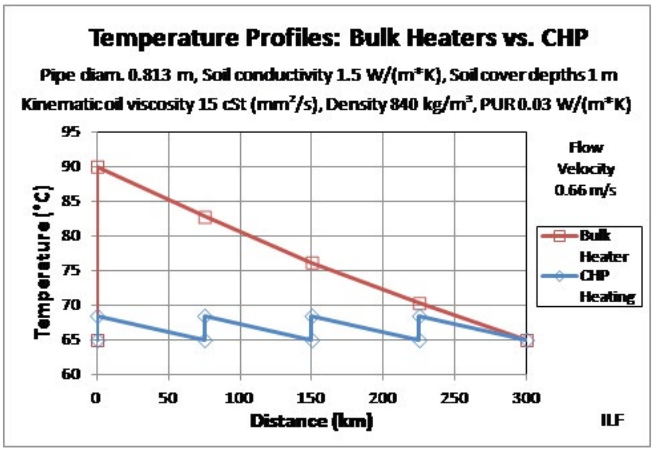

Figure 7: Oil Temperature Profiles for Bulk Heater versus CHP Station & Trace Heat-ed Pipeline Systems

For the same above mentioned crude oil flow rate, both heating systems (bulk heaters, CHP stations) are operat-ed at around 90% efficiency, but the oil inlet temperature and re-sulting heating loss and fuel energy demand for CHP stations are much less than for bulk heater stations. Additionally CHP heated pipeline sections can be operated at even lower oil throughputs at up to 90% efficiency while the supplementary trace heating for bulk heater stations at low flow rates enables only efficiencies of around 30%.

Oil Temperature Increase and Heat Recovery in Pump Stations

For a horizontally laid pipeline, the pump shaft rated power demand can be estimated as:

$$\dot{P}_P = \frac{\dot{V} \cdot \Delta p_f}{\eta_P}$$

where the fraction can be assumed to be dissipated into heat in the pump resulting in oil temperature increase of

$$\Delta T_P = \frac{\dot{Q}_{diss}}{\dot{V} \cdot \rho \cdot c_p} = \frac{\Delta p_f}{\rho \cdot c_p} \cdot \left(\frac{1 - \eta_P}{\eta_P} \right)$$

For a pump with Δp_f =60 bar, ρ =850 kg/m³, c_p =1.9 kJ/(kg·K) and η_P =80%, the ex-pected oil temperature increase in the pump amounts to ΔT_P =0.93 K.

With assumed shaft rated efficiency η_{dr} and efficiency η_{rec} of heat recovery of the pump driving engine, the heat fraction

$$\dot{Q}_{rec} = \dot{P}_P \cdot \frac{\eta_{rec}}{\eta_{dr}} = \frac{\dot{V} \cdot \Delta p_f}{\eta_P} \cdot \frac{\eta_{rec}}{\eta_{dr}}$$

can be used to further increase the crude oil temperature by

$$\Delta T_{rec} = \frac{\dot{Q}_{rec}}{\dot{V} \cdot \rho \cdot c_p} = \frac{\Delta p_f}{\rho \cdot c_p} \cdot \frac{\eta_{rec}}{\eta_P \cdot \eta_{dr}}$$

For assumed efficiency of driving engine of η_{dr} =35% and assumed efficiency of heat recovery of η_{rec} =50%, the ex-pected oil temperature increase reachable by heat recovery amounts to ΔT_{rec} =6.63 K.

The example calculations show that the temperature in-crease by dissipated and recov-ered heat energy in a pump station may reach 7.56 K and can efficiently contribute to the heat balance of a heated crude oil pipeline system.

SUMMARY AND CONCLUSIONS

Heated, heat insulated pipeline systems enable transporting waxy, high pour point crude oil above the WAT from remote locations to international oil markets.

Bulk heater stations installed at approximately regular distances along thermally insulated pipeline sections, combined with electrical trace heating systems as back-up heating sys-tems for cases of low flow or oil re-heating, can be used for pipeline heating purposes but nevertheless show the following major disadvantages:

- Increased heat losses due to much higher oil outlet temperature of bulk heater sta-tions than required for oil transport regarding WAT, resulting in higher heating energy cost
- High heating cost in case of supplementary heating by electrical trace heating due to low conversion efficiency of primary fuel into electrical energy (e.g. only 30%)
- Requirement of installation of relatively large bulk heat-er stations causing high infra-structure / site-related investment and operating cost.

In contrary to this system an innovative heating system is being suggested, comprising the installation of combined heat and power (CHP) stations located at distances up to ca. 100 km. Each CHP station provides the upstream and down-stream trace heating sys-tems with electrical energy and transfers the heat produced to a side stream of the crude oil routed through the CHP station, showing the following advantages:

- Reduced heat losses along the pipeline due to con-siderably lower oil temperature along the trace heated pipeline sections
- High heating system efficiency of up to ca. 90% independent of actual crude oil flow rate resulting in relatively low heating energy cost
- No installation requirement for large bulk heater stations. The power supply stations required anyhow for back-up trace heating systems can be equipped as CHP sta-tions.
- Relatively large distances between CHP stations (up to ca. 100 km) possible when considering installing 3-phase resistance trace heating systems
- Higher system flexibility for operation at lower oil flow rates and for throughput in-crease by adequate diam-eter selection avoiding potential overheating of oil and of pipeline system.

Additionally the following aspects contribute to further system optimization:

- Heat recovery from fuelled combustion engines in pump stations, reducing the sys-tem's heating energy demand
- No electrical power supply required from third-party at low efficiency regarding prima-ry fuel consumption for pipeline trace heating systems and pump stations, minimizing thus related energy cost and potential power supply risks.
- For minimization of environmental pollution, instead of crude oil, refined products or preferentially natural gas should be used as fuel medium provided e.g. by additional fuel line buried in the same trench as the oil transport pipeline.

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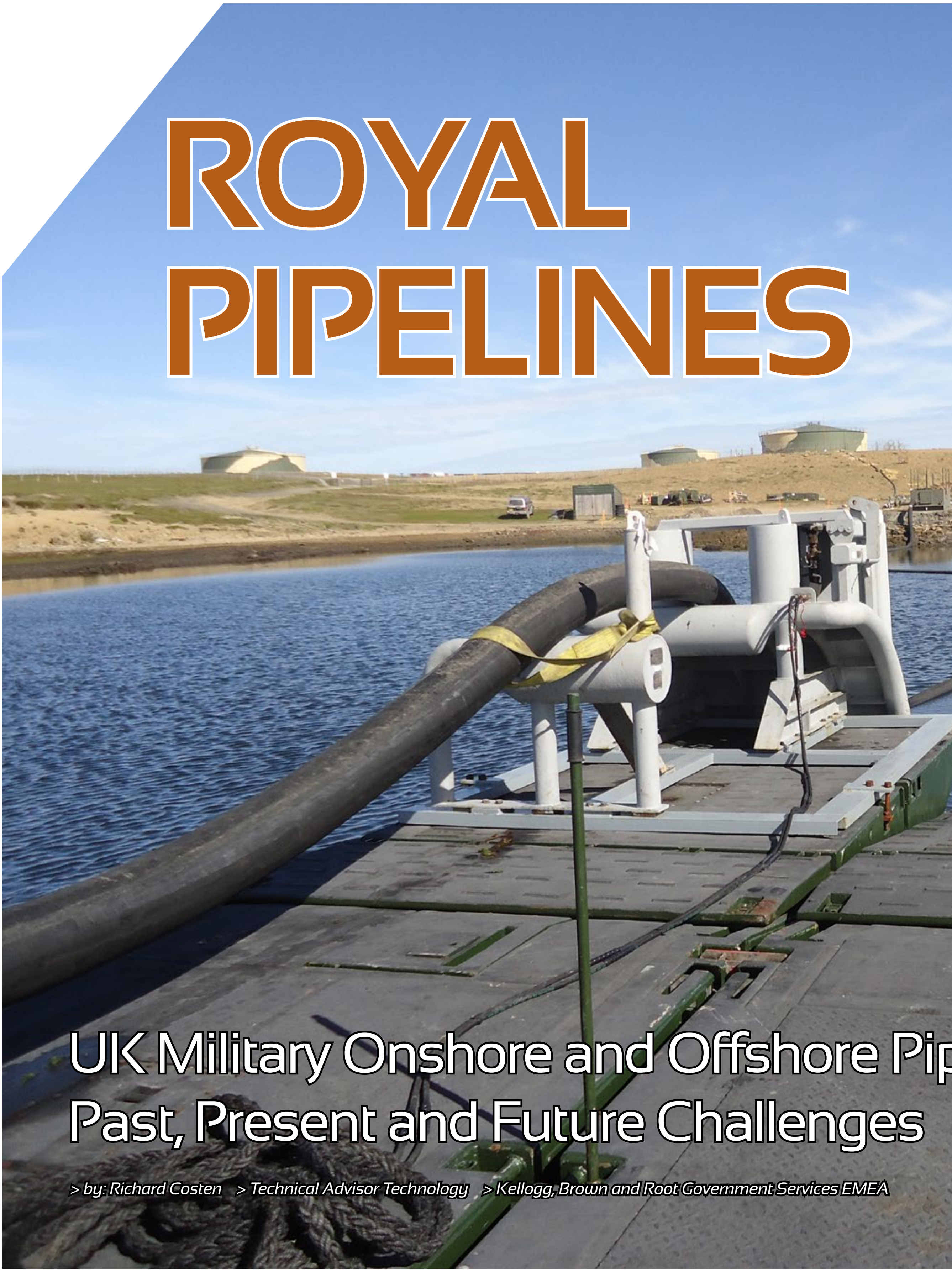
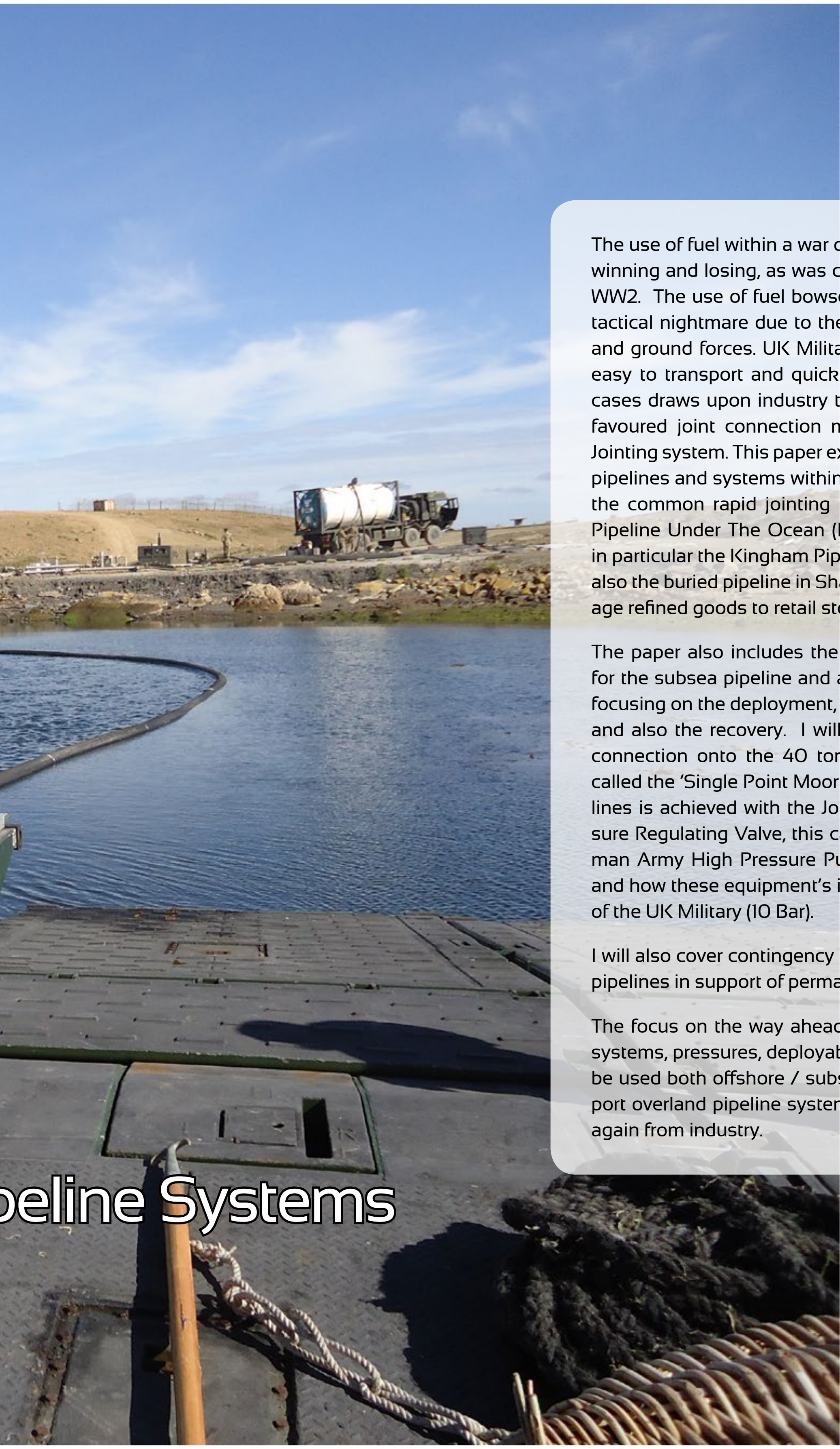


ROYAL PIPELINES

UK Military Onshore and Offshore Pip
Past, Present and Future Challenges

> by: Richard Costen > Technical Advisor Technology > Kellogg, Brown and Root Government Services EMEA



Abstract

The use of fuel within a war or conflict can be the difference between winning and losing, as was clearly evident in the desert campaign in WW2. The use of fuel bowsers has been and still is a logistical and tactical nightmare due to the ease in which they are targeted by air and ground forces. UK Military Pipeline Systems need to be robust, easy to transport and quick to build and deconstruct and in some cases draws upon industry to provide a viable solution, thus far the favoured joint connection method has been the Victaulic Groove Jointing system. This paper explains the history and importance of the pipelines and systems within the Military Environment detailing both the common rapid jointing method of surface pipelines, the WW2 Pipeline Under The Ocean (PLUTO), surface laid overland pipelines in particular the Kingham Pipeline Over the Desert (PLOD) in Iraq and also the buried pipeline in Shaibah logistic base connecting bulk storage refined goods to retail storage.

The paper also includes the current capabilities and methods used for the subsea pipeline and also the two types of overland pipelines focusing on the deployment, laying, obstacle crossing, method of use and also the recovery. I will also discuss the use, deployment and connection onto the 40 tonne Terminal Mooring buoy commonly called the 'Single Point Mooring'. Connection via high pressure pipelines is achieved with the Joint Operational Fuel System High Pressure Regulating Valve, this can be used in conjunction with the German Army High Pressure Pumping and Pipeline systems (100 Bar) and how these equipment's integrate into the lower pressure system of the UK Military (10 Bar).

I will also cover contingency planning and construction of rapid build pipelines in support of permanent infrastructure systems.

The focus on the way ahead, new requirements and developments, systems, pressures, deployablilty and multiple use pipelines that can be used both offshore / subsea and then be re-used for use to support overland pipeline systems will also be discussed with solutions again from industry.

WORLD WAR I

The need for fuel within WW1 Was not a major concern until the use of tanks and the amount of vehicles used increased, in the beginning the need for fuel was provided in the small containers and also drums which were then poured or pumped into the vehicles and aircraft by hand. If any pipelines were made then the usual flanged joint was used on short lengths of pipe until a new system was designed.

After the war Lieutenant Ernest Tribe Royal Engineers perfected a system that was then patented in 1919, Victaulic is the originator and world's leading producer of mechanical pipe joining solutions, including grooved fittings and couplings. Originally known as The Victory Pipe Joint Company, Victaulic began to market a revolutionary new concept in the piping industry -- a mechanical bolted coupling that would engage into grooves and use a gasket seal. The concept of the "victory joint", joining pipe with bolted mechanical grooved couplings and grooved fittings, originated during World War I for rapid deployment of fuel and water lines to Allied forces. Later, combining the words "Victory" and "Hydraulic" the company name was shortened to Victaulic.

WORLD WAR II

Fuel supply during WW2 was paramount to most if not all campaigns; it was used for ground transport, heating, cooking and aircraft. WW2 saw the first real use of major fuel stock and also the transportation and security of these fuel stocks. Fuel dumps were placed in strategic locations in support of the long range desert patrols all the way up to brigade size fuel supply depots that used the now widely used and copied 'Jerry Can' which is still in use today by most armed forces, permanent fuel storage facilities were also taken over or constructed.

Due to the fast moving units and heavy use of aircraft the need for fast expedient and versatile fuel systems were required, the use of short transportable lengths of grooved pipe that could be easily laid and connected using the Victaulic Joint was used in most areas of operation. Long pipelines were laid in Burma and India, shorter ones in Europe and also large fuel farms with pumps were constructed with the Victaulic system.

"The great campaign in North Africa from 1940 to 1943 was decided by the supply of fuel . Fortunately, axis forces had run out of fuel."

> Richard Costen

Both UK and US forces used the Victaulic system; this joint use of a single system was to become very important in the deserts of the Middle East some 50 years later.

As the war progressed Operation Overlord was conceived and along with that followed all of the supporting elements and the problems that came with mounting a sea borne invasion of mainland Europe. The English Channel proved to be very difficult to get fuel over to the troops in Europe, floating barges and tankers were priority targets for the German Luftwaffe. The British army looked towards industry for a solution to get millions of litres of fuel over to the European mainland without using boats or barges. Possibly a technical impossibility.

OPERATION PLUTO

The solution came by an innovative approach to use the theory behind the construction of heavy power cables, thus the Pipeline Under The Ocean or Operation Pluto as it became known was born.

Figure 1: PLUTO Pipe layers

The actual pipe was manufactured in 40 foot long sections and flash welded together and then loaded on to large coned drums, it was from these words that the word 'Conundrum' became into being. The drums were 90ft long and 50ft in diameter and once fully loaded with up to 30 miles of pipe sat in the water half submerged, some drums were loaded with up to 80 miles of pipe. The flow and pressure of the lines ranged from 40 – 80 Gallon per minute at 1250PSI, at the normal pumping rate PLUTO delivered 1,000,000 Gallons of petrol per day.

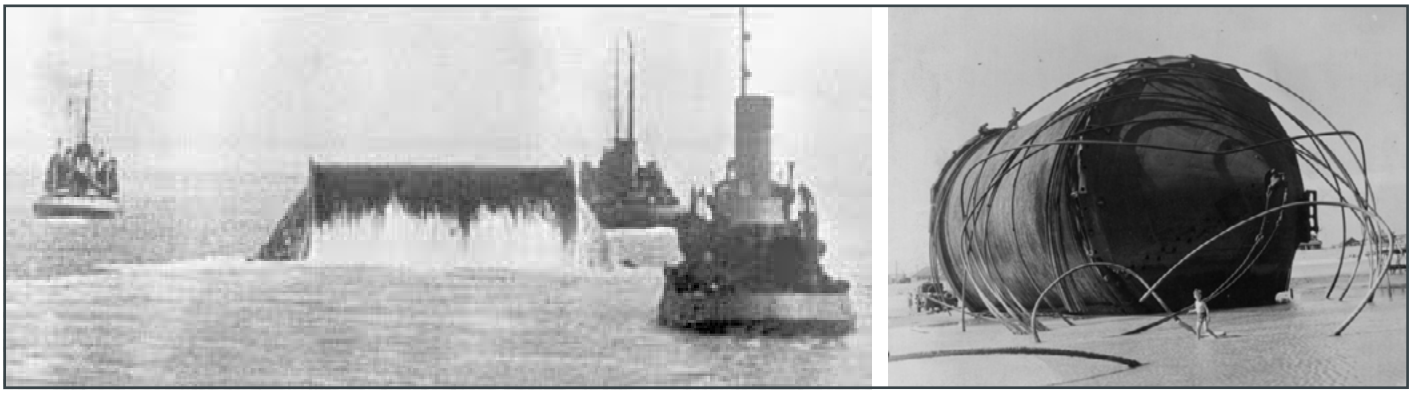


Figure 2: Conundrum PLUTO Deployment and One Drum Landed in France

The pumping stations used to pump this fuel were built in secret and were placed in locations such as houses, bungalows, even an Ice Cream parlour.

Operation Pluto was a huge success not only in the deployment of the pipe but more so the speed in which Industry rose to the challenge to design something that had never been done on this scale before. Some may say that this type of pipe laid the way for the more modern composite bonded and un-bonded spoolable pipes we see available today.

Once the fuel was landed ashore in large deployed fuel terminals there was a need to move the fuel in land in support of the troops moving forward, the use of tankers to move vast quantities of fuel is not and never will be a viable option in areas of conflict. The need for an overland pipeline was identified, the main pipeline open for use was the Victaulic Grooved Pipeline System, this consisted of 20ft lengths of pipe that were joined together with the grooved jointing system as designed just after WW1.

The system was simplistic and modular and very robust and versatile, so versatile in fact that this system is still used today both in industry and also in use by the UK and US Armies as a means to move fuel around the rear battle area.

Victaulic pipelines many thousands of miles long were built in the Far East during WW2. It should be noted that not much has changed in nearly 50 years when it comes to overland pipelines.

Figure 3: Typical 6 inch Victaulic Grooved Overland Pipeline in during WW2

FUEL HANDLING EQUIPMENT

We now move forward a few decades to the fuel system used by the UK military called Emergency Fuel handling Equipment, as time went on and certain items of equipment such as pumps and Filter Water Separators were replaced with more modern equipment the system was renamed as Tactical Fuel Handling Equipment (TFHE), this system was deployed all over the world to support British action in theatres such as mainland Europe where large temporary deployed fuel farms using the Tank Fabric Collapsible and Layflat fuel hose, this was augmented where required by the 20 foot long by 152mm diameter aluminium alloy Victaulic grooved pipe, pipelines many kilometres long were constructed over the great West German farmland.

TFHE was used to great effect in the Falkland Islands conflict where the Dracone Towed Flexible barge was first used to bring fuel ashore at Port San Carlos; TFHE was also used to support Exercises and deployments by NATO forces in the Northern and Southern flanks of the NATO countries. The TFHE system operated at low pressure and medium flow rates, systems were able to be built to refuel Harrier Jump Jets, Naval forces and also ground vehicles.

MARITIME FUEL SYSTEMS

During the late 80's and early 90's there were two maritime fuel systems designed and purchased, these enabled the UK to safely and quickly deploy maritime forces and also be able to deploy and build Maritime fuel infrastructure using in service Naval vessels.

The two maritime systems were called Towed Flexible Barge Discharge System (TFBDS) which could be deployed and ready to transfer and deliver fuel within a very short period of time. The system still utilised the Dracone Barges that were used in the Falklands Conflict. The Dracone had a hydraulic driven pump installed into the nose come part of the Dracone, the Dracone was moored off the shore and was connected to the shore by a layflat floating pipeline. This system could transfer vast amounts of fuel both Aviation and Ground Fuel types. The system could also operate night and day.

It was during the period of time that the TFBDS system delivered the fuel requirement that the larger system called the Ship to Shore Pipeline System (SSPS) was moved into the theatre of operations to take over the fuel transfer once the shore and surrounding area was made safe for the heavier naval assets.

TFHE
Typical TFHE Fuel Storage System Connected With Victaulic Pipe

Figure 4: TFBDS – Beach Side

Figure 5: Transfer of Fuel to Shore

SSPS

The SSPS was an American design and consisted of large bore rubber hose manufactured by Manouli Industries, the system deployable length was approximately half a mile from shore. The system also included a UK built Single Point Mooring, this allowed larger tankers to support the British action or Exercise. The laying equipment was able to be built onto either large offshore support tugs or the British Army MEXE Flote system, the SSPS was never used in anger but is still used today, and it was last used in the Falkland Islands last year. Typically the system can be built and ready to pump fuel within days (weather dependant).

IRAQ

During the Gulf War TFHE was deployed in great quantities, fuel supply was key in the Desert campaign (again)! Large deployed Bulk Fuel Installations were built to store vast quantities of fuel, one installation held in excess of 1 million litres, a joint Anglo – American pipeline was designed and built, and this pipeline was called the Pipeline Over the Desert or PLOD The Son of Pluto. PLOD was 180 miles long and made from the 20 foot long Aluminium Alloy Victaulic Grooved Pipe and also 6 inch Layflat pipeline also supplied by the UK, the UK fuel expert unit that designed the pipeline was called 516 Specialist Team Royal Engineers (Bulk Petroleum) or 516 STRE (BP), a unit that is unique and no other Army in the world has a team like these men.

Figure 6: SSPS construction from shore to Ship using MEXE Flote in the Southern Hemisphere

The UK had the equipment but did not have the manpower required to build it, the manpower was supplied by the US Army. There were pump stations approximately every 10 miles and the system was pushing fuel at rates in excess of 300 gallons per minute. From concept to the first drop of fuel exiting the end of the pipeline took a matter of a couple of months to design, build, test and commission. In total 1.4 million Gallons were pumped through PLOD.

During the years after the first Gulf War the fuel concept remained the same with many pipelines being built in all four corners of the world, along with many real fuel transfers using the TFBDS, SSPS and also on a couple of occasions the use and deployment of the SPM.

The second Gulf War came and was named Operation Telic, the US built another pipeline but because of the safe harbour of Kuwait there was no requirement for an offshore fuel transfer system, TFBDS was taken but never used. During the stabilisation period two large temporary bulk fuel installations were designed by me and built by 516 STRE (BP) and a Squadron of Royal Engineers.

It was during the design phase that I identified the fact that a surface laid pipeline within the so called safe area of the camps was prone to damage both by road traffic but also more importantly from indirect mortar fire.

I sourced a pipeline call Sovereign pipe manufactured by Wellstream and here started the use of commercially off the shelf equipment and pipelines other than the current in service Victaulic. I designed a fuel transfer pipeline to link a bulk fuel installation to a retail petrol and diesel station some 2km away, the pipe was buried to a depth of between 1.5 and 2m, this ensured that the pipe could not be damaged by the larger mortar round, even if the mortar landed directly on top of the pipeline. The buried pipeline also had the added benefit as acting as a heat sink, the fuel temperature started off at 45 degree C as it entered the pipeline, on exit the temperature of the fuel was down to 15 - 20 degrees C. Typical loss due to evaporation was in excess of 2000 litres per day this was reduced to less than 500 litres per day.

I was made aware of this pipeline during the research I conducted during the planning phase for the design of a 600 mile overland pipeline I conducted for the US Military as part of the British Army Fuel Specialist Unit. The pipeline was never purchased or built.

Figure 7: 2 Million Litre TFHE Storage and Dispensing System

The TFHE system was used (with a few equipment upgrades) in this form for many years up to approximately 2007 / 8, it was during this time that the system was declared non-conforming to current Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), a study was conducted and found that none of the equipment that contained moving parts or engines could be declared as DSEAR compliant.

JOINT OPERATIONAL FUEL SYSTEM (JOFS)

A new system therefore was required, this system was designed and supplied by KBR over a period of 2 years, and this new system is called Joint Operational Fuel System (JOFS).

JOFS consisted of utilising any TFHE that can be incorporated into the new JOFS concept of operations, this really equated to the SSPS, TFBDS and all of the old Victaulic systems. New equipment was designed and purchased to augment the old TFHE and was then prepared and used in module form to enable better control and design of the system.

The new JOFS system is able to receive fuel from permanent infrastructure or be supplied by any other NATO nation at a high pressure using the High Pressure Regulating Valve or HPRV, KBR tested this valve in the German Army Petroleum Training Depot witnessed by the manufacturer Mankenburg and both the British and German Army Fuel specialists.

Figure 8: The Composite Pipe used on Op Telic

The JOFS system also has the capability to 'Hot Tap' into fuel pipelines by the fuel specialists. The new system has allowed all of the fuel system users in the British Army a greater degree of flexibility and autonomy with access to more reliable and legislatively compliant equipment.

THE FUTURE CHALLENGES

The selection of commercially available pipe systems that can be used both as subsea and overland pipeline systems with an operating pressure of up to 100 Bar or more using ISO Frame High Pressure portable pumps. The pipe must be easily deployed by minimal manpower, quickly, expediently and also be tough enough to meet the extremes of temperature and also the rigor of Military Service. The pipe laying system will be able to be used on land with different wheel based platforms and at sea on suitable vessels in service or ships taken up from trade. The Victaulic Grooved system will always stay for modular systems already supplied.

Author

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The conferences will feature lectures and presentations on all aspects surrounding oil, gas, water, product, district heating and cooling pipeline, pipe and sewer systems.

Please take a closer look at the following pages and get involved now - reserve your place at the 11th Pipeline Technology Conference & 1st Pipe and Sewer Conference in Berlin.

Dr. Klaus Ritter
Pipeline Technology Conference Chairman
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ptc / PASC CONFERENCE PROGRAM

MONDAY, 23 MAY 2016

09:00-10:00 Registration *(Foyer Hall C/D)*

10:00-10:30 Opening *(ECC Room 1)*

Welcome

Dr. Klaus Ritter, President of EITEP Institute, Germany

10:30-11:00 Keynote Speech *(ECC Room 1)*

Keynote Speech

"The role of national and international technical associations to safeguard an environment for cost-efficient, sustainable, safe and innovative energy solutions"
Prof. Dr. Gerald Linke, Chairman of the Board of Directors, DVGW - German Technical and Scientific Association for Gas and Water, Germany

11:00-12:30 Opening Panel Discussion "Pipeline Supply Options for Europe" *(ECC Room 1)*

Session Chair

Heinz Watzka, Senior Advisor, EITEP Institute, Germany

Panelist

Fuad Ahmadov, CEO, SOCAR MIDSTREAM, Azerbaijan

Panelist

Arno Büx, CCO, Fluxys, Belgium

Panelist

H.E. Dr. Ali Majedi, Ambassador, Embassy of the I.R. of Iran to Germany, Germany

Panelist

Asle Venas, Global Director Pipelines, DNV GL, Norway

12:30-14:00 Lunch Break in the Exhibition Hall

+ Scientific Advances Poster Session
(13:30-14:00)

MONDAY, 23 MAY 2016

Pipeline Track 1

Session Chair: Andreas Döhrer, Head of Consulting and Business Development, GEOMAGIC, Germany

14:00-15:15 *(ECC Room 1)*

Session 1.1 Integrity Management

"Asset Management of High Pressure Installations: Project GRAID - an innovation project to develop a robotics system for internal inspection of buried pipework"
Gary Senior, Pipeline Integrity Engineers Ltd, United Kingdom

"Pipe features identified during inline inspection using MFL pigs"
Dr. Hossein Karbasian, Salzgitter Mannesmann Forschung, Germany

"Pipeline Corrosion Assessment and Fitness for Service"
Guy De Meurechy, Seikowave Inc., United States

Pipeline Track 2

Session Chair: Michael Schad, Director Sales Pipelines International, Denso, Germany

14:00-15:15 *(ECC Room 2)*

Session 2.1 Coating / Corrosion

"Introduction of a new field-applied corrosion system designed for pipelines"
Michael Schad, DENSO GmbH, Germany

"New Technologies Data Management - VintriPLANT & Shawcor Case Study"
Neil Uppal, Shawcor, United States

"Testing non-shielding coating"
Luc Perrad, ExParTech, Belgium

Pipeline Track 3

Session Chair: Dirk Strack, Technical Director of TAL Group, Deutsche Transalpine Oelleitung, Germany

14:00-15:15 *(ECC Room 3)*

Session 3.1 Leak Detection

"Pipeline Leak Detection System Optimization Using Model Based Approaches"
Axel Hundertmark, KROHNE Messtechnik, Germany

"Challenges in Implementing a Software Based Leak Detection System in a Brownfield Environment"
Szilárd Szelmann, Yokogawa, Hungary
Ferenc Péterfalvi, Manager, MOL PLC., Hungary

"Hot tapping and product theft on pipelines: A way to detect and locate these spots during normal operation"
Rene Landstorfer, GOTTSBERG Leak Detection GmbH & Co. KG, Germany

Construction Track

14:00-15:15 *(ECC Room 4)*

Session 10 Special Discussion: Legal impact on the construction of pipelines

Session Chair / Panelist:

Heinz Watzka, Senior Advisor, EITEP Institute / former Managing Director Technical Services, Open Grid Europe, Germany

Panelist:

Anne Pieter Dijk, Project Manager, Max Streicher, Germany

Panelist:

Dr. Nicolai Ritter, Lawyer and Partner, CMS Hasche Sigle, Germany

Pipe and Sewer Track

Session Chair: Klaus-Peter Gießler, Pipeline Technology Consultant, Germany

14:00-15:15 *(ECC Room 5)*

Session 13.1 Inspection

"Preventive Gas Leak Detection in Germany - sample of no value or benchmark for the industry?"
Ulrich Steinacker, Schütz GmbH Messtechnik, Germany

"Pipe robots for internal inspection of pipelines – Ultrasonic wall thickness determination in district heating lines"
Alexander Reiss, INSPECTOR SYSTEMS GmbH, Germany

"Cable-less TV-Inspection of Pipelines with Integrated Leak Detection"
Michael Huainig, MTA Messtechnik GmbH, Austria

15:15-15:45 Coffee Break in the Exhibition Hall

Pipeline Track 1

15:45-17:30 *(ECC Room 1)*

Session 1.2 Integrity Management

"CATES (Consequence Assessment Tool for Emergency Situation)"
Olivier Baldan, DNV GL, Norway

"Predicting the Future - Applying Corrosion Growth Rates Derived from Repeat ILI Runs"
Jane Dawson, PII Pipeline Solutions, a GE Oil & Gas and Al Shaheen joint venture, United Kingdom

"How MFL Inspection data contribute to Integrity Management of Difficult-to-Pig Pipelines "
Peter van Beugen, Pipesurvey International , The Netherlands

Pipeline Track 2

15:45-17:30 *(ECC Room 2)*

Session 2.2 Coating / Corrosion

"Pipeline Monitoring by Intelligent High Performance Elastomer Coatings"
Dr. Michael Magerstädt, ROSEN Group, Switzerland

"Innovative coatings and linings resisting mechanical and chemical wear"
Dr. Friedrich Karau, DUKTUS Rohrsysteme GmbH, Germany

"The Corrosion Control Technology for High H2S and CO2 Content Natural Gas Gathering and Transportation System"
Dr. Li Du, Sinopec, China

"Development of a Remote Cathodic Protection Potential Measuring System Based on IoT"
Dr. Young-don Ryou, Korea Gas Safety Corporation, South Korea

Pipeline Track 3

15:45-17:30 *(ECC Room 3)*

Session 3.2 Leak Detection

"Current topics of odorizing in Germany"
Kerstin Kröger, DVGW-Forschungsstelle am Engler-Bunte-Institut des Karlsruher Instituts für Technologie (KIT), Germany

"Challenges to Achieve Reliable Hydrocarbon Leak Detection. Evaluation of Different External Leak Sensing Systems : Existing Technologies vs. New Sensing Cable Technology"
Raul Risi, TTK, France

"Theft detection and tapping point location using multi-method technology "
Dr. David Dingley, Atmos International , United Kingdom

Construction Track

Session Chair: Dr. Prodromos Psarropoulos, Structural & Geotechnical Engineer, National Technical University of Athens, Greece

15:45-17:30 *(ECC Room 4)*

Session 11.1 Planning & Construction

"Innovations and Technological Developments in Long Distance Water Transmission Systems - Case Study of Riyadh, Saudi Arabia"
Alexander Heinz, ILF Consulting Engineers, Austria

"UK Military Onshore and Offshore Pipeline Systems - Past, Present and Future Challenges"
Richard Costen, Kellogg, Brown and Root, United Kingdom

"Engineering Piping systems and spool prefabrication to enhance plant construction productivity and quality"
M. Kannappan, DEE Piping Systems, India

"Hydrostatic Test Plugs"
A.G.C.M. (Ron) de Rijk, EST Group B.V., The Netherlands

Pipe and Sewer Track

15:45-17:30 *(ECC Room 5)*

Session 13.2 Inspection

"In-Line Inspections in Gas Distribution Pipelines with Extreme Operating Conditions"
Tom Steinvoorte, ROSEN Group, Netherlands

"Field Study on Small Diameter PVC Pipe and Leak Detection Technology"
Yoshiazu Tanaka, National Institute for Rural Engineering, Japan

"Damage Detection in Natural Gas Distribution Pipeline Network Based on Vibration Signal Analysis"
Luis Antonio Zanette, Companhia Paranaense de Gás - COMPAGAS, Brazil

"An Innovative Design for Lateral Pipes in Sewer Systems"
Alaa Abbas, Liverpool John Moores University , United Kingdom

from 17:30 Get-together Party in the Exhibition Hall sponsored by ROSEN Group

TUESDAY, 24 MAY 2016

Pipeline Track 1

Session Chair: Ulrich Schneider, Business Development Manager Continental Europe, KTN

09:00-10:15 *(ECC Room 1)*

Session 4.1 Inline Inspection

"A Case Study How Reduced Uncertainties of Latest Enhancements in Ultrasonic Wall Measurement Ili Technology Benefit Engineering Criticality Assessments"
Stephan Tappert, PII Pipeline Solutions, Germany

"Reveal your pipeline DNA: Uncover Pipe Grade Uncertainties with ROMAT"
Thomas Eiken, Rosen Technology and Research Center GmbH, Germany

"Recent Advancements in Ultrasonic In-Line Inspection"
Herbert Willems, NDT Global, Germany

Pipeline Track 2

Session Chair: Dr. Horst-günter Schulz, Pipeline Consulting, Germany

09:00-10:15 *(ECC Room 2)*

Session 5.1 Pump & Compressor Stations

"Crude Oil Pump Stations – Optimization CAPEX + OPEX"
Dr. Gerd Kloeppner, Siemens, Germany

"Energy Recovery in Crude Oil Pipelines"
Dr. Thomas Rother, ILF Consulting Engineers, Germany

"Optimization Consumption for Diesel Fuel Through Crude Oil Pumping in Western Desert, Egypt"
Dr. Hesham A. M. Abdou, Agiba Petroleum Company, Egypt

Pipeline Track 3

Session Chair: Dr. Axel Scherello, Project Leader, Open Grid Europe, Germany

09:00-10:15 *(ECC Room 3)*

Session 6.1 Remote Sensing

"First experiences with applying CHARM® second generation"
Dr. Axel Scherello, Open Grid Europe GmbH, Germany

"Taking-off with UAVs: Just a hype or future key technology in pipeline integrity management "
Josef Alois Birchbauer, Siemens Austria, Austria

"Automated Small Leak Detection from Hazardous Liquid Pipelines Using Multi-Platform Remote Sensing"
Maria Araujo, Southwest Research Institute, United States

Construction Track

Session Chair: Dr. Prodromos Psarropoulos, Structural & Geotechnical Engineer, National Technical University of Athens, Greece

09:00-10:15 *(ECC Room 4)*

Session 11.2 Planning & Construction

"Innovative socket pipe systems as an economic solution for pipeline construction"
Dr. Friedrich Karau, DUKTUS Rohrsysteme GmbH, Germany

"Underground DC Cable Links - Implementation and Construction Challenges"
Fred Wendt, ILF Consulting Engineers, Germany

"Insights into Europe's largest deep gravity sewer project, the „Emscher Kanal "
Dr. Robert Stein, Prof. Dr.-Ing. Stein & Partner GmbH, Germany

Pipe and Sewer Track

Session Chair: Prof. Dr. Peter Hartwig, Managing Director, aqua consult Ingenieur GmbH, Germany

09:00-10:15 *(ECC Room 5)*

Session 14.1 Asset Management

"Optimizing investment strategies for water distribution networks"
Mike Beck, Fichtner Water & Transportation GmbH, Germany

"Benefits of a holistic water and drainage information system"
Malte Martin, Barthauer Software GmbH, Germany

"Sustainable Complete Streets - integration between urban design and underground infrastructure"
Aloisio Pereira da Silva, Federal University of Santa Catarina, Brazil

10:15-10:45 Coffee Break in the Exhibition Hall

Pipeline Track 1

10:45-12:00 *(ECC Room 1)*

Session 4.2 Inline Inspection

"Essential Parameters for Determining GAS PIPELINE IN-LINE INSPECTION INTERVAL"
Hossein Abdi, National Iranian Gas Co. (NIGC), Iran

"Continuous Depth Sizing of ILI Ultrasonic Crack Detection"
Dr. Marius Grigat, ROSEN Technology and Research Center GmbH, Germany

"Robotic In-Line Inspection of Unpiggable Pump Station Piping on Trans-Alaska Pipeline System (TAPS)"
Jonathan Minder, Diakont, United States

Pipeline Track 2

10:45-12:00 *(ECC Room 2)*

Session 5.2 Pump & Compressor Stations

"Balancing the Electric Grid with a Dual Drive Centrifugal Pipeline Compressor"
Dr. Stefan Stollenwerk, Open Grid Europe, Germany
Wolfgang Faller, Solar Turbines, United States

"Novel minimally-disruptive mitigation methods for pipework vibration issues"
Dr. Toby Miles, DNV GL, United Kingdom

"SGT-750 Gas Turbine Case Study Mexico"
Douglas Petrie, Dresser Rand a Siemens Company, United States

Pipeline Track 3

10:45-12:00 *(ECC Room 3)*

Session 6.2 Remote Sensing

"Airborne automatic oil leak detection - A novel approach"
Eric Bergeron, FlyScan Systems Inc., Canada

"Monitoring Pipeline Right of Way Using Optical Satellite Imagery"
Dr. Igor Zakharov, C-CORE, Canada

"Air Monitoring project – enhanced pipeline monitoring"
Vincent Fournier, AIR MARINE, France

Construction Track

Session Chair: Dr. Klaus Beyer, Executive Director, GSTT, Germany

10:45-12:00 *(ECC Room 4)*

Session 12.1 Trenchless Construction & Rehabilitation

"A Variety of Trenchless Technologies for Pipeline installation"
Michael Lubberger, Herrenknecht AG, Germany

"DTH steel casing drilling for pipeline construction in hard ground and rock conditions: technology and case examples"
Jouni Jokela, Geonex Oy, Finland

"Trenchless replacement of defective sewer pipelines using pipe bursting"
Daniel Mertens, TRACTO-TECHNIK GmbH & Co. KG, Germany

Pipe and Sewer Track

10:45-12:00 *(ECC Room 5)*

Session 14.2 Asset Management

"Pipestatus - a project that deals with condition assessment of buried district heating and water pipes"
Mara Maria Rindelöv, Sweden Water Research, Sweden

"Asset Management and Loss Prevention Strategies for Large Diameter Pipelines"
Pedro Pina, Pure Technologies, Portugal

"Combined wastewater feed directly into final clarification – advantage for receiving rivers"
Prof. Dr. Peter Hartwig, aqua consult Ingenieur GmbH, Germany

12:00-13:30 Lunch Break in the Exhibition Hall

+ Scientific Advances Poster Session (13:00-13:30)

TUESDAY, 24 MAY 2016

Pipeline Track 1

Session Chair: Dr. Gerhard Knauf, Head of Div. Mech. Eng., Salzgitter Mannesmann Forschung / Secretary General, EPRG, Germany

13:30-14:45 *(ECC Room 1)*

Session 7.1 Materials

"A system for addressing the challenge of circumferential Stress Corrosion Cracking."
Roland Palmer-Jones, MACAW Engineering Ltd., United Kingdom

"Reduction of CO_2 Corrosion of API-5L by " 2-Mercapto-benzimidazole" as inhibitor"
Ahmad Zamani Gharaghooshi, Oil Ministry, Iran

"Integrity of longitudinal welds on bends – choice of relevant test methods "
Dr. Marion Erdelen-Peppler, Salzgitter Mannesmann Forschung, Germany

Pipeline Track 2

Session Chair: Ulrich Adriany, Oil&Gas Program Management Lead Europe, ARCADIS Deutschland, Germany

13:30-14:45 *(ECC Room 2)*

Session 8.1 SCADA & Automation

"Pipeline Scada Virtualization - a Dream or Real Lifecycle Cost Saving"
Helmut Wimmer, Siemens Austria, Austria

"Pipeline Management System "
Badr AlHussain, Saudi Aramco , Saudi Arabia

"Developments in SCADA solutions for central control rooms and multi-site infrastructure"
Martin te Lintelo, Yokogawa Europe, The Netherlands

Pipeline Track 3

Session Chair: Asle Venas, Global Director Pipelines, DNV GL, Norway

13:30-14:45 *(ECC Room 3)*

Session 9.1 Offshore Technologies

"Inspection of subsea pipelines with the MEC™-Combi Crawler"
Dr. Konrad Reber, Innospection Germany GmbH, Germany

"Seismic analysis and design of offshore pipelines"
Dr. Andreas Antoniou, National Technical University of Athens, Greece

"Beyond 3D: Extending life of subsea assets by applying advanced simulation and prediction"
Dr. Pawel Michalak, Fugro Roames, Australia

14:45-15:15 Coffee Break in the Exhibition Hall

15:15-17:00 *(ECC Room 1)*

Session 7.2 Materials

"Development of large diameter clad bend"
Elke Muthmann, Salzgitter Mannesmann Grobblech, Germany

"Material Cost Savings from Pipeline Wall Thickness Optimization—Design Case"
Ahmad M. Saif, Saudi Aramco, Saudi Arabia

"Enhancement of Mechanical Properties in High Strength Steels Coils for ERW Casing and Tubing Application"
Kwangseop Ro, SABIC, Saudi Arabia

"Intelligent Pipe Systems via the Smart Combination of Various Materials"
Dr. Thorsten Späth, egeplast international GmbH, Germany

15:15-17:00 *(ECC Room 2)*

Session 8.2 Repair Rehabilitation

"Long term durability of composite pipeline repairs"
James Knights, Clock Spring Company, L.P., United Kingdom

"Asset Integrity Management and the Dilemma of maintenance planning"
Christoph Schmidt, DNV GL Oil & Gas, Germany

"Mobile Compressor - responsible use of primary energies, avoidance of climate-harming methan emissions"
Christian Hadick, Open Grid Europe, Germany

15:15-17:00 *(ECC Room 3)*

Session 9.2 Offshore Technologies

"Deepwater NDT Technology for pipes and tubular structures"
Dr. Yoann Lage, TWI Ltd, United Kingdom

"Probability Risk Assessment in Marine Pipelines by Updating Parameters Configuration of Piramid Tool"
Dr. Jorge González, ESIQIE-IPN (GAID), Mexico

"Assuring the Integrity of Subsea Pipeline Butt Welds through Design, Construction and Operational Life"
Harry Cotton, Wood Group Kenny, United Kingdom

from 18:00 Dinner Invitation Grunewald Hunting Lodge + Berlin Sightseeing Tour

WEDNESDAY, 25 MAY 2016

Session Chair: Dennis Fandrich, Director Conferences, EITEP Institute, Germany

09:00-10:30 Plenary Session "World Pipeline Outlook: New Technologies in Operation" *(ECC Room 1)*

"Iran Pipeline Industry: Capabilities, Technical-Economical Problems & Development Plans"
Hamidreza Ettelaie, Iranian oil Pipeline & Telecommunication Co., Iran

"Fighting Corrosion on an Ageing Pipeline"
Markus Seitz, APA Group, Australia

"BIL - Germany`s approach to implement a cost-free digging request portal"
Jens Focke, BIL eG, Germany

10:30-11:00 Coffee Break in the Exhibition Hall

11:00-12:30 Closing Panel Discussion "What's next? Current Challenges and Future Fields for the Global Pipeline Industry" *(ECC Room 1)*

Session Chair

Tobias Walk, Director of Projects – Pipeline Systems, ILF Consulting Engineers, Germany

Panelist

"Challenges in Network Operations"
Dr. Thomas Hüwener, Managing Director Technical Services, Open Grid Europe / Vice President, Gas, DVGW - German Technical and Scientific Association for Gas and Water, Germany

Panelist

"Collaborative Approach to Pipeline Safety & Integrity"
Cliff Johnson, President, PRCI - Pipeline Research Council International, USA

Panelist

"Internet of Things Technologies in the Pipeline Industry - Main Advantages and Cyber Security Challenges"
Serhii Konovalov, Global Energy/O&G Lead / IoT Vertical Solutions Group, Cisco, United States

Panelist

"Life-Cycle Extension Strategies with Pipeline Integrity Management"
Hermann Rosen, President, ROSEN Group, Switzerland

Panelist

"DC cables – the next big market for underground technologies"
Dr. Christoph Thiel, Overall Project Manager SuedLink, TenneT TSO GmbH, Germany

12:30-12:40 Closing Remarks *(ECC Room 1)*

Closing Remarks

Heinz Watzka, Senior Advisor, EITEP Institute, Germany

12:40-14:00 Closing Lunch Break in the Exhbition Hall

14:00-15:45 Post-Conference Workshops

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DVGW	Germany
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Geonex	Finland
GOTTSBERG Leak Detection	Germany
GSTT	Germany

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Pak gostar Parand	Iran
Pars Pamchal	Iran
Parto Azmoon Azar	Iran
Pergam Suisse	Switzerland
PETRO IT	India
PII Pipeline Solution	United Kingdom
Pipeline Monitors	Iran

Company	Country
Pipesurvey International	The Netherlands
PLIDCO	United States
Polyguard Products	United States
PPSA	United Kingdom
PSI AG	Germany
Pure Technologies	Canada
Quest Integrity	Germany
RAM-100 International	United States
ROSEN Europe	The Netherlands
Savay	Iran
Schneider Electric	Canada
Schütz Messtechnik	Germany
Seal For Life Industries	The Netherlands
Seikowave	United States
Shawcor (Pipeline Performance)	The Netherlands
Siemens	Germany
Symrise	Germany
Tracto-Technik	Germany
TTK SAS	France
Yokogawa Europe Solutions	The Netherlands