

Heating of pipelines (DEH)

When transporting untreated well stream in pipelines, the temperature of oil, gas and produced water will drop rapidly due to cooling from the surrounding seawater. The low temperature results in undesired fluid properties.

At high pressures hydrates start to precipitate, and for some fields wax formation in the flowing crude may also cause operational problems due to increased pressure loss in the pipeline.

Supply of heat to the flow is an effective method to solve these problems, and the direct electrical heating (DEH) method has been developed and qualified for heating of pipelines. This method implies reduced investments of depressurizing systems and recovery plants for chemical residual products.

Close cooperation with Norwegian oil companies, manufacturers and pipeline installation companies has qualified the pipeline heating method for use. SINTEF Energy Research has carried out most of the research and measurement tasks.

Direct electrical heating

For more than 20 years SINTEF Energy Research has been working on finding methods for keeping the temperature of pipelines above critical temperature values by means of electrical heating. The direct electrical heating (DEH) method is based on the fact that an electric alternating current ("AC") in a metallic conductor generates heat, as the transport pipeline is a part of an electrical circuit that is supplied via a cable, which is laid as close as possible to the pipeline to achieve a maximum heating efficiency. The figure on the next page sketches the design of the system.

Status for application of DEH

So far the key facts for application of DEH are:

- DEH systems based on conducting 50/60 Hz current in a pipeline are up and running.
- Applied on nearly 20 pipelines.
- DEH operated more than 150 times.
- Operational experiences confirm simulated results and lab tests.
- For all these projects SINTEF Energy Research has made the design simulations for providing the data for the heating system.

Development and qualification work

Feasibility of the system is proven both by laboratory tests and field test installations, and main results are:

- Required service life and ageing resistance of DEH cable was confirmed
- Anode concept related to leakage currents and AC corrosion was verified
- Feasibility of optical fibre fault detection method on DEH cable at different water pressures.



Ill: SINTEF/Bjarne Stenberg



DEH cable installed with reel laying method

Several studies and tests are carried out for verification and qualification purposes:

- Full-scale tests in seawater for relevant pipeline dimensions and steel quality. The test setup is located in the Orkanger Fjord. Measurements of the conditions in the end zones for the heating system, the efficiency of the system and thermal conditions are studied in these tests.
- Studies of material characteristics of steel grades, and especially the magnetic permeability. A measuring method for this purpose has been developed and used on pipe joints for the projects that have applied the DEH system.
- Calibration of computer tool for the DEH method
- Test of the cable materials and cable construction generally related to applications under high pressure, in seawater, and with varying temperature conditions.
- Laboratory examination of thermal and electrical parameters for the components in the DEH system for large pipeline dimensions (18-30").
- Adaptation of the DEH design on long pipelines (more than 100 km) with a modified cable supply system is verified by simulations and tests.

Further development of the heating method

Studies and tests have proved the functionality for using DEH on subsea pipelines. Through this work, the institute has obtained considerable expertise in test methods and application of simulation tools. Design of the heating system in DEH projects, general knowledge transfer and working closely with the project partners have put SINTEF Energy Research in an excellent position for further projects.

Development work is continued for application of the heating method on pipelines at deep waters (more than 1000 m), long tie-backs (100 - 200 km). Design of the DEH system (topside and subsea) is continuously evaluated in order to improve operational flexibility. This includes implementation of new technology for subsea power supply. SINTEF Energy Research has relevant laboratory facilities (e.g. pressure vessels), in order to perform testing under realistic water pressure conditions.

Status

- DEH is a qualified method for preventing formation of wax and hydrates
- DEH reduces injection of chemicals
- Operational experiences for more than 10 years
- More than 20 pipelines and > 200 km
- Easy to operate and very low operation costs
- Intermediate or continuous operation

Principle

- Open system (earthed power system)
- Single phase system, operated at 50/60 Hz
- Cable as forward conductor, pipe and seawater as return conductor
- Based on commercial components

Development and application

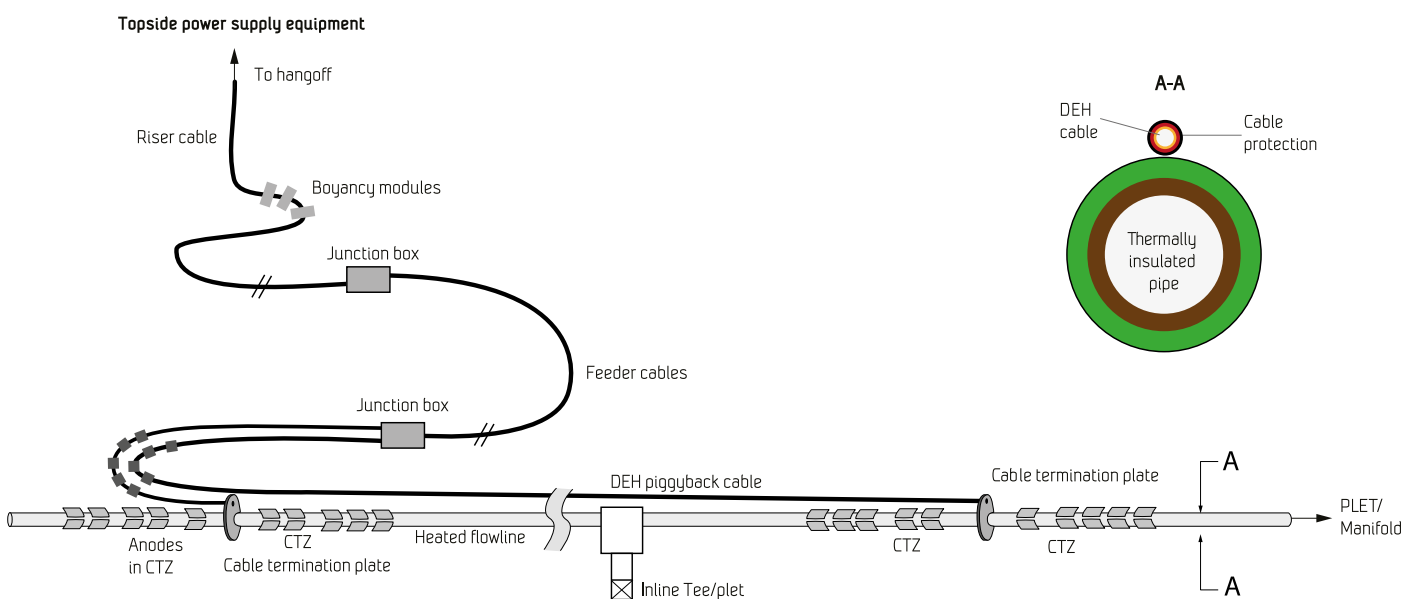
- Qualified by laboratory and field tests
- Applied by Statoil on several pipelines
- Operational experiences confirm the results from calculations and laboratory development work
- Development work for larger and longer pipelines
- Operation at higher power frequencies (90 - 200 Hz)

Key values for rating of DEH

- Typical level of power supply current is between 1000 and 1500 A
- Power requirement is approximately 50-150 kW pr. km pipeline
- Terminal voltage for power supply is 0.3 - 0.6 kV/km

Application of DEH - seawater depths 40 - 1000 m:

- 8 - 14" 13 Cr steel pipelines
- 10 - 30" carbon steel (60 - 65)
- 4 - 43 km pipelines
- back-up system for a 30" pipeline



SINTEF Energi AS (SINTEF Energy Research)
 Phone: + 47 73 59 72 00, energy.research@sintef.no
 www.sintef.no/energy

Contact:

Senior Business Developer Harald Kulbotten
 harald.kulbotten@sintef.no