

## **Direct Electrical Heating of Pipelines as a Method of Preventing Hydrate and Wax Plugs**

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### **ABSTRACT**

Norwegian oil companies, research institutes, cable manufacturers and pipeline installation companies are presently conducting studies and a full scale test on electrical heating of multiphase subsea pipelines to prevent hydrate formation (plugs) during planned shut-downs or reduced flow rate. Traditional methods of clearing pipelines of wax and hydrate deposits are by use of chemical inhibitors. This method is expensive and represents a risk to the environment should leakage occur. Electrical heating is therefore attractive.

The Direct Electrical Heating System consists of a feeder cable installed piggy back to the pipeline subject to be heated. This feeder cable is connected to one end of the pipeline and a return cable is connected to the other end. The feeder and return cables are connected to the topside dedicated power supply equipment through a cable riser section. All cables are based on field proven underwater and offshore cable technology. The water depth limitation with current cable and connector technology is approximately 500 m. Further development can make it feasible to install such a system down to 2000 m water depth. The system can be installed on new subsea developments and it can be retrofitted to existing pipelines.

The evaluation of technical feasibility and cost estimates have been completed for a 50 Hz direct resistive heating system. The electrical rating of the system depends on the heat requirement, pipe material and the pipe length. The feasibility of the concept has been verified through full scale subsea tests. Results from the measurements are used to determine the characteristics parameters of the system on fields in the North Sea. The study includes both carbon steel, duplex steel and martensitic steel (13%Cr.). The heat requirement mainly depends on the thermal conductivity of the pipe insulation and seabed soil / gravel, and in the case of melting plugs, the heat capacity of the pipe, thermal insulation and the hydrate must also be taken into consideration. A temperature rise of approximately 20 degrees C above sea temperature is necessary to prevent plugs in pipelines during planned shut-downs or reduced flow rate.

Possible corrosion problems caused by alternating currents (AC) are investigated. The system is electrically connected to seawater through a number of anodes at the ends of the heated section of the pipeline.

The feeder cable of the Direct Electrical Heating System can be installed as a piggy back line to the production pipeline. A pipe-laying vessel is qualified for this purpose.

### **KEY WORDS**

Electrical heating, subsea pipelines, hydrate and wax prevention, installation, maintenance.

## **1 INTRODUCTION**

### **1.1 Working principle of the Direct Electrical Heating System**

The direct heating system is based on the fact that an electric alternating current ("AC") in a metallic conductor (i.e. cable/pipe etc.) generates heat. In the direct pipe heating system the pipe to be heated is an active conductor in a single-phase electric circuit, together with a single core power cable as the forward conductor, located in parallel with and close ("piggy-back") to the heated pipe. The heating system is supplied from the platform power supply, from which two riser cables provide the electric power to the heating system, see also Figure 1.

One of the two single core riser cables is connected to the near end of the pipe, and the other to the forward conductor which is connected to the utmost end of the pipe.

For safety and reliability reasons, the heating system is electrically connected ("earthed") to surrounding seawater through several sacrificial anodes for a length of approx. 50 m at both ends where the cables are connected, see Figure 1b.

If the heating system (i.e. the whole system of pipe, connections and cables) was electrically insulated from seawater, all the current from supply cables would be traced in the steel pipe,