Trace heating of wet insulated subsea flowlines

Kristian Solheim, Thinn, Martin, Høyer-Hansen
SINTEF Energy Research
Trondheim, Norway

ABSTRACT

This article evaluates flow assurance by heat trace cables for wet insulated flowlines as an alternative to direct electrical heating or chemicals. Heat trace cables are attractive for their simple and flexible design and that they can be retrofitted. Case studies of a 14" flowline, where trace heat cables are placed outside the coating, indicate that fluid temperatures can be maintained at 25-55 °C. Heating capability depend on flowline geometry, heating cable type and burial depth. Commercial heat trace cables are available for flowline lengths including at least 50 km. Heat trace cables with conventional electrical insulation can deliver power in the 100 kW/km range.

KEY WORDS: Hydrate management; flow assurance; electrical heating; flowlines, trace heating; direct electrical heating.

INTRODUCTION

Electrical heating is used to maintain the mixture of oil, gas and other substances in onshore and subsea flowlines at elevated temperatures to prevent wax and hydrates from causing blockage in the flowline. By heating the flowline electrically, the need for chemical injection is reduced considerably.

Electrical heating has proved to be suitable for short, as well as for long flowlines since heat can be generated evenly along the whole length. Electrical heating is expected to be increasingly deployed as an elegant technical solution to optimize flow assurance management during the service life of production flowline. The electrical heating may be used continuously, at production stops and/or during tail production.

Electrical heating has been used for several decades on onshore facility pipes, probably starting with the simple design of an insulated wire (Burpee, 1977). Later, other techniques emerged, such as induction heating, impedance heating and skin effect heating, (Rafferty, 2002). The latter has been installed on a 600 km line (Hamill, 2016), but it has also been tested on a submerged flowline (Wan, 2020). For subsea pipe-in-pipe installations, heat trace cables exist in a few installations and are described in several publications, e.g., in (Gooris 2016; Verdeil, 2019).

For subsea wet insulated flowlines, direct electrical heating (DEH) is the most used technology and is described in (Nysveen, 2007). DEH has been installed on about 50 wet insulated flowlines since year 2000, (Lervik, 2018), with some of the first installations still in operation. Other heating concepts that exist, but to our knowledge have not been installed, are induction heating, (Ahlen, 1992), and trace heated blankets (Marret, 2016). A concept for electrical trace heating of wet insulated flowlines is provided on a web page (Salamander, 2023), but no reference has been found in literature. The same company also provides solutions for downhole heating (Karanikas, 2020).

Trace heating can be very attractive for wet insulated flowlines that will or can be buried (either in soil or by insulated mattresses) and where the fluid temperature requirement is moderate. Trace heating is less complicated than for example DEH and skin effect heating in several ways. There is no need for connections to or modifications of the flowline itself and there is minimal electromagnetic interaction between the trace heating cable and the pipe, or other adjacent structures. This reduces the risk for AC corrosion and the need for anodes. Trace heating can, because of its simple way of operation, be especially attractive where there is a need to retrofit electrical heating. The service time of some existing fields can be extended by retrofitting electrical heating to the flowline.

The aim of the presented work is to investigate whether heat trace cables are feasible for wet insulated flowlines. A simple design is considered, where the cables are placed next to the flowline, i.e. outside the flowline coating. The paper discusses a few relevant case studies. The focus is on the thermal and electrical performances the heat trace design, such as heating capability, cable size, power consumption and efficiency. For comparison, the power consumption of DEH is provided for the same cases. An overview of various heat trace cable types is also provided.

HEAT TRACE CABLES

In heat trace cables, all heat is developed in the cable itself. Thus, heat transfer to the flowline is by thermal conduction. This differs from direct electrical heating where a large share of the heat developed is in the pipe wall.

The heat trace cables can be designed in several ways and can to a large degree be optimized based on project specific needs. Figure 1 shows examples of different designs. The main components of each cable are metallic conductors, electrical insulation, and mechanical protection.