New Developments of Direct Electrical Heating for Flow Assurance

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ABSTRACT

The operating experiences for more than 10 years of hydrate and wax management of pipelines by direct electrical heating have proved high reliability, robustness and operating simplicity. The system is in use for pipelines ranging up to 40 km length and water depths down to approx. 500 m. As the oil and gas industry is moving towards deeper water and longer transport distances, electrical heating becomes even more attractive. In deeper waters plug removal by depressurization may be impossible. Cost and weight are important issues when DEH are being adapted for deep water installations. In general increasing the system power frequency reduces the size and weight of electrical equipment and higher frequencies are now being addressed in the new development programme of DEH for deep water fields.

KEY WORDS: Pipelines; Hydrate Prevention; Electrical Heating; Finite Element Analysis; Electrical Power Requirements; Heat Generation, Power Frequency.

INTRODUCTION

The DEH (direct electrical heating) system is at present qualified for power frequencies of 50/60 Hz fed from the local network commonly used in the North Sea. However, utilizing higher power frequencies will be beneficial due to reduced weight and volume of power supply equipment as well as reducing cross section area for the cables used in DEH, and hence reduced CAPEX for DEH installations. It is generally considered beneficial for development of deep water fields that the cross section area is reduced. Also the potential thermal constraints for the riser cables will be reduced when increasing the frequency. Furthermore increasing frequency reduces the amount of current being transferred to seawater and length of the CTZs (current transfer zones) at the heated pipeline ends. It is therefore expected that increased frequency reduces the amount of anodes needed for ac current transfer and ac corrosion protection. A first approach to the use of higher frequency is to look at 100 Hz, and consider 200 Hz as well. Subsea power cables are in use at these frequencies for other purposes (power cables to pumps by variable speed drive etc.) and it is therefore expected that modifying the cables for DEH use will require limited modifications. However, the application of these power frequencies will imply evaluations of possible impact on cable ageing mechanisms. This issue might depend on converter solution, related to degradation of XLPE (cross-linked polyethylene) insulation (electrical cable insulation) due to voltage transients. Related to the rating of DEH an increased frequency will influence the electrical characteristics of the system, the current distribution between seawater and steel pipe, as well as the current distribution within the power cable conductors, pipe steel and seawater. The paper presents results from theoretical approach. It is expected that qualification work are required for implementation of higher frequency, but this is not covered in the paper.

RATING OF DEH AT HIGHER FREQUENCIES

Main advantages of increased frequency

A sketch of the DEH system (Lervik et al. ISOPE 1993, Lenes et al. 2005) is illustrated in (Fig. 1).