Reliable measurements of wax deposition

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Although wax deposition in production pipeline has been a problem for decades, wax control techniques like pigging are still applied more due to operator experience and trial-error than real knowledge about wax build-up. The reasons are the lack of reliability of the existing wax prediction models and the lack of on-line measurement techniques.

To remedy these shortcomings Statoil has built a new wax deposition test rig where both wax deposition can be studied and new measurement techniques can be tested.

Wax deposition is studied by circulating waxy crude oil at constant temperature through a 6 m 2-in. test section with a cold water annulus. The oil tank's volume of 4 m³ provides enough fluid volume to avoid depletion effects even for thick wax layers (see fig. 1). Wax deposition experiments are performed from 1 day to 3 weeks to investigate the effect of aging. The deposit's composition is analyzed after each experiment. Currently the rig allows for single-phase flow but after a planned modification in 2010 also two-phase oil/water flow will be possible.

Fig. 1. Example from wax deposition experiment (8 mm after 4 days using a real North Sea gas condensate)

During and after the experiment a range of measurement techniques is applied to determine the wax deposit's thickness. The intention is both to assure that reliable data is acquired for further modelling work but also to test and develop new techniques for measurements in production lines.

The applied measurement techniques include

- Calculation from differential pressure measurement (including a correction for non-isothermal flow)
- Laser-based optical measurement
- Calculation from temperature response to an external heat source
- Measurement of change in eigenfrequency

The acquired wax deposition data for a specific crude oil are used directly to tune the existing Olga wax deposition model for the corresponding field. This is necessary since the currently implemented wax deposition model completely ignores the influence of varying flow rates (see fig. 2). Therefore flow loop experiments have to be run at flow rates corresponding to the actual production conditions. To understand better the scale-up of the 2-in. results towards larger pipe diameters it is also intended to installed a second test section with a larger diameter.

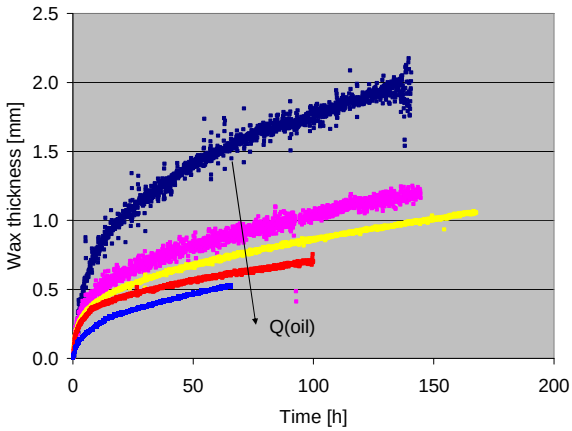

Fig. 2. Influence of oil flow rate on wax thickness

In addition to acquiring data for tuning the model of a specific field it is also built up a data base of experimental data from different fluids under different experimental conditions (temperatures, flow rates). This is intended to be used for verification and validation of future new wax deposition models.

Reference

[1] Hoffmann, R., Amundsen L. (2010) Energy & Fuels 24:1069-1080