Wax Precipitation in Model Oils

Bailey Bruns, Samyukta Koteeswaran, Dr. Peter Clark
Department of Chemical Engineering, Oklahoma State University

ABSTRACT

One of the major problems in the petrochemical industry is wax deposition in underwater pipelines, tanks and storage containers. Wax deposits are a problem especially in shale oils, which are a tremendous resource in the US. Researchers in the industry have been investigating options to prevent and treat these wax deposits. Precipitation begins at a certain Wax Appearance Temperature, which varies depending on the composition of the hydrocarbon. As light ends of the oil are stripped off, the solvent's quality decreases.

INTRODUCTION

In this study we use a model oil in which we use 5 wt.% paraffin wax samples in light and heavy mineral oil to characterize the wax deposition process. To measure the WAT, we used polarized light microscopy viewed via high-powered camera in combination with a temperature-varying stage. We took measurements adding 5, 10 and 15% hexane because this the amount of light ends typically stripped off at the well-head before storage or transportation. Light ends of the crude oil increase the vapor pressure, which increases the volatility of the oil.

OBJECTIVES

- What is the effect of molecular weight on the WAT?
- What is the WAT when adding 5, 10, and 15 wt% Hexane to the model oil?

INSTRUMENTATION AND METHODS

Cross-Polarized Microscopy:

- Olympus Microscope and Linkum Cell
- Video Camera
- Cross-polarizing optics
- Useful for determining crystal growth as a function of time, shear, and temperature.

Data Collection:

- The model oil used is based off of Gareth H. Mckinley's model.
- Experiments ran with 5 wt% wax, typical of common crude
- oils, which have a wax variation of ± 0.5%.
- First we measured the WAT of the light and heavy model oils. The results were reproducible.
- Next we altered the oil composition, adding 5, 10 and 15% hexane (C_6H_{14}).
- Cooled oil at 1°C/minute and held at each temperature for 20 minutes.
- For hexane addition samples, starting temperature was lower to reduce risk of hydrocarbons evaporating before wax precipitated.

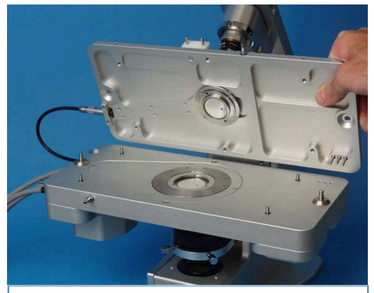


Photo 1: Linkum Cell

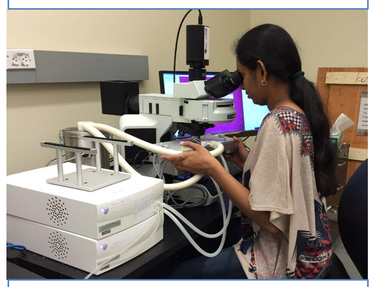
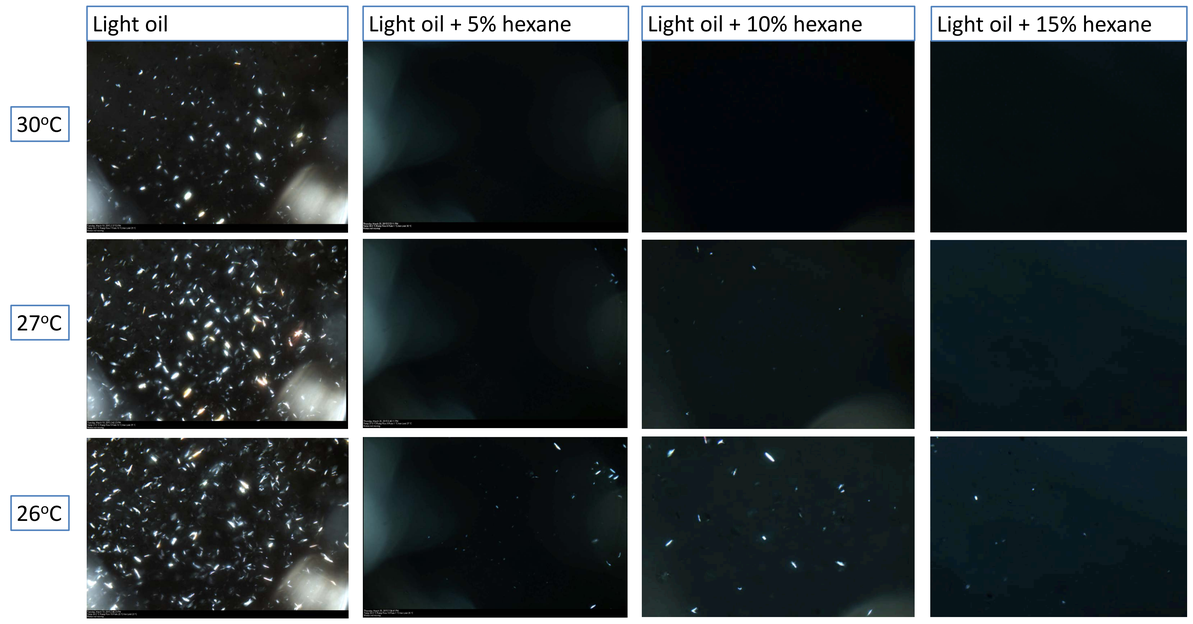


Photo 2: Microscope-cell set up

LIGHT OIL RESULTS



RESULTS CONTINUED

Sample	WAT
5% Wax in Light Mineral Oil (Model)	30
Model with 5% Hexane	27 (after 4 minutes)
Model with 10% Hexane	27
Model with 15% Hexane	26

- We see a definite lowering of the WAT with the increase of molecular weight.
- This is to be expected according to the existing literature.
- The density of the crystal matrix also decreased significantly.
- All of the results bear good reproducibility.

DISCUSSION AND FUTURE WORK

Experiments have been done to watch wax precipitate out of hexane or pentane, but we have not found experiments that watch wax precipitate out of a mixture. Our results suggest the significance and value in further research on this topic. Adding a small percent of the lighter molecules decreases the WAT enough to prevent wax deposition at ambient temperature of storage tanks and pipelines. Next we will run the same experiments using the following methods:

- 5, 10 and 15% Pentane
- 5, 10 and 15% Heptane
- Combinations of pentane, hexane and heptane.

We also hope to use these same tests on heavy oil and actual crude oil samples from different shale fields.

ACKNOWLEDGEMENTS: I would like to thank the Lew Wentz Foundation for funding this research, Samyukta Koteeswaran for her assistance in the lab, and Dr. Peter Clark for the opportunity to research with him over the past three years.