MEDWIN PUBLISHERS
Committed to create value for Researchers

Petroleum & Petrochemical Engineering Journal

A Perspective on Transportation of Waxy Crude Oil

Yingda Lu* and Jinjun Zhang

National Engineering Laboratory for Pipeline Safety/MOE Key Laboratory of Petroleum Engineering, China University of Petroleum, Beijing, China

Mini Review

Volume 1 Issue 2

Received Date: April 18, 2017

Published Date: May 20, 2017

***Corresponding author:** Yingda Lu, National Engineering Laboratory for Pipeline Safety/MOE Key Laboratory of Petroleum Engineering, China University of Petroleum, Beijing, China, Tel: +86-15810566569; E-mail: yingdalu@cup.edu.cn

Introduction

Among the most important energy sources, oils account for 70% of global energy demand and will continue to play a leading role in the energy supply mix [1]. Once produced out from reservoir, crude oils are typically transported in pipelines to downstream facilities for refining and further processing. A majority of the crude oils produced worldwide contain wax and they are known as waxy crude oil [2]. Waxes are typically dissolved in crude oils at reservoir conditions but they tend to precipitate out during pipeline transportation where the operation temperatures are low. This wax precipitation may escalate, causing the following three issues for industrial flow assurance practices

Poor Flowability

The most direct consequence of wax precipitation is a large increase in the viscosity of waxy crude oil and thus poor flow ability. Heating and applying chemical additives such as pour point depressant (PPD) are among the most widely approaches for addressing this issue [3-4]. Developing efficient PPDs has been an active research area during the last two decades and a variety of formulas have been invented [2,4].Though some PPDs show promises in lab-scale tests, their performances often get compromised over time in field operations after the PPDs undergo multiple heating-cooling processes and frequent shearing [5]. The influences of these factors on PPD performance have been largely overlooked in previous studies and they must be considered in future research. Also, most developed PPDs are effective only for crude oil with relatively low wax content whereas a PPD effective for crude oil with high wax content (>20wt %) is still lacking. Finally, due to the high capital costs associated with heating and applying PPDs, there is clearly a room for improvement on developing of more efficient and economical methods to address the poor Flow ability of waxy crude oil at low temperatures.

Wax Deposition

The second wax-related issue is the buildup of wax deposit on the walls of pipeline. The formation of such deposit can greatly reduce the effective flow areas, and if left unchecked, can completely block the pipelines. Remediation techniques for wax deposition generally include mechanical pigging, pipeline insulation, heating and fused chemical reactions. Among these techniques, pigging is the most commonly-use done, where a "pig" is placed into the pipeline to scrape off the formed wax deposit. The pigging operation, however, is extremely costly. Thus the deposit growth rate and the properties of the formed deposit must be known ahead to help design the optimal pigging schedule. Wax deposition models are often employed for these tasks.

Though a handful of deposition models have been developed in the last two decades, few have proven sufficient for field practices. Most models are highly-empirical and contain multiple tuning parameters that need to be determined by fitting with experimental data [6]. Additionally, the majority of the models developed to date are limited only in single-phase (oil) flow and a few particular flow patterns in two-phase (oil-water) flow regime. There is an inevitable need for the development of theoretically sound wax deposition models that can provide reliable predictions in all flow regimes.

Restart Failure

When the transportation of waxy crude oil experiences temporary shutdown due to planned maintenances or emergency situations, the crude oil left inside the pipe may form into a gel. Restart models can predict the pressure required to break the gel and thereby are often employed to guide restart operations. The vital component of a restart model is a reliable constitutive equation that can sufficiently describe the complex change of the rheological properties during the restarting process [5]. Most of the present constitutive equations, however, are less satisfactory, mostly due to the lack of a detailed understanding of the gel structure and its evolvement during the restarting process.

A more fundamental mechanistic understanding of the structure is required if more robust constitutive equations and restart models are to be developed. Recent advances in structure characterization techniques and molecular simulation may help achieve this goal.

Summary Remark

The wax-related issues cause the petroleum industry millions of dollars each year and the R&D activities in this field have been very active. This short introductory mini-review only highlights the key problems and provides the author's views on possible solutions to further benefit the industrial practices. Continued contributions are needed from experts in chemistry, chemical engineering, physics, mechanical engineering, and computational fluid dynamics simulation.

Acknowledgement

This article was prepared with the support from the National Natural Science Foundation of China (No.51534007) and the Science Foundation of China University of Petroleum, Beijing (No. C201602).

References

1. Exxon Mobil (2017) 2017 Outlook for Energy: A View to 2040.

2. Aiyejina A, Chakrabarti DP, Pilgrim A, Sastry MKS (2011) Wax formation in oil pipelines: A critical review. International Journal of Multiphase Flow 37(7): 671-694.

3. Russell RJ, Chapman ED (1971) The pumping of 85 °F pour point Assam (Nahorkatiya) crude oil at 65°F. Journal of the Institute of Petroleum 57(554): 117-128.

4. Yang F, Zhao Y, SjöblomJ, Li C, Paso KG (2015) Polymeric Wax Inhibitors and Pour Point Depressants for Waxy Crude Oils: A Critical Review. Journal of Dispersion Science and Technology 36(2): 213-225.

5. Zhang J, Yu B, Li H, Huang Q (2013) Advances in Rheology and Flow Assurance Studies of Waxy Crude. Petroleum Science 10(4): 538-547.

6. Huang Z, Zheng S, Fogler HS (2015) Wax Deposition: Experimental Characterizations, Theoretical Modeling, and Field Practices. CRC Press pp: 184.