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An In Situ Method for Observing Wax Crystallization under Pipe Flow

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Introduction: As the phenomenon of wax deposition in crude oil pipelines is of great relevance to the petroleum industry, there has been considerable work on both real and model oil pipeline systems in an effort to gain insight into the deposition process itself. It is generally believed that a thorough understanding of the mechanisms behind wax deposition will enable researchers to predict the growth and evolution of an incipient wax layer, allowing for the development of additives and surface treatments which will be more successful in hindering wax deposition within pipelines. The resulting techniques would thereby either minimize or fully alleviate wax-induced flow restriction and plugging in crude oil pipelines - problems which continue to plague the petroleum industry.
In an effort to develop a truly *in situ* means of characterizing the formation and evolution of the wax gel layers deposited in model pipeline systems, we have performed the first x-ray diffraction measurements of wax crystallization in wax-oil mixtures under flow.

Methods and Materials: We performed an investigation of the nucleation and growth of wax crystals and the evolution of the resulting wax gel deposit in mixtures of paraffin wax and dodecane under pipe flow through a standard x-ray quartz capillary of diameter 1mm.

Results: Our finding for lower Reynold's numbers agrees very well with the more detailed experiments reported by Singh *et al.*, where pressure drops, as well as destructive inspections of the interior of the pipe, were used to measure pipeline constriction. This demonstrates that the reduced size of our apparatus does little to change the basic results and further justifies the use of XRD to monitor wax layer growth.

References: P. Singh, R. Venkatesan, H. S. Fogler *et al*., "Formation and Aging of Incipient Thin Film Wax-Oil Gels," American Institute of Chemical Engineers Journal **46** (5), 1059-1074 (2000).