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Prediction method for the Paraffinic Wax Crystal Size Distribution in Solvent Dewaxing Process

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Abstract: A steady state 1-D model was implemented for conventional solvent dewaxing unit. The coupled equations for heat transfer and population balance were solved numerically to obtain the wax crystal size distribution, wax volume fraction along a double pipe scraped surface heat exchangers and chillers that used solvent dewaxing process. The prediction of the mixture physical properties based on the adjustment of the selected higher carbon number as a solid wax and the light ones as liquid by using n-alkanes solubility model. The crystal growth kinetics constants were fitted by the removal wax mass fraction which was obtained experimentally by using differential scanning calorimetry (DSC) technique. Also, the DSC analysis involved the dissolved temperature, onset crystallization temperature, and the wax content as the main input parameters to the model for the Crystal Size Distribution prediction in Solvent Dewaxing. The developed numerical model was proved to be capable to predict wax crystal characteristics for different operating conditions of such complex process.

Keywords: *solvent dewaxing, numerical model, wax crystallization, crystal size distribution CSD*

INTRODUCTION

Wax is probably the most troublesome product in the manufacture of lubricating oil. Its presence in lubricating oils prevents free movement at lower temperatures[1]. One of the separation technique of the wax components is done by solvent dewaxing which is selectively removes higher carbon number n-paraffins due to the highest crystallization temperature wrer the dewaxed oil dominated by non normal paraffins and contains also lower carbon number of normal paraffins [2][3]. The waxy lube oil –solvent mixture was chilled at a specified cooling rate in a series of hairpin double pipe scraped surface heat exchangers (SSHE) and chillers. This method is one of the most popular for dewaxing oils and deoiling waxes because it allows variation in the dilution ratio of the feedstock with solvent in optimum range without affecting the cooling rate and degree of supersaturated concentrations of the flow. Solvent dewaxing is a chemical separation process in which no chemical reactions occur. The composition of the dewaxed oil is completely dependent on the waxy feed and it represents the subtraction of the wax composition. An experimental study was conducted to compare the normal paraffin distribution between solvent and catalytic lube oil dewaxing by analyzing the feedstocks and products from both processes [3]. The chemical analysis of the carbon number distribution for three paraffinic wax samples were conducted using high temperature gas chromatography (GC) methods [3]. The results showed that the distribution of normal and non-normal hydrocarbons remaining in the oils after dewaxing process was clearly different and this suggested that the two processes have different ways in removing the higher paraffin. There are limited literatures dealing with crystallization process in the SSHE, These studies introduced a numerical simulation of the fluid flow and heat transfer combined with the population balance to represent the kinetics of ice particles crystallization using commercial CFD software [4][5].

The publication of the modeling analysis in the dewaxing lube oil feedstock in SSHE for the previous studies was found to be very limited. Bessarabov et. Al [6], proposed an analytical model (1-D) transient of the dewaxing process from a raffinate-solvent solution, the authors suggested that the temperature distribution of accumulated wax layer on pipe wall between two adjacent rotational scrape blades actions can be solved combined with wax crystallization kinetics. The kinetics of crystallization processes is described by using j^{th} moment transformation of population density function. A suggestion that the wax crystallized on the inside tube wall in scraped channel has the form of a hollow cylinder layer, so in order to solve the kinetic problem of wax crystallization in such a way that the temperature distribution in a wax