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Cracking of petroleum residues by reactive molecular distillation

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Abstract

It is known that the Brazilian oils are more heavy - super heavy - viscous, its operation is difficult, especially its production, including all stages - elevation, runoff and primary processing - in addition to their transfer, and refining itself. Studies indicate the existence of oil fields as heavy lifting and that the simple flow of the base of the pit to the surface seems impossible at first sight, especially in off-shore fields, compromising both technically and economically a project to produce a new field. Therefore, efforts are needed to develop alternatives aimed at reducing the API gravity, viscosity and sulfur content of extra-heavy oil, adding a higher commercial value for these oils. This work aims to study, propose and develop enhanced hybrid process that transforms the extra-heavy oil, or part thereof, in lighter crude oil to generate a mixture: lower sulfur content, lower density, lower viscosity, lower content of volatile (aromatics and asphaltenes), greater resistance to the processes of purification. The process studied is the Reactive molecular distillation with the addition of tetralin that suffer from high temperature cracking of molecules, providing protons that help the breakdown of asphaltenes and residues will suffer as a consequence physicochemical changes, such as those mentioned above. This way you can improve the problems associated with the deposition of asphaltenes at high temperatures. The conversion of light with immediate reduction of API gravity and sulfur content promoted a better use of extra-heavy oil and the DMR is a product of high-value oil and very interesting for the oil industry and the environment. The experimental work proposed in this study was conducted to cracking and separation of fractions and petroleum. The evaluation and characterization of the cracking results were obtained after analysis of properties such as density, viscosity, sulfur content, molar mass and mass balance of the currents.

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1. Introduction

The molecular distillation is not a conventional process; it represents a type of low pressures vaporization, and correspondingly low temperatures. It is indicated for the separation of homogeneous liquid mixtures that contain thermal cracking substances of high molecular weight and low volatility [1]. Molecular distillation involves, basically, two mechanisms: evaporation and condensation, in which vapor molecules escape from the evaporator in direction to the condenser, where condensation occurs. It is necessary that the vapor molecules generated find a free path between the evaporator and the condenser, the pressure below and the condenser be separated from the evaporator by a smaller distance than the mean free path of the evaporating molecules [2].

Since there is practically not return of the evaporated molecules to the liquid phase (there not exist vapor-liquid equilibrium), the molecular distillation is considered a process of non equilibrium.

Currently, many companies have adopted process intensification, creating innovative techniques and methods increasing the energy efficiency and the yield of the processes. The combination of chemical reaction and distillation in a unique process has become popular nowadays due to its potential to improve conventional processes design. This combination is advantageous especially for equilibrium limited reactions because the reaction products are continuously removed from the reaction zone. In reactive distillation process the number of equipment and the energy used are frequently much lower than in a conventional process. The reactive distillation process offer several advantages. It allows increase the yield due to overcoming the chemical and thermodynamic limitation of equilibrium; the selectivity is increased through suppression of undesired consecutive reactions [3]; the products are exposed to the heat only once, reducing opportunity for degradation among other things.

In this context, the concept and the equipment of reactive molecular distillation was developed, in which it simultaneously happens the coupling of molecular distillation (high vacuum) and reactive conversion. The configuration of the equipment of molecular distillation allows to submit the material at adequate temperatures (high vacuum process), to have short residence time (operational), and to have a very intense contact of the sample with the catalytic surface. These factors must provide high evaporation rate and high kinetics of reaction, consequently, elevated distillation/conversion rate allowing high processing rates.

In the reactive molecular distiller happens simultaneously the coupling of molecular distillation (high vacuum) and reactive conversion. The new concept and equipment developed by this research group is very robust and it can be characterized as hybrid and intensified process. The design of reactive molecular distiller was developed and constructed by this research group. The configuration of this equipment allows to submit the material at suitable temperatures (high vacuum process), to have short residence time (operational), and to have a very intense contact of the sample with the catalytic surface. The combination of molecular distillation with reaction is advantageous especially for equilibrium limited reactions, since the reaction products are continuously removed from the reaction zone.

Reactive molecular distillation (RMD) process distilled the residue of petroleum with addition of tetralin, this mix suffer from high temperature cracking of molecules, providing protons that help the

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