**The development of an exergoeconomic indicator to define the optimum blending fraction in processing crude oils**

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**Highlights**

* Heavy crude oils have a better exergy efficiency.
* Conventional crude oils are more profitable.
* An indicator is proposed to achieve a compromise between sustainability and profitability.

**1. Introduction**

The reserves of typical crude oils (CO) are scarce, although the society still heavily depends on them. The society is consuming this resource in a non-sustainable way which will make it collapse. 70% of the CO resources are available as heavy CO, oil sands and bitumens, which are less attractive to refineries. Refining these types of CO is more expensive due to their high viscosity and high sulfur content but they are very cheap. Refineries must often blend different types of CO to achieve the desired products specifications. An objective of blending is using heavy CO without compromising the quality of products while increasing the profitability and sustainability of the refining processes.

**2. Methods**

In this work, it is evaluated the impact of the blend composition on the performance of the topping distillation unit. The blend considers the CO: Sahara Blend and Tia Juana Heavy. The mass fraction of each CO is the manipulated variable while the other operatory conditions are kept constant.

Energy analysis is performed to quantity heating and cooling requirements. This is combined with an exergy analysis to identify how energy quality is conserved during the process. Exergy is strongly related to sustainability because it allows reducing the degradation of energy quality.

Exergy is divided into physical and chemical exergy. Chemical exergy is difficult to quantify, especially in petroleum cuts. Each of these cuts is defined as a pseudo-component because its chemical composition cannot be specified. In order to obtain this value, a set of correlations has to be used [1].

Feed composition affects the products obtained in the distillation unit. Heavy CO yield higher percentages of residues which have a lower economic interest. An economic analysis has also performed to identify which compositions are more profitable.

Analyses, where the economic and exergetic perspectives are combined, have been proposed in some literature and are called exergoeconomics analysis [2]. In this work, a new exergoenomic indicator is proposed because improving the exergy efficiency may incur in additional costs and it may not be attractive for a company to implement the proposed optimization.

**3. Results and discussion**

Heating and cooling duties vary during this analysis because a lighter blend requires more heating due to a higher content of light-ends to be distilled (Figure 1).

Exergy efficiency decreases with the amount of typical CO (Figure 2). Heavy CO yield a greater amount of fractions with high boiling points and, according to the definition of exergy, a stream with higher temperature has more energy quality.

Figure 2 – Effect of the feed composition on the exergy efficiency.

Figure 1 – Effect of the feed composition on the utilities consumption.

Economically, conventional CO increase the profitability of the process because the fractions obtained have higher economic interest (Figure 3). This indicator measures the added value to the production. Since exergy and economic indicators have contrasting results, a new indicator was proposed to evaluate both aspects simultaneously. This indicator is a compromise between the profitability and sustainability of the process and is obtained through the multiplication of the previous indicators (Figure 4).

Figure 4 – Proposed exergoeconomic indicator.

Figure 3 – Effect of the feed composition on the economic efficiency.

**4. Conclusions**

In this work, it was evaluated the effect of crude oil composition on the overall performance of the topping distillation unit. Energy, exergy and economic analyses were performed. Heavy CO have higher exergy efficiencies while conventional CO are more profitable. A new indicator was proposed to achieve a compromise between profitability and sustainability indicating the optimum blend fraction.

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**References**

1. Coker, A.K., Petroleum Refining Design and Applications Handbook. 2018: John Wiley & Sons.
2. Tsatsaronis, G., Definitions and nomenclature in exergy analysis and exergoeconomics. Energy, 2007. 32(4): p. 249-253.