Determination of True Boiling Point curves of heavy and extra heavy oils using a manual distillation system from University of Espírito Santo

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Until recently, heavy and extra heavy oil reserves did not attract much interest. The lowest oil profitability, the low price of the oil barrel in the international market, the difficulties involved in its extraction and its refining, and the large amount of light and medium oils to be explored could not justify the investments. But the shrinking supplies in conventional light and medium crude oils, the significant increase in oil price, and the discoveries of new heavy and extra heavy fields are, and will be, increasingly forcing the petroleum industry to increase and improve the heavier crude oils processing[1].

The adequacy and improvement in the heavy oil refining steps requires knowledge of the physical-chemical properties of the petroleum and its products, in order to establish the treatments to be applied in the process and the optimal processing conditions to ensure the quality of the final products, once the heavier oils don't behave the same way that the light and medium oils in the conventional refining.

The physical-chemical property mainly used for oil characterization is the distillation curve, True Boiling Point (TBP), with this curve it is possible to evaluate the yields of the products that will be obtained in the refineries, as well to establish operational strategies and process optimizations. Small variations in the TBP curve can have significant impact on process controls and especially in the profitability of oil. The TBP curve determination is made using the standards ASTM D 2892[2] distillation of crude oil until a final cut temperature of 400°C and ASTM D 5236 for vacuum distillation of heavy hydrocarbons with initial boiling point (IBP) of 150ºC up to 565ºC.

Therefore, this work aim to optimize the distillation process of heavy and extra heavy oil and to determine the TBP curves of these oils, according to the ASTM D 2892 standard in a manual system at LabPetro at University of Espírito Santo.

The distillations were performed in duplicate using two different oils with API gravity of 16.5 and 13.1 classified, respectively, as heavy (Petroleum 1) and extra heavy (Petroleum 2) oils. The Petroleum 1 was distillated (A and B) using atmospheric and reduced pressures of 100.0 and 2.0 torr up to 360ºC, while the distillations (C and D) of Petroleum 2 was only possible to be performed using pressures below 10 torr due to its high IBP. In distillation C pressures of 10.0 and 2.0 torr were used while in D only one step using a 2.0 torr pressure was made, in order to optimize the process time. It was also possible to do the direct distillation of this oil using the ASTM D 5236 method. All the reduced pressure steps were preceded by the oil heating and the adding of Raschig rings to ensure a homogeneous boiling.

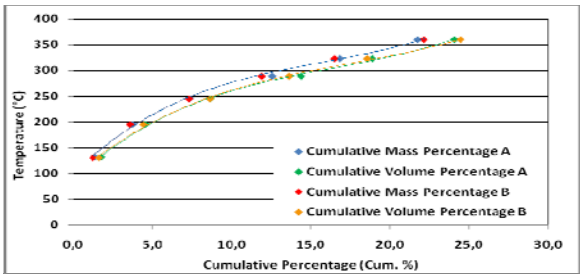

Fig. 1. TBP curves in percentage of cumulative mass and volume versus boiling point temperature of Petroleum 1.

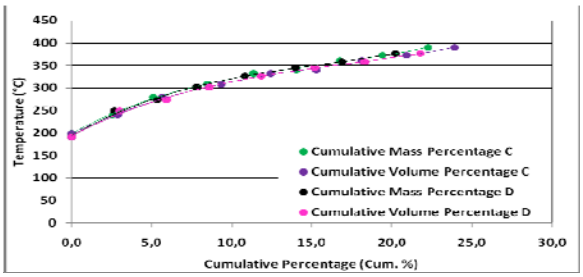

Fig. 2. TBP curves in percentage of cumulative mass and volume versus boiling point temperature of Petroleum 2.

The TBP curve data obtained for each oil showed reproducibility according to the values established by the ASTM D 2892 standard. The TBP curves in cumulative percentages of mass and volume for the Petroleum 2 are similar due to the high density of the distilled fractions.

In the Figures 1 and 2 it is possible to observe that the mass percentage removed from both oils using the ASTM D 2892 method were about 25%, however, the Petroleum 2 achieved a final cut temperature of 400ºC while the Petroleum 1 was distillate up to 360ºC.

The knowledge of the composition and properties of the crude oil allow the refiner to optimize the petroleum conversion in order to obtain products with high commercial value.

References

[1] Barillas, J. L. M., Dutra Jr., T. V., Mata, W. (2008) Braz. J. Pet. Gas. Vol. 2, 45-54.
[2] ASTM D2892-03a, Standard Test Method for Distillation of Crude Petroleum; (15-Theoretical Plate Column), 2003.