SLURRY INFLUENCE OVER THE VISBREAKING PROCESS

Carrillo J.A., and Garzón G.
ECOPETROL-Instituto Colombiano del Petróleo Km 7

Bucaramanga, via a Piedecuesta, Colombia S.A.

Introduction

The Visbreaking is a process of thermal cracking applied to the barrel bottoms, being this vacuum bottoms or deasphalting bottoms (DEMEX bottoms). This is a process used to reduce the viscosity [1, 2]. The severity limit in the visbreaking is determined by the fuel oil stability and by the coke production [3]. In this study we present the results of processing different quantities of slurry into the visbreaking feed. We found that with the increase in the slurry content in the feed, to reach the same conversion we should decrease the furnace temperature. In addition to that we notice that the light cycle oil (LCO) in the feed produces an increase in the distillate production. The addition of slurry to the feed causes a reduction in it viscosity in higher amount than expected just for dilution. It means a positive change in the colloidal equilibrium of the system [4-6].

Methodology.

For this study it was applied the methodology reported in [7]. The feed was DEMEX bottoms. There were prepared samples with 0, 10, 15 y 20 wt % of slurry and 8 wt % of LCO, and in addition to that there was a sample with no slurry and with no LCO. All the feed samples were characterized and compared. To have a reference point, the sample with no slurry and with no LCO was run at different temperature condition and its products were analyzed. Then the samples with different concentration of slurry and with 8 wt % of LCO were run at the visbreaking pilot plant. In all the runs at pilot plant level it was maintained constant steam (0.4 wt %) and reaction time (1,3 minutes). The tested temperature points were: 468, 476, 481 y 485 °C.

Results*:*

1. Feed

From fig. 1 and table 1 we can see that as the slurry concentration in the feed is increased, the viscosity, sulfur, CCR and insolubles in the feed decrease and VBN increases according to the equations:

Viscosity @ 177 °C $y = -0.0076x^2 - 0.1011x + 6.3467$ R2 = 0.8702

Viscosity @ 190 °C $y = -0.0113x^2 + 0.042x + 3.5442$ R2 = 0.9731

Sulfur $y = -0.0202x + 2.3194$ R2 = 0.8042

CCR $y = -0.2859x + 33.194$ R2 = 0.9809

Insolubles i nC_7 $y = -0.0068x2 - 0.1836x + 23.368$ R2 = 0.945

VBN $y = 0.0115x2 + 0.0206x - 3.3122$ R2 = 0.8783

x- slurry concentration, wt.

Up to 10 wt % of slurry concentration in the feed, the changes in the viscosity, insolubles and VBN correspond to the straight line, but after that point the trend change to polynomial. It is possible that before 10 wt % concentration of slurry in the feed it behaves as simply diluent, and after that concentration it causes changes in the colloidal system that produces more reduction in viscosity, insolubles and VBN than expected as can be seen from fig. 1 and 2.

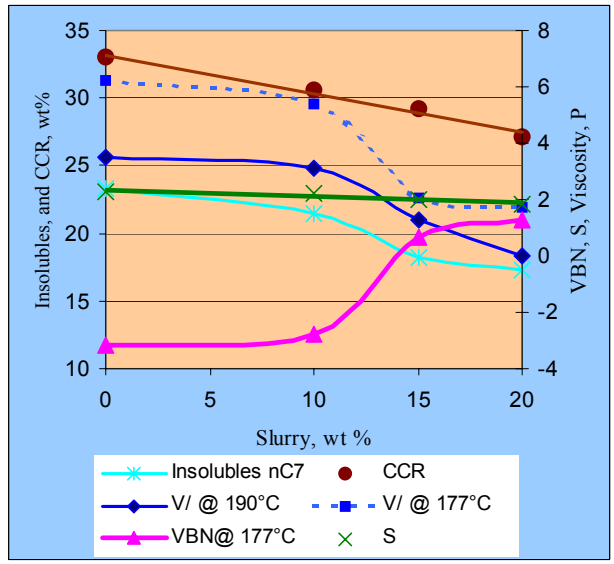

Fig. 1. Influence of slurry over the physical properties of the feed.

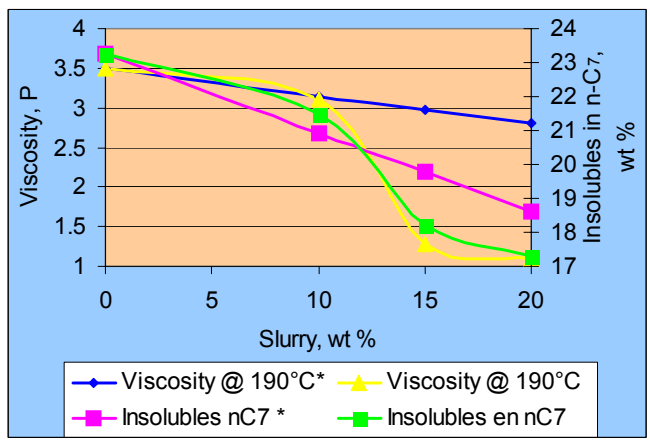

Fig. 2. Colloidal behavior of the mixture of feed with slurry; *- Expected values.

The other properties like CCR and sulfur maintain the same linear trend in the analyzed interval.

The correlation between insolubles in nC_7 and nC_5 is linear and correspond to the equation:

$$y = 1.2986x + 4.0088 \quad R2 = 0.9894$$

y- insolubles in nC_5; x- insolubles in nC_7.

Another analyzed influence of dilution was the incidence of LCO and slurry over the simulated distillation. We found that with the addition of 8 wt % of LCO, the summa of light and heavy gasoils increases from 17.3 to 30.0 wt %, but the expectance was 25.3 wt %. It means that with the use of LCO we can increase the distillate production in the topping units. The addition of slurry increases de distillation production in the expected quantity.

2. Runs at visbreaking pilot plant.

To have a reference point there were held three runs with DEMEX bottoms without slurry, at three different temperatures. The results are shown in table 1. It was found that the reference feed could be processed up to 481 °C, and after that temperature the product is unstable by Merito Test.

Table 1. Severity by temperature (steam: 0,4 wt %; LCO: 8 wt %,; Slurry: 0 wt %; Feedstock: DEMEX bottoms; t: 5 min.)

T, °C	Merito test	Bottoms, wt %	Lights, wt %	Gases, wt %	Coke, wt %	Conversion, wt %
476	6	90.76	7.11	1.09	1.05	8.2
481	7	90.25	7.16	1.48	1.11	8.6
485	8	85.88	10.03	1.81	2.28	11.8

As the slurry concentration in the feed is increased, the reaction temperature (at which the maximum allowable conversion is reached) decreases, and the properties of the visbreaking bottoms such viscosity, CCR and sulfur decrease. As a result we have the following consequences:

- The decrease in the reaction temperature means an important fuel saving.
- The viscosity reduction or the increase in the VBN (Viscosity Blending Number) represents a reduction in the diluent needed for the fuel oil preparation.
- The higher concentrations of slurry in the feed (15 an 20 wt %) present a relative low ΔVBN, but at the same time they present low viscosity. For that reason they need the lowest quantity of LCO as diluent.
- The sulfur reduction as a consequence of slurry addition to the feed means a sulfur reduction in the fuel oil. It is one of the main purposes to reduce atmospheric pollution.

In the material balance, the conversion, corresponding to different concentration of slurry in the feed for all studied cases, is similar, but with the addition of slurry to the visbreaking feed we have:

- A reduction in the furnace coke production, that means longer runs
- The decrease in the visbreaking bottoms and increase in the Gas Oil production is caused by slurry dilution factor.

References

1. Savaya Z.F and others, 1989. "Stability of fuel Oil produced by visbreaking of vacuum residue" Fuel, V68, p1064-1066.
2. Zanker A., 1878. "Visbreaking resid? Figure value", Hydrocarbon Processing, November, p205-206
3. Yan T.Y., 1989. "Characterization of visbreaking feeds". ACS meetin. Dallas, April 9-14, p428-433.
4. Furlong L.E and others, 1976. "The Exxon Donor Solvent Process" CEP August p6975.
5. Bianco A.Del. and others, 1993. "Thermal cracking of petroleum residues: Hydrogen donor solvent eddition". FUEL, V72, January, p8185.
6. Michel T. And others, 1989. "Visbreaking of Safaniya vacuum residue in the presence of additives". FUEL, V68, March, p318-322.
7. J. A. Carrillo; J. Saavedra and L. G. Garzón, 2001. "Processing of slurry in the visbreaking unit". Fuel Division, 222nd National Meeting, August 26-30,

Table 2. Behavior of the different visbreaking bottoms produced at maximum allowable temperature

Feed			Visbreaking bottoms			Products, wt %					
Slurry wt %	T °C	Viscosity @ 375°C, cP	ΔVBN	S wt%	CCR wt %	Coke	Bottoms	Gas Oil	Naphtha	Gas	Conv
20.0	468	52	2.41	1.7	32.2	1.0	40.5	50.0	7.1	1.4	8.5
15.0	472	58	2.25	1.8	32.0	1.0	38.6	50.9	7.8	1.7	9.5
10.0	476	99	3.61	1.8	32.0	1.1	40.5	49.2	7.7	1.5	9.1
0.0	481	175	1.98	1.9	35.0	1.1	46.5	43.8	7.2	1.5	8.6