A rapid thermal analysis to assess asphaltene unstability in crude oils

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Asphaltene deposition is a flow assurance problem in upstream and downstream processes that causes significant economic loses to petroleum companies [1]. Studies in order to determinate the absence or presence of this deposition problems becomes, therefore important. Many works deal with prevention studies based on prediction models, but these models require as input some experimental data that are time consuming (i.e. SARA analysis).

This work presents a simple and rapid thermal method to asses in a qualitative way the stability related to asphaltene formation and deposition. More than 10 dead crude oils with very different physical characteristics have been analyzed. Asphaltenes have been separated by IP-143 standard and a method modification using different n-paraffins as precipitants. Once solids have been isolated, a thermogravimetric analysis (TGA) under inert nitrogen atmosphere has been carried out. Asphaltenes and solid residues obtained after thermal treatment have been characterized by several techniques, namely infrared spectroscopy (FT-IR), elemental analysis (HCNS) and proton nuclear magnetic resonance (NMR H^+).

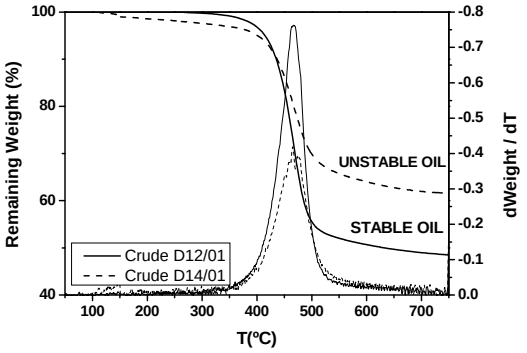

Fig. 1. TGA for two different crude oils: one instable and one instable.

Results have shown that asphaltenes that come from problematic oil wells lose less mass during thermal treatment (weight losses under 35%), with a gap between them and non-problematic asphaltenes of 15-20 % in weight. Figure 1 shows an example of these results for 2 crude oils, one stable and one unstable from the point of view of asphaltene deposition. This behaviour seems to be related to a greater loss of paraffin chains in the case of unstable asphaltenes. Therefore, the degree of aromaticity in asphaltene fraction seems to be a controlling factor in the stability of these molecules in crude oil, as greater problems are observed for crude oil with more aromatic asphaltenes (Figure 2).

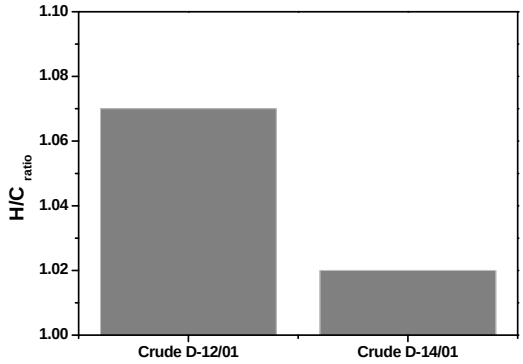

Fig. 2. H/C results obtained using HCNS technique.

However, there is not a significant decomposition temperature shifting between the samples under investigation (around 460 ºC). Furthermore, the unstability of asphaltenes as function of some physical parameters such API density, asphaltene content, carbon residue percent, viscosity or REID vapour pressure has been assessed.

All in all, results confirm that this thermal analysis is a powerful, easy and rapid method to assess asphaltene deposition problems.

References

[1] Creek, Jefferson L. (2005) Energy and Fuels. 19, 1212-1224.