Pressure drop and CO_2 injection effects on asphaltenes stability in a live oil

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Gas injection is a well known process used in the oil industry to enhance oil recovery. Injection of light compounds in the oil in place can favour its mobility by decreasing the viscosity. If one adds the combat of greenhouse effect, CO_2, due to its thermodynamics and chemical properties is a perfect candidate for this purpose. Nevertheless, CO_2 injection can also lead to dramatic effects when employed with asphaltenic crude oils. As attested by numerous papers, CO_2 is able to destabilize asphaltenic systems and induces flocculation and solid deposit formations.

Before operating such fields preliminary experiments and simulation must be done to get reliable certainties. If the phase behavior of asphaltenic crudes is now better understood, fundamental topics are still on debate today. Nor team is able to predict the gas quantity that will induce asphaltene flocculation, the pressure (versus temperature) at which the phenomenon will start, the amount and the quality of the deposits that are likely to form.

Among the experimental techniques available to follow asphaltenes stability under reservoir conditions, the sampling through a filter is completely suitable. The work presented here focuses on pressure drop and CO_2 injection effects on asphaltene stability in a Brazilian live oil for which the state of aggregation of asphaltenes has been followed by high-pressure filtrations sequences.

The entire experimental device, developed at Pau University, can be divided in three key building blocks: (i) an automatic moving piston PVT cell rated for a maximum pressure of 100.0 MPa from 293 to 423 K and allowing the homogenization of the fluids by means of a magnetic stirrer. This cell is equipped with a sapphire window that allows visual observation of the entire cell. A second sapphire window is fixed on the cylinder wall in order to light the fluid with an optical fibre (ii) an injection cell with an operating pressure of 70.0 MPa, a maximum temperature of 423.15 K and a total volume of 50 cm^3. (iii) a filtering system, which consists of a 0.5 μm porosity filter (Swagelok) fixed in a filter holder that can stand up to 100 MPa.

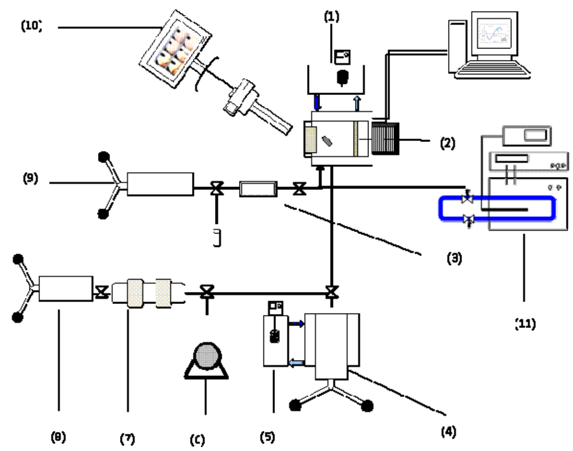

Fig **1.** Scheme of the experimental setup: 1, circulating bath; 2, automatic high pressure cell with sapphire windows; 3, filter holder/filter 0.5 μm 4, manual pump for CO_2 injection; 5, circulating bath; 6, vacuum pump; 7, live oil container heated with eating collars; 8, manual pump for fluid transfer/pressure control; 9, Manual pump for isobaric filtration; 10; endoscope; 11, high pressure densimeter

The asphaltene stability of the live oil sample was investigated after the injection of 10, 20 e 30% of CO_2 (molar fraction). All tests were performed at the reservoir temperature, 58.7ºC, and pressure, 56.3 MPa, and slightly above the bubble point, 42.5 MPa. A preliminary experiment showed that no asphaltene flocculation occurs during the de-pressurization of the pure oil (without CO_2 addition). The tests revealed that the lower quantity of CO_2, 10%, was not sufficient to modify the live oil asphaltene stability. Asphaltene flocculation was observed when the CO_2 amount was increased to 20% close to the bubble point. Under this condition an induction time of 96 hours was observed before the flocculation onset. The induction time was shortened to less than 24 hours when 30% of CO_2 was added.

The behavior of the system with 20% of CO_2 was investigated below the bubble point, 19.5 MPa. During this pressure drop, a second liquid phase appeared around 38.0 MPa. This asphaltene rich oil phase was observed sticking on the sapphire window. This second liquid phase disappeared when the system was put again in a single phase above the bubble pressure.

Pressure, temperature and CO_2 amount effects will be presented in details and discussed.