Experimental improvement of rheological parameters of crude oil in flow

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Abstract

Several technics have been used to increase the mobility of crude oil pipeline transportation. The addition of the copolymer, poly (ethylene-co-vinyl acetate) (EVA) containing 12 % of vinyl acetate, can improves the rheological parameters and ease the flow of crude oil. In this present study we studied the effect of the concentration of vinyl acetate containing (EVA) on the viscosity, and the yield stress of Algerian crude oil from oil fields TFT. The rheological tests were made at low temperature 6.3,10 and 40 °C. Different concentrations of copolymer (EVA12) were tested 100, 200, 300, 400 ppm. The results obtained showed that the EVA allows reducing the apparent viscosity and the yield stress of crude oil and the results not only depends on the concentration of poly (ethylene-co-vinyl acetate) (EVA) but the temperature; also have an important influence.

Keywords: *Rheological behavior, viscosity, Crude oil, yield stress.*

1. Introduction

With the increasing demand for crude oil in the international market and the saturation of transport systems, oil companies plan to optimally exploit of existing networks whilst avoiding problems of engineering **[1]**.The transport of crude oil by pipelines from the production wells is expensive and involves various difficulties depending on the conditions of each climate composition field. In order to improve the flow properties of crude oils, an pre-treatment of the crude oil is necessary for which the rheological properties of the crude oil undergo changes for easier transportation [2,3].Different studies were conducted to discover useful techniques in order to reduce the pressure drop and viscosity of the crude oil respectively for the pipeline transport and other applications (heating, dilution, oil-in-water systems, the crude oils also are blended with a kerosene distillate fraction) [4]. This process has its disadvantages. The Heating often requires considerable amounts of energy on the other hand in some cases up to 30 wt. % of kerosene must be added to sufficiently reduce the viscosity [4].This uses up a great quantity of a valuable commercial product. Another technique which can be employed for the transportation of crude oil, the adding of some polymer, co-polymer or surfactant in the crude oil is one of the major techniques used for improve the properties rheological and to increase the mobility of crude oil in transportation of crude oils through pipelines [5,6], for this reason, poly (ethylene-co-vinyl acetate) (EVA), was used in this study. These co-polymers are among the additives that can be used since they present a good efficiency as crude oil flow modifiers [7,8]. The objective of this study was to evaluate the influence of EVA copolymers, with different vinyl acetate concentration on the yield stress, viscosity of crude oil Algeria.

2. Materials and Methods

The specimens of crude oil used in this study came from the reservoir of the sector of Tin Fouye Tabankort (Algeria).The physic chemical characteristics of the crude oil used are listed in Table 1.

Table 1.Sample characteristics of the crude oil used in this study.

Sample characteristics	
API gravity	32.7
Liquid Density (26°)	0.847
TVR (35.5°)	339
BSW %	0.05

2.1 Rheological measurements and protocols testing

The rheological behavior of different samples was studied by exploiting the performance of the rheometer AR-2000 from TA-Instruments. Initially the crude oil sample is subjected to shear rate of 1000 s^{-1} to delete the memory of the sample. All the samples will be subjected to pre-shear of 60 s with a shear rate of 0, 1 s^{-1} to establish a uniform initial state [9]. The samples will be left at rest during 1 min. Then, the procedure of acquisition is started; the shear rate is imposed by stages which go up gradually growing between 0.01 s^{-1} and 500 s^{-1}.

3. Experimental results and discussion

The figure 1 represented the evolution of the viscosity according to the shear rate for different concentration of

EVA12. In the plot it can be seen that the additive compound, EVA 12, used have a diverse effect on viscosity.

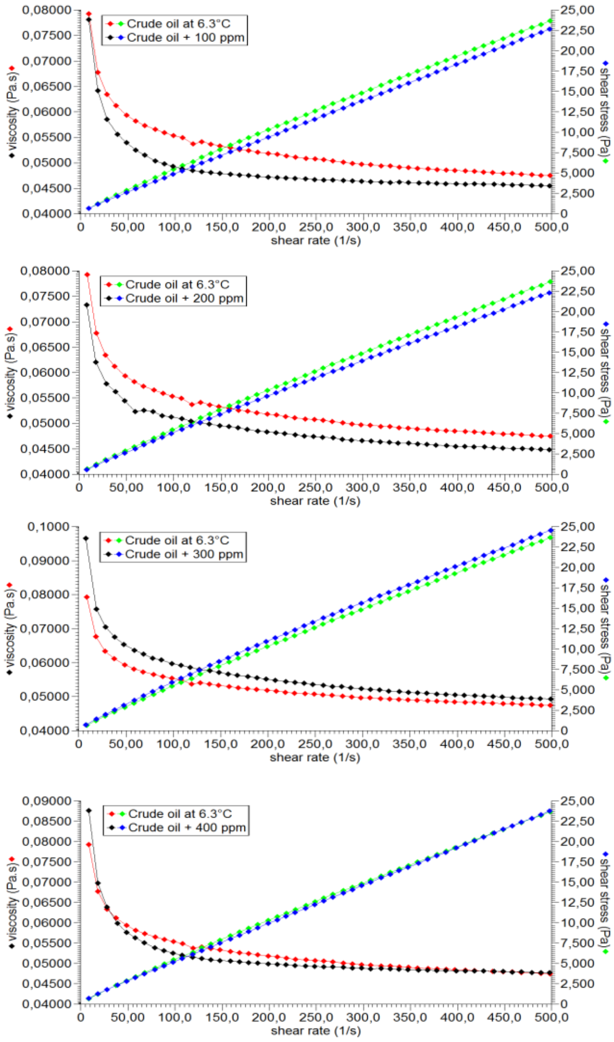
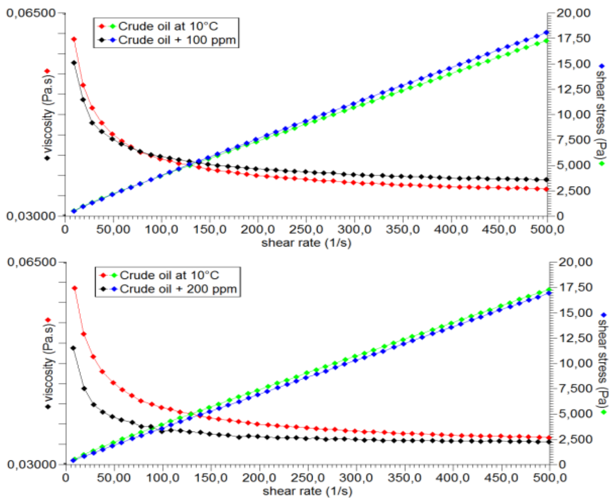


Fig.1: Variation of apparent viscosity and shear stress with shear rate of treated Algeria crude oil at 6.3°c.



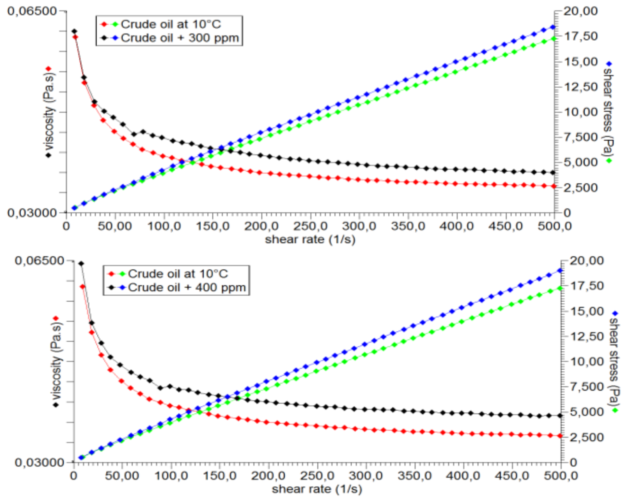


Fig.2: Variation of apparent viscosity and shear stress with shear rate of treated Algeria crude oil at 10°c.

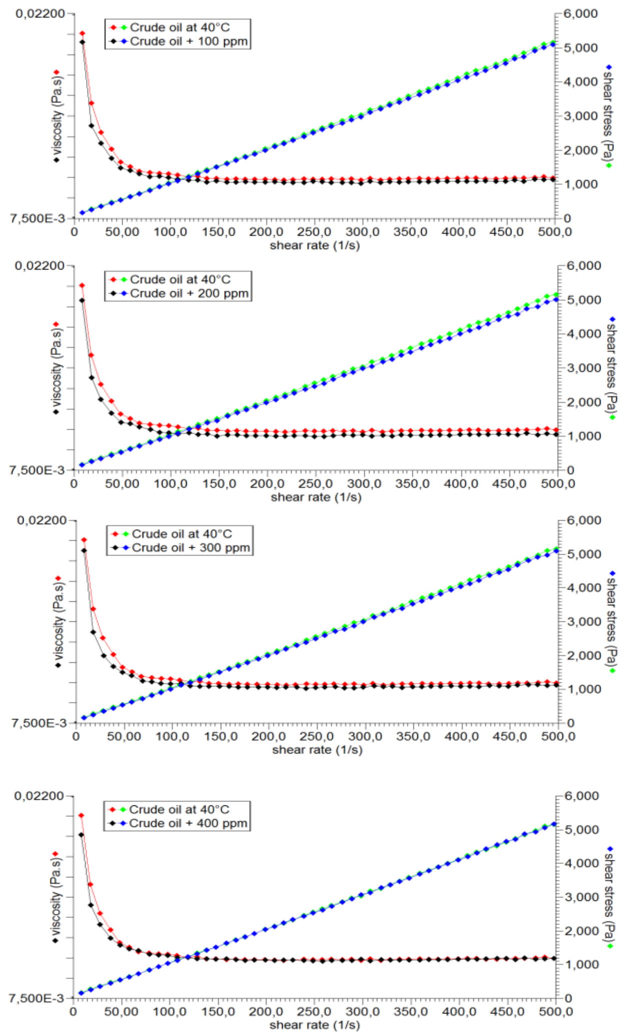


Fig.3: Variation of apparent viscosity and shear stress with shear rate of treated Algeria crude oil at 40°c.

Figure 1, 2 and 3 represented the evolution of the viscosity according to the shear rate for different concentration of EVA12 at 6.3,10 and 40°C. In the plot it can be seen that the additive compound used have a diverse effect on viscosity. These results not only depend on the concentration of the copolymer used but also the temperature will play a major role in viscosity reduction of crude oil/EVA12 system [10,11]. A reduction in the apparent viscosity it was observed for 100, 200 and 400 ppm concentration of additive at 6.3°C. Particularly an increase in viscosity was observed at a concentration of 300 ppm for the crude oil containing the EVA 12. The best reduction of viscosity result was obtained for the crude oil containing 100 and 200 ppm of additive.

At 10°C, the results show that the temperature has considerable effect on the performance of the copolymer used. In this temperature and for some concentration the additive lost its efficiency the figure 2, illustrate that the viscosity increases when the concentration was 100, 300 and 400 ppm. However, the best performance was obtained with EVA 12 at 200 ppm.

At 40°C, the reduction of the viscosity is relatively low and EVA 12 show low efficiency as the reduction of viscosity for this crude oil at the concentration range used. According to the obtained results (fig 1, 2 and 3) the crude oil behaves as a non-Newtonian fluid of Herschel Bulkley type. It is also noted that the Newtonian behavior occurs at high values of shear rate gradient. The non-Newtonian behavior is very pronounced for the low shear rate gradients.

4. CONCLUSION

1) The viscosity of the crude oil decreases significantly with temperature and shear rate over the range of temperatures 6.3, 10 and 40 °C.

2) At 10°C, The addition of 200 ppm of additive to the crude oil causes a strong reduction in the viscosity of the crude oil.

3) Yield stress decreased considerably with the addition of additive EVA12.
4) The best performance an reduction of viscosity was obtained with EVA 12 at 6.3°C for all concentrations.

5) Results show that the shear rate has a noticeable effect in decreasing viscosity particularly and that the viscosity tends to stabilize at higher shear rates.

6) The crude oil studied behaves as a rheofluidifiant fluid with yield stress and follows the rheological model of Herschel-Bulkley.

5. REFERENCES

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