Evaluation of reservoir fluid viscosity models applicable for heavy oil conditions using empirical data analysis

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ABSTRACT

The viscosity of crude oils remains a key factor in the simulation of reservoir flow behaviour. It is particularly necessary to ascertain production potential and the recovery of the crude oil. Experimental determination of viscosity is expensive, cumbersome and not always feasible due to time and financial constraints.

Linked to the above, is the interesting emergence of the recovery of heavy oil recovery technology. This has been as a result of various circumstances including depleting light oil reserves. The simulation of heavy oil viscosity remains a very important area of relevance. In this regard, this Research Report explores, from a theoretical basis, the conventional models used in oil exploration with the aim of evaluating the viscosity of heavy oils, evaluating other viscosity-related properties (such as bubble point pressure) of heavy oil and developing a framework in the development and/or selection of viscosity models applicable to heavy oils.

Various models that are commonly used were explored from data available in literature. Two main themes were identified, namely Black Oil type and Corresponding states type. Three models were identified, namely Beal, Beggs-Robinson and Labedi. These models were evaluated using experimental data of Egyptian Oil under dead and undersaturated oil conditions. It was found that the Beggs-Robinson displayed the best correlation behaviour to the measured samples.

Various trends were observed from the overview of viscosity behaviour trends of the conventional models. It was found that the Beal's model under-predicts viscosity at high temperatures, while the Beggs-Robinson model tend to over-predict viscosity at lower temperatures.

The relationship between heavy oils and viscosity was expanded upon extensively. In this regard, various other properties of heavy oil including the bubble point pressure were explored. The constant composition expansion test was used for the Egyptian oil samples. Various properties like the relative volume, oil compression and pressure were briefly examined. Furthermore, reservoir performance was evaluated in order to obtain PVT data. PVT data is important for the development of viscosity models. The differential liberation expansion and multistage separator test was used to undertake this evaluation.

In our comparison between the experimental and simulated viscosity, all of the models under observation generally displayed good correlation in their estimation across both oil conditions. In conclusion, a theoretical framework is proposed for the selection of a viscosity model for heavy oils.