Petroleum and Chemical Engineering Department-College of Engineering-Sultan Qaboos University

Prediction of Under saturated Omani Crude Oil Viscosity

Majda Ahmed AL-Balushi

Abstract

Numerical correlations are widely used in the petroleum industry in order to predict crude oil viscosity at different pressures (above, below and at bubble point pressure) and bubble point pressure. These correlations often use field-measured variables. This study is mainly conducted to develop a new correlation for predicting the viscosity of the under saturated Omani crude oil with field-measured data due to its importance in oil industry since it represents the viscosity at the initial stage for reservoirs above the bubble point pressure. In addition, the correlations for bubble point oil viscosity and bubble point pressure are also established in this study based on measured data for Omani crude oil which can be used to predict under saturated oil viscosity in case these data were not available.

The first step in this study was creating a large database from 118 pressure-volume-temperature (PVT) reports and screening them to remove all unreliable data. Then the available correlations in the literature for predicting under saturated crude oil viscosity, bubble point oil viscosity and bubble point pressure were evaluated for Omani crude oil. Since most of the available under saturated oil viscosity correlations provided good predictions for Omani crude oil viscosity, therefore those correlations were modified for Omani crude oil to reduce the error further so that they can better predict the under saturated oil viscosity. Then a new correlation was developed for under saturated Omani crude oil viscosity with field-measured data using an optimization routine based on the Genetic Algorithm (GA) method in Matlab with an average absolute relative error (AARE) of 4.12%. Two new correlations were developed for bubble point oil viscosity for different ranges of stock tank oil API gravity with an AARE of 14.06% for the complete range of data. In addition, a new correlation was developed for the bubble point pressure with an AARE value of 11.16%.

Finally, the accuracy of the predicted correlations was validated against the available ones. The validation tests showed that the performance of the proposed correlation for under saturated oil viscosity is better than the best three published correlations and equivalent to the best three modified ones with field-measured data having an AARE value of 3.96%. In addition, the proposed correlations for bubble point oil viscosity and bubble point pressure were found to outperform the available ones with an AARE of 14.98% and 14.30% respectively. Moreover, it was indicated that using different correlations for bubble point oil viscosity predicted for different ranges of stock tank oil API gravity improves the performance of all available correlations for undersaturated oil viscosity. This is due to the fact that oil density is a fundamental characteristic on which different oil properties depend on. Oils with different API values will have different

properties. Therefore, different correlations for different ranges of API are more representative for predicting oils physical properties. On the other hand, calculated bubble point pressure does not show noticeable effect on the performance of the undersaturated oil viscosity. This can be explained by the high degree of randomness in pressure differential values with respect to oil viscosity which cannot be explained by the model.