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# Viscosity prediction in selected Iranian light oil reservoirs: Artificial neural network versus empirical correlations

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**Abstract:** Viscosity is a parameter that plays a pivotal role in reservoir fluid estimations. Several approaches have been presented in the literature (Beal, 1946; Khan et al, 1987; Beggs and Robinson, 1975; Kartoatmodjo and Schmidt, 1994; Vasquez and Beggs, 1980; Chew and Connally, 1959; Elsharkawy and Alikhan, 1999; Labedi, 1992) for predicting the viscosity of crude oil. However, the results obtained by these methods have significant errors when compared with the experimental data. In this study a robust artificial neural network (ANN) code was developed in the MATLAB software environment to predict the viscosity of Iranian crude oils. The results obtained by the ANN and the three well-established semi-empirical equations (Khan et al, 1987; Elsharkawy and Alikhan, 1999; Labedi, 1992) were compared with the experimental data. The prediction procedure was carried out at three different regimes: at, above and below the bubble-point pressure using the PVT data of 57 samples collected from central, southern and offshore oil fields of Iran. It is confirmed that in comparison with the models previously published in literature, the ANN model has a better accuracy and performance in predicting the viscosity of Iranian crudes.

**Key words:** Viscosity, crude oil, artificial neural network, empirical equations

## 1 Introduction

Viscosity is an important parameter needed for petroleum engineering analysis (Egbogah and Ng, 1990; Larter et al, 2008; Shi et al, 2010). The oil viscosity is a strong function of temperature, pressure, oil specific gravity, dissolved gases and composition of oil mixture (Riazi and Al-Sahhaf, 1996; Martín-Alfonso et al, 2007). Although oil viscosity can be measured isothermally at reservoir temperature and different pressures, viscosity data at different temperatures other than reservoir temperature are needed for design of processing equipments, tubing-string, gas-lift, pipelines and particularly for thermal recovery processes (Beal, 1946; Moharam et al, 1995; Das, 1998; Chang et al, 1999; Kilonzo and Margaritis, 2004; Obanijesu and Omidiora, 2009). In order to solve this problem, empirical correlations are used to predict the viscosity when experimentally measured data are not available. These correlations usually vary in complexity and accuracy depending upon the available crude oil data.

Several studies have been reported on the development of empirical correlations for prediction of crude oil viscosity as a function of reservoir temperature, oil API gravity, and solution-gas oil ratio (Beal, 1946; Khan et al, 1987; Beggs and Robinson, 1975; Kartoatmodjo and Schmidt, 1994; Vazquez and Beggs, 1980; Chew and Connally, 1959; Elsharkawy and Alikhan, 1999; Labedi, 1992). Most of these correlations are developed for a given area or region using limited viscosity data. These correlations have limited accuracy in estimating crude oil viscosity when applied to new area or regions (Sutton and Farshad, 1990). Other empirical or semi-empirical models use reservoir fluid composition to predict oil viscosity (Lohrenz et al, 1964; Little and Kennedy, 1968).

The physical properties of crude oils determined by an experimental method have high accuracy. However, it is expensive and time-consuming. The oil industry requires a method which is fast, workable and more cost effective than the experimental method. Artificial neural network (ANN) is taken as the best alternative for predicting the physical properties of crude oils, as it takes a short time and is not costly (Van der Walt et al, 1993; Elsharkwy and Gharbi, 2000; Obanijesu and Omidiora, 2009; Omole et al, 2009; Dong et al, 2010). The ANN is currently used in prediction of properties in chemical and petroleum engineering (Roosta et al, 2012; Zendehboudi et al, 2012), prediction/estimation of the solubility of different solvents in supercritical carbon

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