Shahrood University of Technology

JOURNAL OF RESEARCH ON APPLIED GEOPHYSICS
(JRAG)
2018, VOL. 4, NO. 2
(DOI): 10.22044/JRAG.2017.5552.1106

Application of support vector regression to estimate the formation water saturation in one of the largest oil fields located in the southwest of Iran

Reza Ahmadi[1*] and Mohammad-Sadegh Amiri Bakhtiar[2]

1- Assistant professor, Mining Engineering Department, Arak University of Technology, Arak, Iran
2- M.Sc. Student, Abadan Petroleum University of Technology, Abadan, Iran

Received: 1 April 2017; Accepted: 17 October 2017

*** Corresponding author: rezahmadi@gmail.com**

Keywords

Water Saturation (S_w)
Support Vector Regression (SVR)
Asmari Formation
Well Logs Data

Extended Abstract

Summary

Water saturation (S_w) of a hydrocarbon reservoir is an important petrophysical parameter having a great impact on the accuracy of primitive estimation of the reservoir. Due to highly importance of this parameter dealing with the economic calculations of the reservoir, it must be estimated precisely. Although experimental analysis of core samples taken from a reservoir leads to very useful information about S_w of the reservoir, this experimental method is highly expensive and time consuming; and therefore, this method is applicable only for a small number of wells in a field. To overcome this problem, an intelligent pattern recognition method, known as support vector regression (SVR), has been employed in the current research to estimate S_w from well logs data of 3 wells in one of the largest oil fields of Iran. The performance of the algorithm has also been validated through different criteria. The results of this research indicate that the SVR model can estimate S_w from well logs data accurately, in which the determination coefficients of 87 and 76 percent have been obtained from the training and test steps, respectively.

Introduction

Generally in most commonly hydrocarbon reservoirs, S_w is estimated using well logs data through applying Archie's fundamental empirical relation. However, this relation is just satisfied for clean sandstone formations (without clay minerals). So far several empirical models have been proposed to measure S_w using well logs data. The main disadvantage of these models is their formation dependency, which makes the models specific and not comprehensive to be applied in a variety of other formations. In addition to empirical methods, several linear regression techniques have also been applied to estimate this parameter using well logs data. These techniques cannot estimate S_w appropriately due to the complexity of the parameter features. Resistivity and porosity logs are the most important well logs used to estimate S_w by Archie's relation. The porosity of a formation can be very accurately determined through sonic, density and neutron logs. However, resistivity logs are very sensitive to the presence of shale and other clayey impurities in formations. Their effects can be adjusted by means of gamma ray (GR) log. Therefore, to estimate S_w, employimg an intelligent method using appropriate well logs data will be useful. The oil reservoir, studied in this research, is located in Asmari formation in southwest of Zagros Mountain. Overall this formation in the investigated region has been formed from a sequence comprising of carbonate rocks (limestone and dolomite), sandstone and shale.

Methodology and Approaches

In the current research, to estimate S_w, SVR method has been applied to well logs data from 3 wells in one of the largest oil fields of Iran. In this study, appropriate well logs data comprising of GR, neutron porosity, formation bulk density, sonic transit time and true resistivity from deep induction log (ILD) have been used. Moreover, S_w values measured from cores in the laboratory are available for whole depth of the wells. In order to employ SVR to estimate S_w, the model needs to be trained using appropriate input and output data in MATLAB environment. In the current research, the input consists of 5 variables (well logs data) while the output is only the S_w parameter. From 1211 data points (containing 5 variables of well logs data and S_w parameter measured by core) available from the 3 wells, about 80 percent (i.e. 988 samples) were selected for training and the remaining 20 percent (i.e. 223 samples) were chosen for test. To compare the estimated values with the measured ones for the reservoir in the study region, visually, chart of lithology, water and hydrocarbon saturations of the formation were also depicted for the 3 wells by means of Geolog software.

Results and Conclusions

The performance of the algorithm has been validated through different criteria such as scatter plot of S_w values from cores versus the estimated S_w values from well logs data of 3 study wells by means of SVR model as well as computing statistical parameters indicating the accuracy of the results. Furthermore, the results of the research revealed that the SVR model can estimate S_w using well logs data accurately so that it has estimated the training and test data with the determination coefficients of 87 and 76 percent, respectively. As a result, the proposed method, i.e. SVR, is an accurate, fast and cost-effective method to evaluate the petrophysical parameter S_w.