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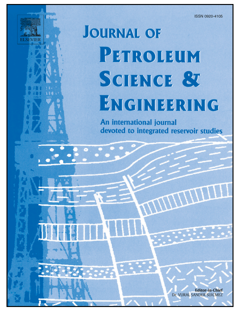

Application of artificial neural networks for viscosity of crude oil-based nanofluids containing oxides nanoparticles

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Application of Artificial Neural Networks for Viscosity of Crude Oil-Based Nanofluids Containing Oxides Nanoparticles

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Abstract

In this research, the effect of general performances of radial basis function (RBF) method of artificial neural networks (ANN) with laboratory data on NiO, WO_3, TiO_2, ZnO and FeO_3 nanoparticles in different temperatures and mass fractions on viscosity of crude oil were studied. The morphology and nanoparticles stability were analyzed with the DLS and TEM analysis. The results showed that the average nanoparticles diameter ranged from 10 to 40 nm for different oxide nanoparticles. For learning RBF networks, the major method for calculating isotropic Gaussian basis functions span for RBF networks containing special algorithm were presented. The results declared RBF neural networks had an acceptable performance because of having strong academic basic and ability of filtering the noises. This method contain all the experimental data perfectly, and provides the possibility of using different mass fractions and temperatures and simulated charts for knowing the information about the viscosity. For TiO_2, ZnO and FeO_3 nanoparticles, adding small amounts of nanoparticles decreased the relative viscosity comparing to the base fluid viscosity. But for WO_3 and NiO nanoparticles the viscosity of nanofluids was higher than base fluid with any mass fractions.

Keywords: Artificial neural network, RBF, Nanofluids, Oxide nanoparticles, Viscosity.

Nomenclature

$\boldsymbol{w}$	Mass fraction of nanoparticles (%)
$\boldsymbol{T}$	Temperature (˚C)
$\boldsymbol{\mu}$	Viscosity (mPa.s)
$\boldsymbol{\rho}$	Density (kg/m3)
$\boldsymbol{S.D.}$	Standard deviation
$\boldsymbol{E}$	Experimental viscosity at fixed mass fraction and temperature (mPa.s)
$\boldsymbol{\bar{E}}$	Average of experimental viscosity at fixed mass fraction and temperature (mPa.s)
$\boldsymbol{n}$	Number of measured viscosity at fixed mass fraction and temperature, equal to 5
G	N*N symmetric Green's matrix
$\boldsymbol{\lambda}$	regularization parameter
$\boldsymbol{w_j'}$s	unknown synaptic weights
xj	particular data point
$\boldsymbol{\sigma_j}$	isotropic spread of the jth Green's function
$\boldsymbol{\lambda^*}$	optimum regularization parameter
N	number of training exemplars and the number of Regularization network neurons
ek	is the kth unit vector of size N
IN	N * N unit matrix
H($\boldsymbol{\lambda}$)	smoother matrix originally defined by Hastie and Tibshirani
df	degrees of freedom