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Experimental Studies on Viscosities of Ferrous Oxide and Graphene Nanofluids and Their Dependence on Temperature, and Nanoparticles' Loading and Size

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Abstract

Studies on nanofluids have shown the great ability of nanoparticles in extracting oil left behind in formation after primary recovery (i.e. flow of hydrocarbons due to pressure differences between well head and bottom-hole of the well) and secondary recovery (i.e. processes of injecting water, gas, CO_2 or other substances into formation to maintain or enhance reservoir pressure in order to recover more hydrocarbons). Nanofluids can result in uniform oil phase displacement, reduction in interfacial tension between oil and water phases and altering surface wettability or increasing water wettability; thus, leading to high sweep efficiency of hydrocarbons. Nevertheless, the increase in viscosity due to nanoparticles suspension is one of the major problems in flow characteristics especially in microchannel flow. Viscosity increase will result in lower pressure drop and pumping difficulties. Therefore, designing nanofluids and their viscosities is essential for any application involving flow of nanofluid, especially in microchannels. However, very few theoretical models have been developed based on unique properties of nanofluid, and many empirical correlations are based on specific base fluid types, restricted sizes and volume fractions of nanoparticles, and limited temperature range. This caused another problem regarding estimating viscosity for various types of nanofluids.

Therefore, in this present work, the viscosity of two deionized water based nanofluids containing ferrous oxide (Fe_2O_3) and graphene nanoparticles, respectively, were studied. The dependence of viscosity on temperature and size of particles were found to be inverse, while as volume loading of nanoparticle was increasing; the viscosity was also increasing. New semi-empirical correlation for both nanofluids was obtained using Buckingham theorem and Non-linear regression for experimental data points. This model exhibited better agreement with experimental results than other previously published models in literature.

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