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Empirical Viscosity Modeling for SiO2 and Al2O3Nanofluids using the Response Surface Method

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Abstract:
The ability of nanofluids, an engineered fluid, to effectively remove heat has been proven to exceed that of a conventional fluid. However, dynamic viscosity may put a limitation on this ability. This paper presents the results of the experimental measurement of the dynamic viscosity for water-based nanofluids and the development of empirical viscosity models using the response surface method (RSM). The nanofluids that are being considered in this work aresilicon dioxide (SiO2)-water and aluminum oxide (Al2O3)-water at a concentration of 0.01, 0.055 and 0.1 vol.%. Experiments were designed and analyzed according to the face-centered central composite design (CCD) in the RSM. ANOVA was used to evaluate the significance of the independent factors, which are the nanoparticle concentration and temperature. Empirical models to predict the dynamic viscosity of both nanofluids at a specific temperature and volume concentration were developed and validated. Excellent fits of the models were demonstrated by their high coefficient of determination, R2. Results indicate that dynamic viscosity increases with nanoparticle concentration and decreases with temperature. It is also observed that the addition of less or equal than 0.1 vol.% of SiO2 in water would not significantly change the viscosity.