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Heat Transfer and Pumping Power of Al_2O_3-Water Nanofluids in Commercial Galvanized Iron Pipes

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Abstract: Employing nanofluids as heat transfer agents may enhance the heat transfer but at the expense of the pumping power needed. Most of the studies investigated this issue counted for smooth pipes; however, the rough pipes have larger friction factors and consequently larger pumping power penalty. To fulfill this gap, in this paper the rough pipes made of galvanized iron have been studied, rather than the smooth pipes. Particularly, Al_2O_3-water nanofluids running in commercial galvanized iron pipes have been considered. The studied variables are the nanoparticles concentration (0.01 – 0.1%) and nanofluid velocity in terms of Reynolds number (4000 - 100000). A multi- objective optimization method (ε method) is used to formulate and solve the problem considering the galvanized iron pipes roughness in order to maximize the heat transfer enhancement along with decreasing the pressure drop via manipulating the nanofluid concentration and velocity. The optimization results are plotted in a Pareto front whereby sets of trade-offs between the minimum pumping power and the maximum convective heat transfer are given along with the corresponding nanoparticles concentration and nanofluids velocity. The results indicate that at low nanoparticle concentrations, the extra pumping power is almost negligible; from Pareto front the minimum pumping power penalty along with maximum convective heat transfer can be attained for instance at a nanofluid velocity of 0.5 m/s and nanofluid concentration of 0.005. A linear relation between the maximum pressure drop and the nanofluid velocity is noticed.
Keywords: Rough galvanized pipes, Al_2O_3-water nanofluids, Convective heat transfer, Pumping power, ε multi- objective optimization method, Energy systems.

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