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Experimental study on the effect of bio-functionalized graphene nanoplatelets on the thermal performance of liquid flat plate solar collector

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Abstract
Synthesis of carbon-based working fluid involves toxic acids that are hazardous to the human and surrounding environment. In the current experimental investigation, thermal analysis of liquid flat plate solar collector was carried out using distilled water and environmentally friendly, covalent functionalized graphene nanoplatelets. Gallic acid was grafted on GNPs using the green free radical technique. Chemical characterization was analyzed using EDX and FESEM. Colloidal stability of GGNP nanofluids was found to be stable for more than 60 days. GGNPs were dispersed in distilled water with varying mass concentrations from 0.025 to 0.1%, and analysis was carried out for flow rate ranging from 0.5 to 1.5 L min−1 for different heat flux intensities and inlet temperature. The thermal performance of LFP solar collector augments with the surge in GGNP concentration, flow rate and heat flux intensities, whereas declines with the increase in reduced temperature parameter. Maximum thermal efficiency enhancement of 21.48%, 16.06% and 12.36% is achieved using 0.1%, 0.05% and 0.025% GGNP nanofluid than distilled water. A penalty in the form of a slight surge in pressure drop and pumping power was observed with a subsequent increase in GGNP concentration. The maximum increase in pressure drop and pumping power was about 0.85% and 0.567% for 0.1% concentration and mass flow rate 1.5 L min−1. A maximum reduction of about 25% in the size of the LFP solar collector area is attained using 0.1% GGNPs than base fluid. © 2021, Akadémiai Kiadó, Budapest, Hungary.

Author Keywords
Covalent functionalization; Graphene nanoplatelets; Green nanofluid; Liquid flat plate solar collector; Thermal analysis

Index Keywords
Drops, Free radicals, Graphene, Graphene Nanoplatelets, Pressure drop, Solar collectors, Sols, Thermoanalysis; Chemical characterization, Experimental investigations, Flat-plate solar collectors, Functionalized graphene, Solar collector areas, Surrounding environment, Temperature parameters, Thermal efficiency enhancement; Heat flux

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