Science for Environment Policy

Titanium dioxide-water nanofluids enhance the performance of solar collectors

Adding nanoparticles to water in solar collectors, which are used to capture the sun's energy, can considerably improve their performance, a recent study on nanofluids has found. The energy efficiency of the collector can be increased by up to 76.6% when using water containing 0.1% by volume of titanium dioxide nanoparticles, compared with water alone.

Energy from the sun is a renewable resource that can be harnessed to replace energy from fossil fuel sources. There are various types of solar energy systems that capture the sun's energy. One of the key components of these systems is a solar collector, which transforms sunlight into heat in water heating systems, and solar radiation into electricity in photovoltaic systems. A common type of solar collector is the flat plate solar collector, which transfers the heat it collects from the sun to a circulating, contained fluid.

Flat plate solar collectors, however, are not particularly efficient. One way to improve their efficiency is to replace the collector fluids that are typically used, such as water, with nanofluids.

Nanofluids are liquids containing a small quantity of suspended nanoparticles, which help boost the thermal energy conductivity of the liquid. In this study, the researchers evaluated the performance of a nanofluid made up of titanium dioxide nanoparticles suspended in distilled water.

Nanoparticles have a tendency to aggregate or form clusters and may settle down due to gravitational forces, making them less effective in enhancing solar energy absorption. To make the nanofluid, the researchers coated the nanoparticles with polyethylene glycol. This acts as a dispersant and stops the particles from aggregating. Then they used a high pressure system to evenly disperse the nanoparticles throughout the water.

After leaving samples of the nanofluids for 30 days, microscopic examination showed there was little tendency for the dispersed nanoparticles to group together in the nanofluid, and only small increases in nanoparticle sizes. This suggests the nanofluid would be stable when used in a flat plate solar collector, where liquid is constantly circulated in any case.

To test the prepared nanofluid, the researchers set up a flat plate solar collector angled to receive the maximum solar radiation, in Kuala Lumpur, Malaysia. They tested two concentrations of the nanofluid: 0.1% and 0.3% by volume of titanium dioxide nanoparticles in water. This was circulated through the solar collector at three different rates: 0.5, 1.0 and 1.5 kg/min.

From the results of the experiments, the researchers calculated two measures of energy to determine the efficiency of the collector. First, results showed that the energy efficiency (heat transferred from the sun) was increased by 76.6% (in relative terms) for a 0.1% (vol) nanofluid flowing through the collector at the rate of 0.5 kg/min, when compared with plain water.

Second, the exergy efficiency (a measure of available energy from the process, as some is lost through the system) was increased by 16.9% for the 0.1% (vol) nanofluid with a flow rate of 0.5 kg/min, compared with plain water.

The researchers did find a correlation between the volume of the nanofluid and the thermal conductivity, which increased proportionally between volumes 0.1% to 0.3%. The optimum volume was 0.3%, which increased thermal conductivity by up to 6%. This concentration could only be realised experimentally.

29 October 2015
Issue 433

Subscribe to free weekly News Alert

Source: Said, Z., Sabiha, M.A., Saidur, R., Hepbasli, A., Rahim, N.A., Mekhilef, S. & Ward, T.A. (2015). Performance enhancement of a Flat Plate Solar collector using Titanium dioxide nanofluid and Polyethylene Glycol dispersant. *Journal of Cleaner Production*. 92: 343-353. DOI:10.1016/j.jclepro.2015.01.007

Contact:
saidur@kfupm.edu.sa

Read more about:
Climate change and energy,
Environmental technologies

To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.

European Commission

Science for Environment Policy

Titanium dioxide-water nanofluids enhance the performance of solar collectors

(continued)

However, it was observed that nanofluids with lower % volume fractions yielded better results in terms of efficiency, as they disperse well, contain smaller sizes of nanoparticles, and show the least aggregation compared to larger volume fractions.

These results demonstrate that the addition of titanium dioxide nanoparticles to water can considerably improve the performance of flat plate solar collectors. Furthermore, the addition of the nanoparticles did not significantly affect the flow of the fluid, compared with plain water. Therefore, using nanofluid would not require more energy to be pumped around a solar collector system.

29 October 2015
Issue 433

Subscribe to free weekly News Alert

Source: Said, Z., Sabiha, M.A., Saidur, R., Hepbasli, A., Rahim, N.A., Mekhilef, S. & Ward, T.A. (2015). Performance enhancement of a Flat Plate Solar collector using Titanium dioxide nanofluid and Polyethylene Glycol dispersant. *Journal of Cleaner Production*. 92: 343-353. DOI:10.1016/j.jclepro.2015.01.007

Contact:
saidur@kfupm.edu.sa

Read more about:
Climate change and energy, Environmental technologies

To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.