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# Direct Absorption Process in an Annular Space for Innovative Solar Collector

Amar Hasan Hameed [1], Mohammed Yaseen Nawaf [2]
[1]KTO Karatay University, Faculty of Engineering, Mechanical Dept., 42020 Karatay, Konya, Turkey
[2]The University of Turkish Aeronautical Association, 06790 Etimesgut, Ankara, Turkey

New configuration for direct absorption solar collector has been developed. In the new configuration, none-circulated nano-fluid absorbs solar radiation through glass wall. The absorbed heat directly transfers to circulated water flowing inside copper tube submerged into the nano-fluid. Numerical model has been developed for flowing water, nano-fluid annular region and the copper tube which separates the two different fluids. Heat absorption of concentrated solar arrays reflected by parabolic trough is simulated as a heat source in the energy equation solved in nano-fluid region. Three size ratios of copper-to-glass tube diameters have been examined under same solar radiation. The efficiency of one meter of solar receiver unit with glass-to-copper tube size ratio of (1/2) increases significantly with flow rate up to 65%. Since, water flow rate changes increasingly affect the efficiency, heat convection at water side plays very important role. The size ratio of (1/4) shows slightly lower efficiency for all flow rates, while (3/4) size ratio shows very poor efficiency due to insufficient depth of absorption and reduced Reynolds number of water flow. Circulating water restricts the raising of nano-fluid temperature and in turn reduces thermal losses. At the side of nano-fluid, both optimal depth of absorption and characterized length of natural convection seem to be at size ratio of (1/2) or slightly less. Temperature rising per one meter decreases with flow rate despite of performance enhancing.

**Keywords:** Solar collector, direct absorption, concentrated solar collector, nano-fluid.

## 1. INTRODUCTION

Solar energy harvesting needs further development to reduce the consumption of fossil fuel due to its cost and its environmental concerns of burning it. However, solar collectors got extended interest from researchers, but still the incident heat of the sun faces multi stages of thermal resistances to flow of heat to the hand of the user. Direct solar absorber collector (DSAC) is a novel technique used recently for the new generation of solar collectors. Instead of using metallic tube painted with special spectral paint to absorb solar irradiation and transfer heat to a fluid inside the tube, flowing nano-fluid in a glass tube absorbs solar radiation directly and transport the absorbed energy as heat for usage. However, DSAC's are newly developed, many researchers studied the performance of these collectors numerically and experimentally and compared it with the normal solar collectors. Water was found as the best absorber for solar radiation among four liquids, namely; water; ethylene glycol; propylene glycol and therminol VP-1, which has been tested by Otanicar [1]. However, it is still a weak absorber, only absorbing 13% of the energy. The presence of nanoparticles promises superior capability for solar irradiation absorption since nanoparticles are generally opaque and may be black. Tyagi [2] observed that for non-concentrating flat-plate collector the presence of nanoparticles increases the absorption of incident radiation by more than 9 times over that of pure water. The efficiency of DAC by using nano-fluid has been found to be up to 10% higher than that of flat-plate collector. Nanofluids, even of low-content, has good absorption in direct absorption collector (DAC) compared with the base fluid or compared with coating absorber as has been demonstrated by Luo [3]. The model of Xu [4], consists of

*Email Address: dr.eng.amar@gmail.com