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Development of a polymer-based thermal collector for solar hot water system for arid climate domestic use

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The Saudi Arabia's Vision 2030's Renewable Energy Initiatives targets 9.5 GW of electricity generated from solar energy by 2030. This is to compensate the ever growing energy demand that could not be sustained by oil and gas in the future. Saudi Arabia is blessed with high solar radiation throughout the year, with an annual average daily global irradiance of 5.7 to 6.7 kWh/m2 [1]. This fact make it a very promising producer of solar power in the world. Energy saving and environmental sustainability through the use of solar energy is one of key importance in Saudi Arabia especially in the time of reducing oil-dependent economy. KSA is one of the highest energy user nation in the world with 8741 kWh/capita as compared to world average of 3104.7 kWh/capita. The utilization of solar energy to produce hot water for residential use can significantly reduce energy consumption in this sector. In Saudi Arabia, residential sector consumed about 52% of electrical energy from which around 30% of electricity cost goes to water heating. The main user for residential electricity is air conditioning which consumes 60% of electricity bills. Excessive space cooling has reverse effect on the required energy for water heating. Water is often cooled inside the walls of cooled indoor space, thus consuming extra energy. Much attention are needed to reduce electricity use through wall insulation, highly efficient AC units and solar water heater to save energy have been recommended. In this project, an alternative to metal-tubed thermal collector for solar hot water system (SHWS) is presented. Metal tubes experience thermal stress and scaling of heavy water due to long exposure to extreme sunlight especially during summer. As an alternative, polymer tubes were used. A 1 m by 2 m thermal collector with 2.5cm diameter PVC tubes arranged in rectangular spiral was developed. Metal brush was placed between the collector tubes and insulation layer to retain more heat in the collector box. The solar collector was tested under direct sunlight during the winter season with ambient temperature of 20oC between 10 am and 3 pm. Maximum water temperature of 70oC was achieved after over 2 hours of operation. Polymer materials are one of the main products in petrochemical industry in KSA. It is used in solar thermal absorber applications for many reasons including low cost, easy to fabricate and maintain as well as resistance to scaling from heavy water