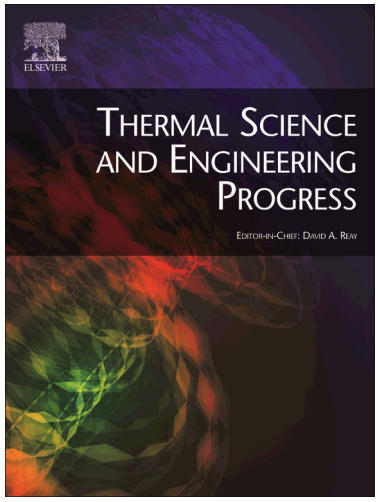

Performance of evacuated flat solar thermal collectors

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Performance of evacuated flat solar thermal collectors.

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Abstract

Heat losses from a flat panel solar collector can be significantly reduced by lowering the internal pressure to <0.5 Pa. Compared with conventional collectors, the resulting increase in efficiency is predicted to give a significant gain in annual heat output in the context of a temperate climate with low median irradiance.

Two experimental collectors were built and tested to investigate theoretical aspects of evacuated flat plates and develop appropriate technological solutions. One had a metal tray to the rear, the other used two sheets of glass. An array of pillars supports the glass against atmospheric pressure. The experimental procedure was designed to minimise measurement uncertainty. Testing under a solar simulator, with and without a vacuum, showed a sudden drop in heat loss as the pressure was reduced below 0.5 Pa. When evacuated the heat loss coefficient fell from 7.43 to 3.65 W/m^{2}K and the efficiency at a nominal test condition of ΔT = 60°C, G = 1000W/m^2 increased from 36% to 56%. Heat losses from absorber to glass were within 9% of the predicted level. This demonstrates that the heat loss mechanism is well understood.

Keywords: Solar thermal, flat plate, vacuum, evacuated, uncertainty.

Declarations of Interest: none.

Nomenclature

G	total (beam + diffuse) irradiance (W/m^2) measured perpendicular to collector
T_a	ambient temperature (°C)
T_{env}	environment radiative (sky) temperature (°C)
T_g	cover glass temperature (°C)
T_p	plate mean surface temperature (°C)
T_M	mean temperature difference $T_p - T_a$ (°C)