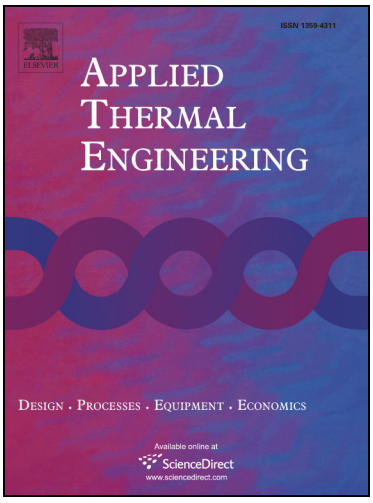

Design and fabrication of a hydroformed absorber for an evacuated flat plate solar collector

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Design and fabrication of a hydroformed absorber for an evacuated flat plate solar collector.

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Abstract

The concept of an evacuated flat plate collector was proposed over 40 years ago but, despite its professed advantages, very few manufacturers have developed commercial versions. The absorber is a key component of a flat plate collector: in the context of an evacuated panel, absorber design poses a number of technical challenges.

A flooded panel absorber has been designed for use in evacuated flat plate solar collectors. The aim was to obtain higher efficiency, in a low out-gassing material, than would be possible using a conventional serpentine tube design.

Initial plans for a micro-channel plate were modified when optimisation analysis showed that a flooded panel could achieve as good performance with easier fabrication. The absorber plate is made from hydroformed stainless steel sheets welded together and features an array of through-holes for the glass supporting pillars with the square panel sub-divided into two rectangles connected in series for ease of fabrication and better flow distribution. The coolant flow was modelled in Star-CCM+. FEM simulations based on tensile test data informed the choice of sheet thickness and weld radius around the holes to withstand the 1 bar pressure differential.

Hydroforming is an effective method for producing sheet metal components, e.g. plates for heat exchangers or solar absorbers. As a thermal engineering experimental technique, the tooling is significantly cheaper than press tools since the mould does not need a matching die. In a research context, the ability to form plates in-house and explore profile and tooling options at low cost is very useful and might find application in other fields such as experimental heat exchangers.

A hydroforming facility was built using 85 mm thick steel sheet and a 25 MPa hydraulic pump. This proved highly effective at forming 0.7 mm stainless steel sheet. A total of eight absorbers were fabricated and successfully leak tested using helium. Two variants were made: one kind for use in enclosures with a metallic rear tray, the other for enclosures with glass on both sides. The collector efficiency factor is estimated to be 3% higher than for commercial tube-on-plate designs.

Highlights

- Flooded panel design overcomes poor thermal conductivity of stainless steel
- Sufficiently uniform flow was achieved in each rectangular half-panel
- 0.7 mm annealed stainless plate was required to withstand the 1 bar pressure load
- Hydroforming trials at up to 48 MPa demonstrated the technique
- 8 absorbers were built and pressure tested