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DESIGN AND OPTIMIZATION OF BAFFLED FLUID DISTRIBUTOR FOR REALIZING TARGET FLOW DISTRIBUTION IN A TUBULAR SOLAR RECEIVER

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RÉSUMÉ

Solar energy, especially Concentrated Solar Power (CSP), is considered as one of the promising alternatives to conventional fossil sources. As a key component in current commercial or experimental CSP projects, tubular-type solar receiver is widely used because of its relatively low cost and long lifetime. However, the problem of fluid flow maldistribution (non-optimal distribution) is frequently encountered in CSP solar receivers due to their multi-tubular or multi-level configurations, consequently leading to "hotspot" and the reduced lifetime of the receiver. The optimal fluid flow distribution can be obtained by using the optimality criterion of identical temperatures on the centerline to minimize the peak temperature on the receiver, but how to realize such optimal distribution remains as an open question. This study presents an original method on the design and optimization of baffled fluid distributor for the realization of optimal fluid flow distribution in a tubular solar receiver. The basic idea is to install a perforated baffle in the inlet fluid distributor and to optimize the configuration of orifices on the baffle so as to approach the target flow distribution among downstream parallel tubes. A pressurized-air solar receiver comprising of 45 parallel tubes is used for study, with copper or Inconel 600 used as the filling material, as shown in Fig. 1.

Results show that the final fluid flow distributions realized by the geometrically optimized baffles are in good agreement with the target curves. The peak temperature on the receiver wall can be minimized accordingly by optimizing the flow distribution (from 753.2 K to 747.8 K for the copper case, and from 1322.8 to 1086.4 for the Inconel 600 case). The total pressure drop of the solar receiver system with insertion of optimized baffle is about 0.21 bar for the copper case, and about 0.41 bar for the Inconel 600 case. The pressure drop increase due to the baffle insertion is relatively moderate (0.04 bar for the copper case; 0.24 bar for the Inconel 600 case). It is shown that the insertion of a geometrically optimized baffle is generally a practical solution with various features: capable of realizing non-uniform target distribution; small pressure drop increase; compact geometry; flexible and adaptive; easy fabrication with a reasonable cost, etc.

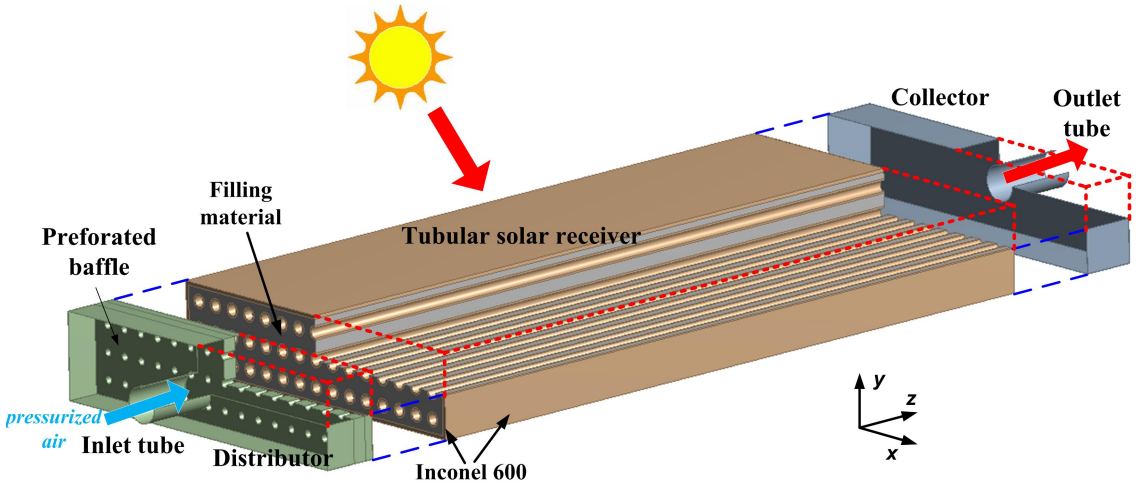

Fig. 1: Schematic view of the tubular solar receiver equipped with an inlet fluid distributor and an outlet fluid collector.

Mots Clés : *Flow distribution; Tubular solar receiver; Perforated baffle; Optimization method; Pressure drop*