ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Reduction in convective heat loss from a bladed receiver using an air curtain

Farzin Ghanadi[1], Juan F. Torres[2], Maziar Arjomandi[1], John Pye[2]

[1] *Centre for Energy Technology, School of Mechanical Engineering, The University of Adelaide, Adelaide SA Australia*

[2] *Research School of Engineering, ANU, Canberra ACT, Australia*

The convective heat loss is highly nonlinear and very complex to reduce in open-ended configurations such as solar receivers with oriented tube banks in the form of blades. The aim of this study is to reduce convective heat loss from a bladed receiver through application of an air curtain. A few amount of research studies have focused on high-temperature receivers employing cavity-based geometries using a downward air jet for redistribution of heat to the cavity internal wall [1]. These studies show that the jet momentum for air curtain needs to be strong enough along the hot surface of receivers to withstand the upcoming air flow. It was found that the localised pressure drop in the vicinity of the cavity opening has a significant effect on the stability of the air curtain. Thus, the jet angle is also a critical parameter for optimal sealing. While the potential application of downward air curtain as an aerodynamic seal for a cavity has been demonstrated in the literature, no experimental attempts to quantify the efficiency of the proposed method yet exists. In this study, a scaled model of the bladed receiver consists of a box with a rectangular face was tested in a wind tunnel. The bladed 'receiver' section is composed of three blades with a thickness of 3 mm and blade depth to spacing ratios of 1, 2 and 3. The removable/replaceable blades are mounted protruding normally from the aluminium base of dimensions of 300 mm × 300 mm. Four mineral insulated strip heating elements are mounted immediately behind the base plate. A closed-loop control system was used to adjust the electrical power to each heating element, to maintain constant uniform temperatures of either 100°C or 200°C. All measurements were conducted in the open-jet section of a large wind tunnel at the University of Adelaide with a test section of 5.5 m length and a cross-section of 2.75 m × 2 m. Both mixed and forced convective heat losses were analysed when the wind speed varied from 3 to 6 m/s. As shown in Figure 1, the air curtain is generated by a mini-low speed wind tunnel (MLSWT). The outlet section of MLSWT is adjustable and then the angle of the air jet (θ) can be changed from 0 to 20°. The outcomes of the present study provide an understanding of the relationship between the characteristics of the air jet and the heat loss from the receiver which represents an area of important future work to enable robust design of air curtain-equipped solar thermal cavity receivers.

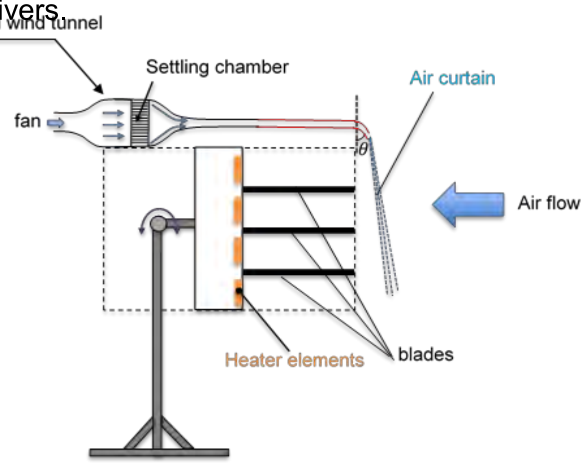

Figure 1. Schematic of experimental rig located in the wind tunnel at the University of Adelaide

[1] McIntosh, A., Hughes, G. and Pye, J, 2014, 'Use of an Air Curtain to reduce Heat Loss from an Inclined Open-Ended Cavity', 19th Australasian Fluid Mechanics Conference, Melbourne, Australia.