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Letter

Effect of Inclined Ribs on Heat Transfer Coefficient in Stationary Square Channel

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HIGHLIGHTS

- The ribs with square cross section were used to place on two side walls for study.
- Three different types of rib arrangement for inclined ribs, V-shaped ribs and inverted V-shaped ribs were investigated.
- The results showed that the average Nusselt number on surface with rib inclined angle at 60°, 45° and 60° V-shaped ribs was improved up to about 20%, 25% and 30% higher than case of angle 90o and the rib inclined angle at 60° V-shaped ribs provided the highest Nusselt number covering largest area when compared to the othercases.

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ABSTRACT

The main objective of this research is to study the effect of rib arrangement on the distributions of the local heat transfer coefficient in a stationary channel. In this study, the ribs with square cross section were used to place on two side walls for study. The rib height-to-hydraulic diameter ratio (e/D_h) and the rib pitch-to-height (p/e) ratio were fixed at 0.133 and 10, respectively. Three different types of rib arrangement for inclined ribs, V-shaped ribs and inverted V-shaped ribs were investigated. The rib angle of attack (α) was varied from 30° to 90° for inclined ribs and 45° and 60° for both V-shaped and inverted V-shaped ribs, and compared at constant Reynolds number Re=30000. Thermal Liquid Crystal sheet was applied for evaluating the heat transfer distributions. The results showed that the average Nusselt number on surface with rib inclined angle at 60°, 45° and 60° V-shaped ribs was improved up to about 20%, 25% and 30% higher than case of angle 90° and the rib inclined angle at 60° V-shaped ribs provided the highest Nusselt number covering largest area when compared to the other cases.

The demand for gas turbine engines with higher thermal efficiency and power output is required to cut fossil fuel consumption and CO_2 emissions. One of the general ways is by increasing the turbine inlet temperature (TIT) which current advanced gas turbines operate at TIT up to about 1700°C. Hence, it need effective cooling technologies to enhance heat transfer distribution with small amount of cooling air, such as rib-roughened passage flow cooling, impingement cooling, film cooling and pin-fin cooling shown in Fig. 1.

Ribs are generally installed on cooling channel for internal cooling of gas turbine blades. Many researchers have studied both flow and heat transfer characteristics for rib attachment for different rib arrangements in different aspect ratio of channel. For example, Han et al. [1, 2] studied the effect of rib inclined angle (α) and rib pitch-to-height (p/e) on the heat transfer coefficient and pressure drop in a rectangular channel with rib attachment on two opposite side walls. They found that the maximum heat transfer distribution and friction factor occur at the pitch-to-height ratio of 10 with rib inclined angle of 60° when compared to the other rib arrangement case. One of the earlier studied on the heat transfer distribution and friction factor for case of rib angle of 90° and 45° V-shaped ribs with a fixed pitch-to-height ratio p/e=10 in a square channel was carried out by Taslim et al. [3]. They explained that the heat transfer enhancement and friction losses with inclined rib at angle 45° and V-shaped ribs

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