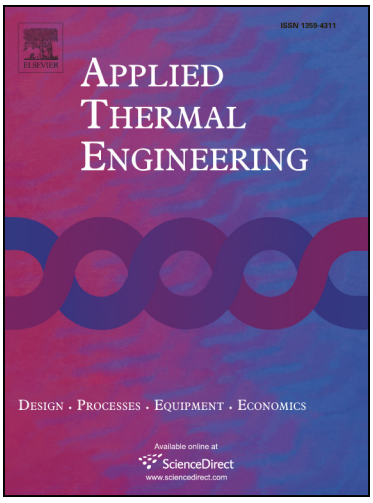

Experimental Investigation of the Effect of Compound Protrusion-Pin Array on Heat Transfer in an Internal Rotating Cooling Channel

Ankith Ullal, Shuo-Cheng Hung, Szu-Chi Huang, Yao-Hsien Liu

PII: S1359-4311(17)37781-5
DOI: https://doi.org/10.1016/j.applthermaleng.2018.05.019
Reference: ATE 12158

To appear in: *Applied Thermal Engineering*

Received Date: 8 December 2017
Revised Date: 23 April 2018
Accepted Date: 7 May 2018

Please cite this article as: A. Ullal, S-C. Hung, S-C. Huang, Y-H. Liu, Experimental Investigation of the Effect of Compound Protrusion-Pin Array on Heat Transfer in an Internal Rotating Cooling Channel, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.05.019

Experimental Investigation of the Effect of Compound Protrusion-Pin Array on Heat Transfer in an Internal Rotating Cooling Channel

Ankith Ullal[1], Shuo-Cheng Hung[2], Szu-Chi Huang[2], Yao-Hsien Liu[2]

[1]Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University, Houghton, USA

[2]Department of Mechanical Engineering, National Chiao Tung University, Hsinchu, Taiwan

ABSTRACT

An experimental investigation was conducted to study the effect of protrusions and their combination with pins on heat transfer enhancement in a rotating internal passage with an orientation angle of 90° for Reynolds numbers (Re) of 10000 and 20000. The trailing surface showed the highest Nusselt number (Nu). The highest and lowest local Nusselt number was at the front and back of the protrusion respectively. A short disturbed wake region was observed behind the protrusion as a result of complex three dimensional flow. Addition of pins in the configuration resulted in an increase of the average Nusselt number, specifically a 35%, 50% and 142% for trailing, static and leading surfaces respectively, compared to protrusions only case for Re of 10000. On removal of the third column of protrusions, average Nusselt number showed a decrease of 8.25%, 3.1% and 2.3% for trailing, static and leading cases respectively, compared to the protrusion-pin case for Re of 10000. It also caused elongation of the stagnation and wake flow fields around the fourth column comprising of pins. Pressure drop results indicated that the protrusion only case was the lowest compared to protrusion-pin.

Keywords: protrusion, pin, liquid crystal technique, internal cooling, rotating rig

NOMENCLATURE

C : Gap distance (clearance) between the endwall and fin
d : Pin-fin/protrusion diameter
D_h : Hydraulic diameter
f : Friction factor
f_0 : Friction factor for smooth channel
h : Heat transfer coefficient
h_p : Protrusion height
H_p : Pin-fin height
k_{air} : Thermal conductivity of air