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CFD analysis of slot jet impingement cooling on concave surface

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ABSTRACT

2 dimensional CFD simulation of slot jet impingement cooling on concave surface is reported using Ansys FLUENT Post software at specified geometry and boundary conditions. Realizable k-ª model has been used for resolving the turbulence.It has been observed that the results obtained from CFD model are in good agreement with that of the experimental results.

Key words: Heat transfer, Computational Fluid Dynamics (CFD), contours.

INTRODUCTION

CFD has now become an integral part of the engineering design and analysis[2-3]. Engineers can make use of the CFD tools to simulate fluid flow and heat transfer phenomena in a design and predict the system performance before manufacturing. The advantages of CFD are numerous, namely, fewer iterations to the final design, shorter time to launch the product, fewer expensive prototypes and so on.

Furthermore, CFD provides a cost-efficient means of testing new designs and concepts that would otherwise be too expensive & hazardous to investigate.

CFD analysis

2 dimensional CFD simulation of slot jet impingement cooling on concave surface is performed using Ansys FLUENT Post software. Geometry and boundary conditions are obtained from [1] .

Details on Boundary Conditions

Inlet

Inlet velocity = 3.48933 m/s
Temperature = 300K
Turbulent intensity = 10%
Hydraulic diameter = 0.06 m

Heated wall

Heat Flux = 10000W/m^2

Wall and nozzle walls

Adiabatic

Outlet

Pressure-outlet

Solver setting

Pressure-velocity coupling = SIMPLE

Discretization

Pressure $\rightarrow$ Standard
Momentum $\rightarrow$ Second Order Upwind

Turbulence Kinetic Energy → Second Order Upwind
Turbulence dissipation rate → Second Order Upwind
Energy → Second Order Upwind

Under relaxation factors

Pressure → 0.5
Density → 1
Body Forces → 1
Momentum → 0.5
Turbulence Kinetic Energy → 0.6
Turbulence dissipation rate → 0.6
Turbulence Viscosity → 1
Energy → 1

RESULTS AND DISCUSSION

Temperature contours (K)

These are shown in the figure 1, 2 & 3. It has been observed that The maximum temperature exist in the zone which is far away from the stagnation point.

Nusselt Number Profile Comparison

2 dimensional CFD simulation of slot jet impingement cooling on the concave surface is reported using Ansys FLUENT Post software at the required and specified boundary conditions. The Nusselt number profile comparision at Z/B = 4 and

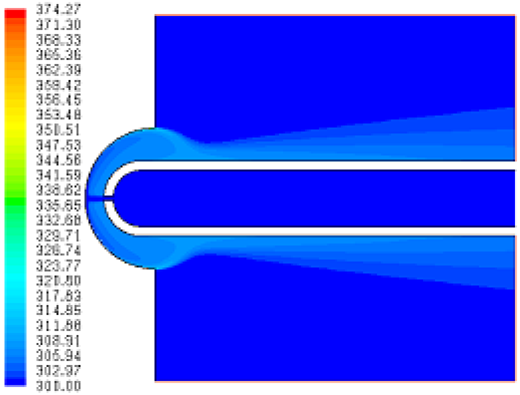

Fig. 1:

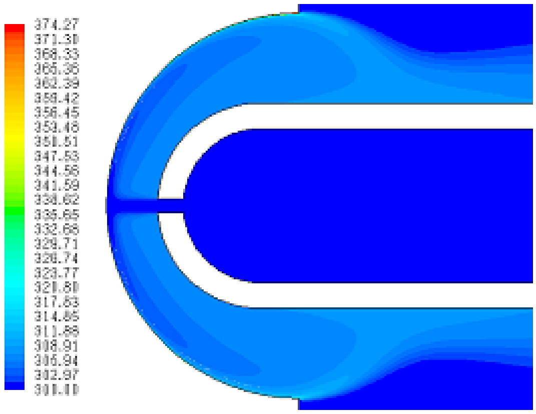

Fig. 2:

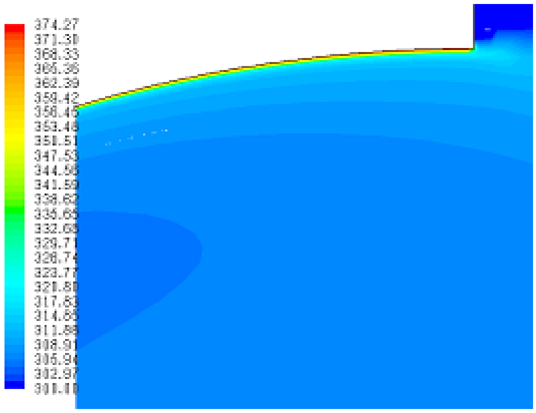

Fig. 3:

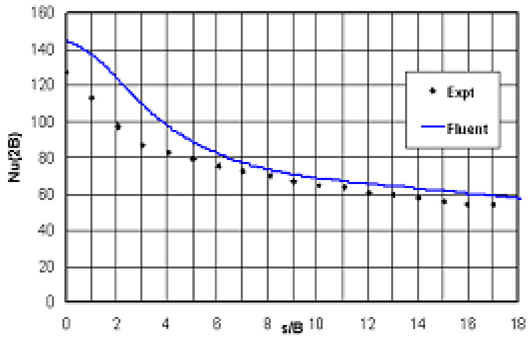

Fig. 4 : Variation in Nusselt number at Z/B = 4 and Reynolds number = 23400

Reynolds number of 23400 is as shown in the figure 4. It is observed from the figure 4 that the Nusselt number in CFD analysis is in good agreement compared with the experimental results.

CONCLUSIONS

The results obtained from the CFD analysis and experimental results are quite close to each other.It clearly indicates that model developed in CFD analysis is in good agreement with experimental values thereby,validating the procedure for formulation of model using CFD . This procedure can be adopted with confidence for predicting the values for any kind of surface.

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