7 CONCLUSIONS AND FUTURE SCOPE

7.1 Conclusions

From entire investigations, following conclusions are drawn.

Nusselt Number distribution

- The local Nu distribution along Y axis is follows symmetry and symmetry is seen to be unaffected to changes jet inclination.
- As inclination angle decreases, the coolest points with heat transfer shifts to downhill side of target plate and observed for 15 to 75 degree jet inclination.

Average Nusselt Number

- The inclination of 45 and 60 Degree shows the better cooling compared to jet inclinations of 15, 30 and 75 Degree.
- It is concluded that average Nusselt Number decreases with decrease in angle of jet inclination.

Maximum Nusselt Number

- For inclinations of 75 and 60 Degree almost the performance is same and getting maximum Nu_{max} up to 300, by producing cold spots on target surface. For 45 degree jet impingement, the Maximum Nu_{max} is widely spread.
- It is clearly seen that as AR increases, Nu_{max} also increases.
- It is concluded that as diameter increases, the Maximum Nusselt Number also increases drastically.
- Also the Nusselt number on target surface reduces along the wall in flow direction.
- As Reynolds number increases, the maximum Nusselt Number shifts nearer to leading edge.

Position of Maximum Nusselt Number

- This indicates that at higher angle ratio, angle is dominating parameter compared Reynolds Number.
- At lower angle ratio, the inclined jet with higher Reynolds number is giving the cooling point away from leading edge.
- Maximum Nusselt Number position almost remains unchanged for a specific angle and target to jet height.
- It is observed that for a particular angle of incident location of maximum Nusselt Number, measured from leading edge of target is ahead than that of stagnation point in stated condition.

Center line temperature analysis (For D=16mm)

- The location of minimum temperature during cooling by jet impingement, goes to downhill side for jet impingement with an angle of 75,60,45,30 and 15 Degree.
- The phenomenon of fluid jump is observed at 30 Degree inclination at beyond X/D of 13.
- Cooling increase up to X/D = 5, and then it declines.
- The variations of dimensionless temperature ratio and dimensionless (X/D) is giving almost similar trends for all range of Reynolds number at jet inclinations of 15, 45 and 75 Degree.
- By this coolest point is seen at (X/D) of around 5 to 7. But at high Reynolds Number, because of high momentum of flow, coolest point is at extreme end of target plate (X/D = 13 above).
- Reynolds Number is having lesser impact on cooling performance related to cold spot analysis.

Temperature profile of a target

- During analysis of temperature profile of a target, it is concluded that apart from geometrical stagnation distance and nearby region, the temperature profile is

shows large variations in temperature, which is difficult to predict owing to boundary effects.

The Enhancement Factor (EF)

- It will be difficult to predict effect of H on Enhancement Factor, especially for inclined jet cooling with changing angle and Reynolds Number.
- Average EF is highest for inclination of 45 Degree.
- The effect of inclination on average Nusselt number is invalidated at Reynolds Number below 8000.
- Optimisation tequnices are showing thet 16mm diameter of jet at inclination of 60 and 45 Degree inclination are giving highest cooling results.

7.2 Future scope

Variety of fluids can be investigated in jets. The fluid like nano particle fluids, other gases like Argon. Nitrogen can also be investigated. These fluid are having various thermo physical properties and will effect on heat transfer characteristics of target. But these are to be investigated by using confined jets due to experimental constraints. More number of inclined jets, at cross locations to each other, micro inclined jets will give different results by creating turbulence in wall jets. Jets with different orientations and positions, opposite jets will be giving another physical system varying heat transfer. The inclined jets can be used in LED cooling, PCB cooling, turbine blade cooling, etc.

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