Experimental Investigation of Heat Transfer Distribution Due to Impinging Synthetic Jet

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ABSTRACT

The implementation of synthetic jets for use in the cooling of electronics is a relatively new technology. It is well established that effective rates of cooling can be achieved using conventional steady flow impinging jets. However it has been shown that synthetic jets can deliver similar cooling effects without the need for an air supply system and therefore represent an extremely promising alternative for thermal management applications. An experimental investigation has been undertaken to study the heat transfer distribution to an impinging synthetic jet flow. The jet is directed on to a thin SS foil heater, which approximates a uniform wall temperature. Nusselt number profiles generated by the synthetic jet for various driving frequencies and for different distances between heater plate and jet orifice were obtained. It is well established fact that for continuous jets mean heat transfer distributions have a direct relation to jet velocity profiles, however, for synthetic jets, the present investigation shows the fluctuations in local heat flux and strong dependence on the driving frequency

Categories and Subject Descriptors
ECD-Electronic Devices & Circuits

General Terms
Measurement, Performance, Design, Experimentation.

Keywords
Impinging synthetic air jets, *Heat* transfer, cooling, Nusselt number, Orifice.

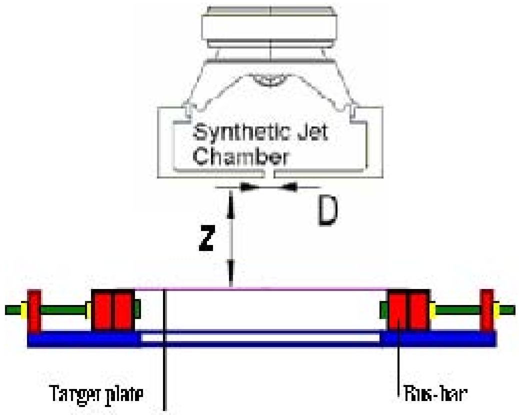
1. INTRODUCTION

Impinging synthetic air jets can be used to transfer heat in applications ranging from the cooling of a manufacturing process to the thermal management of electronics, in particular microprocessors. This latter application is increasingly important as current trends in electronic components show a continuous increase in heat flux densities as both processor clock frequency and the numbers of transistors required for a given implementation grow. This increase has led to an even greater need for more efficient and higher density heat removal in closely packed systems; this need is predicted to continue to grow by a factor of two every four years for the foreseeable future. While forcing more air through the system or designing an elaborate heat sink can sometimes meet increasing thermal demands, there is not only a significant cost increase associated with more elaborate solutions but also environmental regulations can limit system (fan) noise. It is for this reason that we are looking to new technologies such as synthetic jets to reduce both the cost per watt of heat dissipated and the environmental noise produced by these systems.

2. THEORY

Synthetic jets operate on a simple principle; a flexible membrane forms one side of a partially enclosed chamber. Opposite to the membrane is an opening, such as an orifice. A mechanical actuator, piezoelectric diaphragm or magnetic coil causes the membrane to oscillate and periodically force air into and out of the opening. These results in a non-zero mean stream wise pulsating jet formed in front of the orifice which can be directed at a heated surface to enhance cooling. Average heat transfer characteristics using isothermal heaters varying few parameters like Reynolds number, jet-to-plate distance and frequency. However, there are many other factors like, nozzle configuration, shape of the nozzle, size of the nozzle, orientation of the target surface, curvature of target surface, etc. Hence, the present study focuses on the experimental investigations to study the local heat transfer and fluid flow characteristics of impinging synthetic air jet for various configurations.

3. PROPOSED WORK



The present study focuses on the experimental investigations to study the local heat transfer characteristics of impinging synthetic air jet.

4. RESULTS & DISCUSSION

Experimental investigations are carried out for local heat transfer distribution due to impinging synthetic jet. The diameter of the orifice is kept constant at 3mm and jet to plate distances are varied (Z/d=4.5.6) for each of the configuration, the frequency is varied from 100 to200Hz. Local temperature distribution are obtained using IR sensor of fluke make model 566.flow visualizations studies in the synthetic free jet are also made. The major results are discussed as follows.

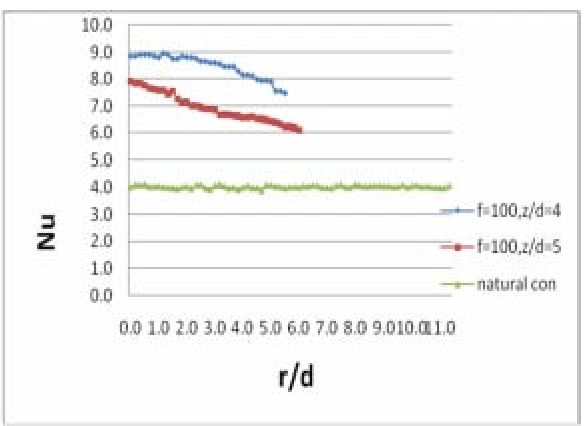


Fig 4.1

Figure 4.1 shows the variation of Nusselt number for various r/d ratios, for the constant frequency of actuation (f=100Hz) and Z/d ratios of 4&5,it is observed that Nusselt number are higher for Z/d=4 than that of Z/d=5 at all radial locations.

5. CONCLUSION

Experimental investigations are carried out for local heat transfer distribution due to impinging synthetic jet. The diameter of the orifice is kept constant at 3mm and jet to plate distances are varied (Z/d=4.5,6,9) for each of the configuration, the frequency is varied from 100 to225Hz.

Hence conclusion can be drawn from the above result that heat transfer enhancement is quite possible by impinging synthetic jet. Investigation can be still improved by altering the design of synthetic jet cavity, orifice diameter, diaphragm,& height of the cavity. The study greatly influences the heat transfer characteristics, this technology can be further used for cooling of electronic components effectively. This is primarily because of generation of jet locally without the compressor.

6. REFERENCES

[1] Dr. V. V. Katti &Prabhu S. V.(2007) Experimental study and theoretical analysis of local heat transfer distribution between smooth flat surface and impinging air jet from circular straight pipe nozzle.

[2] B.L.Smith, A. Glezer, The formation and evolution of synthetic jets, Physics of Fluids 10 (1998) 2281–2297.

[3] D.C. McCormick, Boundary layer separation control with directed synthetic jets, AIAA Paper 2000-0159, 2000.

[4] W. Hwang, J.K. Eaton, Creating homogeneous and isotropic turbulence without a mean flow, Experiments in Fluids 36 (2004) 444–454.

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