International Journal of Scientific Research and Management Studies (IJSRMS)
ISSN: 23493771 **Volume 1 Issue 9, pg: 297-300**

REVIEW ON A HEAT TRANSFER CHARACTERISTICS OF PULSATING FLOW

Siddhanath V. Nishandar[1], R.H.Yadav[2]
[1]Student, [2]Asst. Professor,
Dr. J. J. Magdum College of Engineering, Jaysingpur, Maharashtra, India

ABSTRACT

New and efficient heat transfer enhancement techniques are an important requirement from many industries. Research on heat transfer enhancement is carried out by many researchers. In last few years many researchers working on heat transfer enhancement are attracted towards the new technique known as pulsation. Fluid pulsation is an active type of heat transfer enhancement technique where external aid is required and can be adapted for many applications. The aim of this paper is to provide a review on heat transfer enhancement in a fluid flow through a pipe with pulsating and also other aspects of pulsating.

KEYWORDS: *Heat transfer enhancement, Pulsation, Heat transfer characteristics*

I. INTRODUCTION

Several techniques for heat transfer enhancement have been introduced to improve the overall thermal performance of heat exchangers resulting in the reduction of the heat exchanger size and the cost of operation. In general, the heat transfer enhancement techniques can be classified into two methods including active method (requires external power source) and passive method (not requires external power source). The mechanism for improvement of heat transfer performance in the passive method is promoting the turbulence near the tube wall surface to reduce the thermal boundary layer thickness. This turbulence introduces a chaotic fluid mixing which acted by several enhancing modified tubes such as a finned tube, tube with rib, tube with spirally roughened wall, corrugated tube, fluted tube, helical tube, elliptical axis tube and micro-fin tube, etc.

Active techniques, which require an extra external power source, include mechanical aids, surface vibration, fluid vibration, fluid pulsation, electrostatic fields, injection or suction of fluid and jet impingement. Consideration about tube heat transformation in the inner gradient of temperature was mainly concentrated on the boundary layer, if boundary layer could be broken effectively and the thermo-resistance which lay in laminar boundary layer or turbulence sub layer could be diminished, we could enhance local heat exchange coefficient and intensify heat exchange process by convection.

Thinking of such notion, one such technique that has been widely used in industry is the use of flow pulsation in the tube. In a pulsatile flow, boundary layer thickness is altered when pulsation is forced on the flowing fluid. The velocity gradient is much higher for pulsatile flow at the tube wall compared to steady flow thereby producing a much higher heat transfer for the former compared to the latter.

The pulsating flow includes the steady and time-dependent velocity component. Typical and natural examples of pulsating flows are the arterial flows in the human body. Pulsating flow and heat transfer occur in many industrial applications, such as pulse combustor, pulse tube cry-cooler, cooling system of nuclear reactor, pulse-jet and compressors, electronic cooling, metallurgy, aviation, chemical, food technology etc.

The pulsating flow parameters affect the performance of many thermal engineering applications. When pulsations are applied to the flow, then a change in heat transfer to or from it can be expected, because the pulsation would change the thickness of the boundary layer and thus the thermal resistance. From this perspective, an increase in the heat transfer due to the decreasing of the boundary layer thickness is expected. Therefore, recently, great interest is being evinced in studying the effects of pulsating flow on convective heat transfer.

II. LITERATURE REVIEW

Many researchers have presented experimental, numerical and analytical studies on the effect of pulsation on heat transfer characteristics. Experimental investigations on laminar pulsating flow have been performed by researchers.

Among these studies, Mamayev et al. [1976] found that, at low frequencies the heat transfer rate for pulsed air flow is lower than that of the steady flow. As frequency increased, the relative heat transfer coefficient also increased. Flow and heat transfer characteristics in a pulsating pipe flow are also studied by different researchers. Kearney et al. [2001] experimentally investigated the time-resolved structure of a thermal boundary layer in a laminar pulsating channel flow. They reported that differing degrees of flow reversal showed that the primary impact of reversed flow is an increase in the instantaneous thermal boundary layer thickness and a period of decreased instantaneous Nusselt number. They concluded that flow reversal is not necessarily a requirement for enhancement.

Habib et al. [2002] experimentally investigated the characteristics of laminar pulsating flow within a tube or channel under uniform constant heat flux. An increase as well as a reduction in Nusselt number has been reported, depending on both Reynolds-number and frequency. Zheng et al. [2004] experimentally studied the heat transfer enhancement with pulsating flow. Mostafa et al. [2005] experimental study for forced convection heat transfer laminar pulsating flow inside a tube was studied by the amount of heat transfer declines in the case of laminar flow, compared with steady flow. Flow pulsation reportedly causes a decrease in Nusselt number, about 22 % of the average value than the steady flow.

Hesham et al.[2005] experimentally investigated pulsating turbulent pipe flow uniform heat flux. The results showed an increase and reduction in the mean Nusselt number with respect to that of the steady flow. Many parameters have an influence on heat transfer characteristics of pulsating turbulent flow. Among those, pulsation frequency, its amplitude, axial location, Reynolds number, Prandtl's number and pulsator type and its location. In order to understand the phenomena of the effect of pulsation on the heat transfer coefficient and to resolve these problems of contradictory results, different models of turbulence for pulsating flows were considered. Zohir et al. [2006] investigated the heat transfer characteristic inside a pipe for a wide range of Reynolds numbers. They defined the range of improvement of heat transfer coefficient with pulsating flow for both laminar and turbulent flow regimes.

Elsayed et al. [2008] investigated experimentally the heat transfer characteristics of pulsating turbulent air flow in a pipe heated at uniform heat flux were experimentally investigated. The experiments were performed over a range of $104 < Re < 4 x104$ and $6.6 \leq f \leq 68$ Hz. This situation finds applications in modern power generation facilities and industrial processes.

With installing the oscillator downstream of the tested tube exit, results showed that Nu is strongly affected by both pulsation frequency and Reynolds number. Its local value either increases or decreases over the steady flow value. The variation is more pronounced in the entrance region than that in the downstream fully developed region. It is observed also that the relative mean Nu either increases or decreases, depending on the frequency range. Although the deviations are small, it seems to be obvious at higher values of Reynolds number. The obtained heat transfer results are classified according to turbulent bursting model and looked to be qualitatively consistent with previous investigations.

Wang et al. [2014] studied riction and heat transfer characteristics of pulsating flow induced by rolling motion. In the present study the flow rate is adjusted through control the impeller rotator speed of the pump. The results show that the flow rate pulsation simultaneously with the rolling motion and the relative amplitude of the flow rate pulsation decreases with the increasing flow rate.

III. CONCLUSIONS

From this review, it can be observed that, due to variety of heat transfer control parameters, previous work showed conflicting results for effect of pulsation on heat transfer.

- Some investigators reported increases in heat transfer due to pulsated flow. While others reported little increase, no increase, and even decrease in heat transfer.
- Many parameters have an influence on heat transfer characteristics of pulsating turbulent flow. Among those, pulsation frequency, its amplitude, axial location, Reynolds number, Prandtl's number and pulsator type and its location. Out of which pulsating flow parameters such as frequency and amplitude have a major impact on the performance of heat exchangers used in many engineering applications.
- Pulse flow could enhance heat exchange and improve average heat exchange coefficient noticeably.
- Pulsation source could improve heat exchange coefficient by convection when it was located in the upstream, but when it was located in the downstream that didn't have any patent distinction with heat exchange by invariableness flow.
- The pulsation source could reduce heat exchange coefficient by convection when it was located in the downstream, which also weakened heat exchange
- Pulse flow might enhance or weaken heat exchange that lied on flow parameter
- The time average Nusselt number of a laminar pulsating internal flow may be higher or lower than that of the steady flow one, depending on the frequency.
- There is a huge scope in this area for further research work.

REFERENCES

[1] Mamayev, V.V., Nosov, V.S. and Syromyatnikov N.I., "Investigation of heat transfer in pulsed flow of air in pipes", Heat Transfer-Soviet Research, Vol. 8, No. 3, pp. 111–116, 1976.

[2] Kearney, S.P., Jacobi, A.M. and Lucht, R.P., "Time-resolved thermal boundary layer structure in a pulsatile reversing channel flow", ASME Journal of Heat Transfer, Vol. 123, No. 4, pp. 655–664. 2001.

[3] Habib M.A., Attya A.M., Eid A.I. and Aly A.Z., "Convective heat transfer characteristics of laminar pulsating pipe air flow", Heat and Mass Transfer, Vol. 38, No. 3, pp. 221–232, 2002.

[4] Zheng, J., Zeng, D., Wang, P. and Gao, H., "An experimental study of heat transfer enhancement with pulsating flow", Heat Transfer-Asian Research, Vol. 23, No. 5, pp. 279–286, 2004.

[5] Mostafa, H. M., Torki, A.M. and Abd-Elsalam, K. M., "Experimental study for forced convection heat transfer of pulsating flow inside horizontal tube", 4th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics, Cairo, Egypt, paper no. AK3, 2005.

[6] Hesham, M., Mostafa, A., Torki, M., Abd-Elsalam, K.M., Experimental study for forced convection heat transfer of pulsating flow inside horizontal tube. In: Fourth International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics. Cario, Ak3.2005

[7] Zohir, A.E., Habib, M.A., Attya A.M. and Eid, A.I., "An experimental investigation of heat transfer to pulsating pipe air flow with different amplitudes", Heat and Mass Transfer, Vol. 42, No. 7, pp. 625–635, 2006.

[8] Elsayed A.M. Elshafei, M. Safwat Mohamed, H. Mansour, M. Sakr, "Experimental study of heat transfer in pulsating turbulent flow in a pipe" International Journal of Heat and Fluid Flow,29 ,1029–1038,2008.

[9] Chang Wang, Xiaohui Li, Hao Wang·Puzhen Gao[b,] "Experimental study on friction and heat transfer characteristics of pulsating flow in rectangular channel under rolling motion" Progress in Nuclear Energy**,**Volume 71, March 2014, Pages 73–81,2014.

AUTHORS SHORT BIOGRAPHY

S. V. Nishandar was born in Sangli, India, in Year 2011. He received the Bachelor in Mechanical Engg degree from the University of Kolhapur, city, in Year. He / She is currently pursuing the M.E. degree with the Department of Heat Power Engineering, City. His research interests include heat transfer optimization.

R. H. Yadav was born in Sangli, India. He received the Bachelor in Mechanical Engg degree and Master degree in Heat power Engg. His research interests include heat transfer optimization and heat transfer techniques.