REVIEW PAPER ON RATE OF HEAT TRANSFER ENHANCEMENT BY USING VORTEX GENERATOR

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ABSTRACT

In the world of advance technology and scientific evolution here effectively created Longitudinal Vortex Generator arrangement which will help to improve heat transfer through multiple longitudinal vortex generators. This project carries longitudinal vortex generator arrangement and hot air passed through this arrangement so heat transfer takes place because of friction occurred at the longitudinal vortex. This project uses hollow tube with longitudinal vortex arrangement with encapsulation with insulating material to avoid heat loss. To identify temperature at the vortex layer a particular temperature detector arrangement used. This project can be use at aero plane panels, navigation, railways and refrigeration and evaporation assembly. Heat exchangers are widely used in many industrial systems e.g. Aerospace, Transportation, Electronics cooling, etc. In such systems, the main challenge is to design ultra compact heat exchangers with low cost and less environmental impact. The common method of reducing the air-side thermal resistances are by increasing the surface area of the heat exchanger, but it leads to increase in material cost and increase in volume of the heat exchanger.

Keyword: - *Heat transfer, High-performance thermal system, Thermal boundary layer, Vortex Generator, Winglets, Winglet pairs.*

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1. INTRODUCTION

Heat exchangers are widely used in many industrial systems e.g. Aerospace, Transportation, Electronics Cooling, etc. In such systems, the main challenge is to design ultra compact heat exchangers with low cost and less environmental impact. The common method of reducing the air-side thermal resistances are by increasing the surface area of the heat exchanger, but it leads to increase in material cost and increase in volume of the heat exchanger. The design limitations of different heat exchangers require innovative approaches to further reduce the volume, material cost, and flow noise. One of the best methods to reduce boundary layer thickness is by the generation of passive vortices. In this technique the flow field is changed by an obstacle to generate a vortex which leads to reduction in the thermal boundary layer. Longitudinal vortices causes increase in heat transfer rate against small expense of the additional pressure loss. The sole effect of such vortices is an average increase in the heat transfer. Because the air-side thermal resistance is dominant, even modest enhancements in the air-side thermal-hydraulic performance could lead to smaller, lighter, and more energy efficient systems. Thus reason to use vortex generators is to generate secondary flow in the direction of fluid flow which could disturb the thermal boundary layer and extract the heat from the wall to the main streamline of the flow by generation of turbulence. Thus mechanism of flow reattachment and separation introduces a strong shear flow on the surface behind each vortex or winglet, which ultimately leads to an effective disruption of the thermal boundary layer and results to improvement of the heat transfer.

A vortex-generator (VG) is an aerodynamic device, consisting of a small vane usually attached to a lifting surface (or aerofoil), such as an aircraft wing or a rotor blade of a wind turbine. VGs may also be attached to some part of an aerodynamic vehicle such as an aircraft fuselage or a car. When the aerofoil or the body is in motion relative to the air, the VG creates a vortex, which, by removing some part of the slow moving boundary layer in contact with the aerofoil surface, delays local flow separation and aerodynamic stalling, thereby improving the effectiveness of wings and control surfaces, such as flaps, elevators, ailerons, and rudders. Vortex generators are most often used to delay flow separation. To solve this problem, they are often placed on the external surfaces of vehicles and wind turbine blades. On both aircraft and wind turbine blades they are usually installed quite close to the leading edge of the aerofoil in order to maintain steady airflow over the control surfaces at the trailing edge. VGs are typically rectangular or triangular, about as tall as the local boundary layer, and run in span wise lines usually near the thickest part of the wing. They can be seen on the wings and vertical tails of many airliners. Vortex generators are positioned obliquely so that they have an angle of attack with respect to the local airflow in order to create a tip vortex which draws energetic, rapidly moving outside air into the slow-moving boundary layer in contact with the surface. A turbulent boundary layer is less likely to separate than a laminar one, and is therefore desirable to ensure effectiveness of trailing-edge control surfaces. Vortex generators are used to trigger this transition. Other devices such as vortilons and various winglets, leading-edge extensions, leading edge cuffs, also delay flow separation at high angles of attack by re-energizing the boundary layer.

2. LONGITUDINAL VORTEX GENERATOR ARRANGEMENT

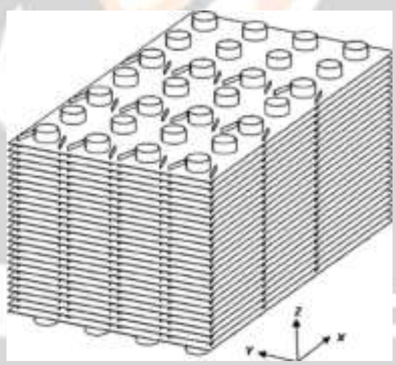

Fig -1: Vortex Generator

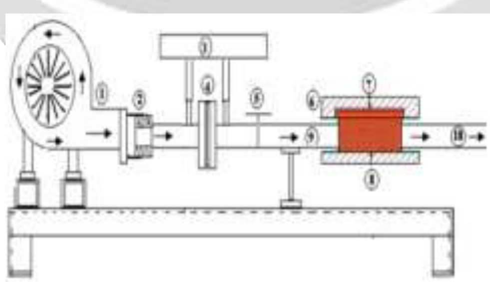

Fig-2: Experimental Arrangement

3. PROCESS

1. Initially start fan and pass this air towards duct.

2. Hollow duct carrier vortex arrangement so pass this air towards vortex unit.
3. Air which is to be pass through longitudinal vortex generator is heated by heater.
4. Finally hot air travelling through longitudinal vortex generator maximum heat transfer takes place.
5. This hot air measured at the thermocouple as a temperature detector.

4. RESOURCES USED

- Heater/Burner
- Plates
- Air Blower arrangement
- Fan
- Hollow Tube duct
- Insulating Material
- Air Inlet arrangement
- Air Outlet arrangement
- Temperature Detector Sensor
- Outer Jacket
- Coupling
- Switch Box

5. LITERATURE REVIEW

[1] S.M. Pesteei in the paper presented that local heat transfer coefficients were measured on fin-tube heat exchanger with winglets using a single heater of 2 inch diameter and five different positions of winglet type vortex generators. The measurements were made at Reynolds number about 2250. Flow losses were determined by measuring the static pressure drop in the system. Results showed a substantial increase in the heat transfer with winglet type vortex generators. It has been observed that average Nusselt number increases by about 46% while the local heat transfer coefficient improves by several times as compared to plain fin-tube heat exchanger.

[2] Ya-Ling He investigated the heat transfer enhancement and pressure loss penalty for fin-and-tube heat exchangers with rectangular winglet pairs (RWPs) were numerically investigated in a relatively low Reynolds number flow. The purpose of this study was to explore the fundamental mechanism between the local flow structure and the heat transfer augmentation. The RWPs were placed with a special orientation for the purpose of enhancement of heat transfer. The numerical study involved three dimensional flow and conjugate heat transfer in the computational domain, which was set up to model the entire flow channel in the air flow direction. The effects of attack angle of RWPs, row-number of RWPs and placement of RWPs on the heat transfer characteristics and flow structure were examined in detail. It was observed that the longitudinal vortices caused by RWPs and the impingement of RWPs directed flow on the downstream tube were important reasons of heat transfer enhancement for fin-and-tube heat exchangers with RWPs.

[3] Guobing Zhou performance of a pair of new vortex generators curved trapezoidal winglet (CTW) has been experimentally investigated and compared with traditional vortex generators rectangular winglet, trapezoidal winglet and delta winglet using dimensionless factors e j/j0, f/f0 and R ¼ (j/j0)/(f/f0). The results showed that delta winglet pair is the best in laminar and transitional flow region, while curved trapezoidal winglet pair (CTWP) has the best thermo-hydraulic performance in fully turbulent region due to the streamlined configuration and then the low pressure drop, which indicates the advantages of using this kind of vortex generators for heat transfer enhancement. An appropriate spacing between the leading edges of a pair of CTW VG should be considered for different flow regions. In addition, double rows of CTWP do not show better thermo-hydraulic performance due to the larger pressure drop and the spacing between the two rows of CTWP should also be optimized.

[4] J.M. Wua achieved heat transfer enhancement and lower pressure loss penalty, even reduction in pressure loss; two novel fin-tube surfaces with two rows of tubes in different diameters are presented in this paper. Numerical simulation results show that the fin-tube surface with first row tube in smaller size and second row tube in larger size can lead to an increase of heat transfer and increase of pressure drop in comparison with the traditional fin-tube surface with two rows of tubes in the same size.

[5] K. Torii proposed a novel technique that can augment heat transfer but nevertheless can reduce pressure-loss in a fin-tube heat exchanger with circular tubes in a relatively low Reynolds number flow, by deploying delta winglet-type vortex generators.

[6] Feibig experimentally investigated the HTE and drag effect by delta and rectangular wings and winglets in laminar channel flow and found that the HTE per unit vortex generator area was highest for delta wings closely followed by delta winglets; rectangular wings and winglets were less effective; the average heat transfer was increased by more than 50% and the corresponding increase of drag coefficient was up to 45%.

[7] Azita Abdollahi carried the experimentation for the optimization of shape and angle of attack of winglet vortex generator in a rectangular duct for heat transfer enhancement and found that RVG provides the highest heat transfer enhancement and pressure drop followed by the TVG and DVG due to having the largest area facing the flow of air. They also concluded that When the Reynolds number is low; variation of the angle of attack of the VG does not lead to the significant changes in the nusselt number. But at higher Reynolds number, this parameter is very crucial. VG at angle of attack 45° possess the more heat transfer enhancement in comparison with the other angles of attack.

[8] Xiaoze Du performed the experiment for heat transfer enhancement of wavy finned flat tube by punched longitudinal vortex generators i.e. delta wing, rectangular wing, delta winglet pairs and rectangular winglet pairs and reported that delta winglet pairs is the best longitudinal vortex generators among these four configurations of vortex generators. The air-side heat transfer coefficient increases with the number of the delta winglet pairs punched on the fin surface which also leads to increase in pressure drop.

[9] N.K. Mitra employed punched longitudinal vortex generators in form of winglets in staggered arrangements to enhance heat transfers in finned oval tube heat exchanger. He noted that staggered arrangement of the winglets was more effective than the inline arrangement for heat transfer enhancement. Two staggered DWPs resulted in 20% higher heat transfer enhancement with 14.5% lower additional pressure loss than three in-lines DWPs.

[10] S. Caliskan investigated heat transfer in a duct with PTVGs and PRVGs and concluded that the averaged heat transferred from surfaces with PTVGs was higher than that of the PRVGs. He also observed that at low Reynolds number the effects of attack angles and the distance.

6. CONCLUSIONS

From above literature study it concluded that by varying geometrical shape of vortex generator, changing it's position heat transfer rate can be increased at the penalty of pressure drop. In this paper by using semicircular vortex generator arrangement heat transfer rate can be studied.

7. APPLICATION

- Airplane
- Aerofoil's
- .Aerospace
- Transportation
- Electronics Cooling and heating
- Navigation.
- Railways
- Refrigeration and evaporation assembly

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