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AN OVERVIEW OF HERRING BONE & SMOOTH WAVY FIN HEAT EXCHANGER FOR HYDRAULIC OIL COOLING SYSTEM

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ABSTRACT:

Power from hydraulics is very important and researchers have started acting on the energy conservation from this, the energy conservation was limited to electrical till 20th century. At the start of 21st century researcher have understood there are other ideas from where also we can save some energy. The major thing must be kept in mind that when we think of power saving it must be carried out for without compromise of reliable operation and low maintenance. Above stated factors should not be compromised. The major aspect of the hydraulic system design was to prevent hydraulic oil heating while in operation. The reason behind heating of hydraulic oil it is a reason of inefficiencies of oil, these inefficiencies results in the losses of input power, this power loss is converted into the heat. If the total input power lost to heat is greater than the heat dissipated, the hydraulic system will eventually overheat. Coolers are frequently used while designing temperature-optimized hydraulic systems. This is used for keeping oil temperatures within a tolerable range. Such circuits are basic prerequisites for cost-efficient operation, as they provide a number of performance, economic, and environmental benefits.

KEYWORDS: Heat sink, fin, heat exchanger, hydraulic, cooling, etc.

INTRODUCTION:

In this method maintaining the correct temperature is the biggest challenge. At the same time maintaining the temperature in tolerable range is very important to maintain and retain the viscosity. If the viscosity of the system is good then all mechanical components will work properly. Hydraulic and lubricated devices will run at its highest efficiency if the viscosity and oil temperature is in limited range. If the oil temperature is increases beyond the recommended value then life of the used hydraulic reduces and this may results in system failure because of poor lubrication, higher internal leakage, a higher risk of cavitations, and damaged components. By maintaining the temperatures low will also helps in ensuring the oil and other components life will get increased. Excess heat can deteriorate hydraulic oil, form harmful varnish on component surfaces, and deteriorate rubber and elastomeric seals. Operating within recommended and tolerable temperature range will definitely increase a hydraulic system's availability and efficiency, profit for organization. Finally, with more machine downtime and fewer shut downs, it will decreased services and repair cost. Objective of the project to overcome above problems it is required to develop a Heat Exchanger with optimized internal structures where in herringbone and smooth wavy fin structure selected for analysis. Comparative analysis will be done on the parameter of temperature gradient of air, temperature gradient of oil, Overall heat transfer coefficient, pressure drop across the fins, Heat transfer rate.

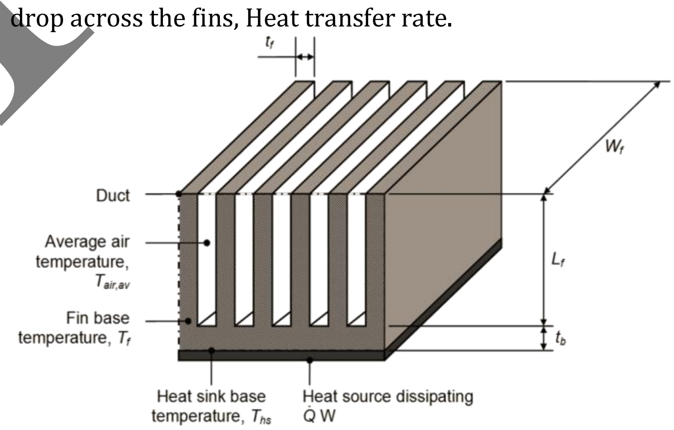

Fig. No. 1: Conventional Heat Sink

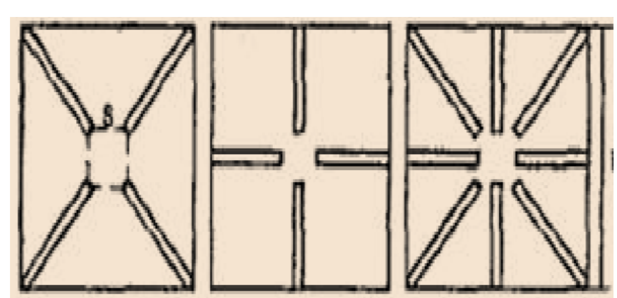

Fig. No. 2: Fluted Heat Sink

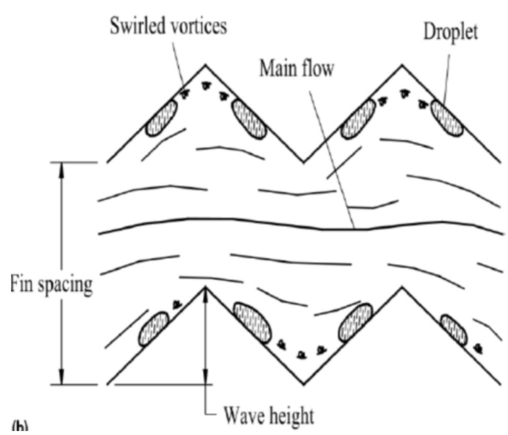

Fig. No. 3: Wavy Fin Heat Sink

OBJECTIVES:

- To avoid over heating of oil.
- To avoid power loss of oil in terms of heating of oil.
- To maintain correct temperature of oil at its recommended Viscosity.
- To ensure of mechanical components are properly lubricated and hydraulic devices run at peak efficiency.
- To developed efficient heat exchanger with optimized internal structure to obtain the maximum Temperature gradient, and Overall heat transfer coefficient, Heat transfer rate.

METHODOLOGY:

- To design Heat exchanger with Herringbone wavy fin and smooth wavy fin.
- Thermal analysis of herringbone and wavy fins.
- Comparative analysis of both fin and optimized best one fin structure.
- To validated the results by using ANSYS Software.

LITERATURE REVIEW:

Beecher and Fagen had tested 28 fins and tube heat exchangers that consisted of 7 plain and 21 wavy fin configurations. All tested wavy fin and tube heat exchangers were arranged in a triple row staggered layout. The effects of fin pitch on the air side performance of the heat exchangers having a fin thickness of 0.12mm were investigated. The variation of Nusselt number based on the arithmetic mean temperature difference (AMTD) with Graetz number was presented. However, they used a single channel model where the fins were electrically heated, which is uncommon as compared to a practical design. A series of investigations of the herringbone wavy fin and tube heat exchangers was conducted by Wang et al. The effects of fin pitch and number of tube rows were examined. The results of the air side heat transfer and friction characteristics were presented in terms of the Colburn factor and friction factor, respectively. Both factors were plotted against the Reynolds number based on the fin collar outside diameter (Re Dc). However, the test results by Wang et al. were valid for fins having a thickness of 0.12mm.

Wang et al. tested 22 wavy fin and tube heat exchangers having 0.12, 0.18 and 0.25mm fin thickness. However, the effects of fin pitch and number of tube rows were not performed systematically at the same fin thickness. Wang Q. studies the influences of different fin patterns on heat transfer and pressure drop performance and simplified the actual physical model. Fin is analyzed at inlet/outlet air temperatures of 373/323 K, and the cooling water inlet temperature is about 300 K. Under such operation condition, it is reasonable to assume the air to be incompressible with constant physical properties. Therefore, the working fluid (dry air) is assumed to be incompressible with constant physical properties, and the flow is assumed to be turbulent, steady, three dimensional with no viscous dissipation Air and hot water were used as working fluids.

Wang and Vanka were analyzed convective heat transfer technique for completely developed flow in a periodic wavy passage for several Reynolds numbers Patel published a pair of papers dealing with flow through a channel with a single wavy wall. One paper dealt with steady laminar flow over a wall with six waives and the other addressed turbulent flow over the same wall. In the case of a laminar, the pressure and friction coefficients are plotted over the course of the wavy wall. It should be noted, however, that these calculations are performed for a channel Reynolds number of 10,760, a value that is considerably higher than the expected transition Reynolds number.

Garg and Maji had used a finite-difference technology for solving the governing equations for steady laminar flow and heat transfer in a furrowed wavy channel. M.Quzzane and Z.Aidoun conducted a numerical study on wavy fin and tube CO2 evaporator coil. The developed addresses are of a of mathematical model used for designing and analysis of air-CO2 wavy fin evaporators coils. CO_2 gas will flow in the CO2 flows inside horizontal tubes and air flows across the coil at the same time and over the fins, on the outside the tubes.

C. Wang, W.Tao and Y. Du .investigated effect of waffle height on the air-side performance of wavy fin-and-tube heat exchangers under dehumidifying conditions. Totally 12 different heat exchangers, which also includes eight having wavy fins and four having plain fins configurations were examined by them. The results obtained in this study shows that the effect of waffle height on the heat transfer enhancement ratio, compared to the plain-fin counterpart, is pronounced only for smaller fin pitch and larger waffle height, while its effect on the pressure drop is very pronounced throughout the test range and is almost two times higher than in dry conditions. A numerous studies done earlier for investigation of the thermal and hydraulic characteristics of the wavy fins has been revisited and reviewed in this work. While predominantly used with air as a working fluid, few studies have been addressed issues especially with liquids.

Kays (1984) has proposed three sets of geometric parameters using air as a working fluid. These geometries had (fins per inch) FPI = 11.4, 11.5, and 17.8, respectively with ¸ = 0.375 in (9.525 mm. Goldstein and Sparrow (1977) studied corrugated channels with triangular waves. Although triangular waves were somewhat different from sinusoidal waves, many flow features were common to both triangular waves and sinusoidal waves. They were among the first to provide detailed data on triangular waves. They carried out experiments based on the naphthalene sublimation technique to determine the local and average transfer characteristics for flow in a corrugated wall channel. The range of their experiments encompassed the laminar, transition, and low-Reynolds-number turbulent regimes (Re =150–2000).

Sandip S. Kale1, V.W.Bhatkar2, M.M Dange have proposed that the plate fin-and-tube heat exchangers are widely used in variety of industrial applications, particularly in the heating, air-conditioning and refrigeration, HVAC industries. In most cases the working fluid is liquid on the tube side exchanging heat with a gas, usually air. It is observed that the performance and various parameters of heat exchangers can be greatly increased with the use of unconventionally shaped flow passages such as plain, perforated offset strip, louvered, wavy, vortex generator and pin. The current study is focused on wavy-fin. The wavy surface helps in increase in path of the airflow and cause better airflow mixing. For designing a better heat exchangers and come up with efficient designs, a thorough understanding of the flow of air in these channels is required.

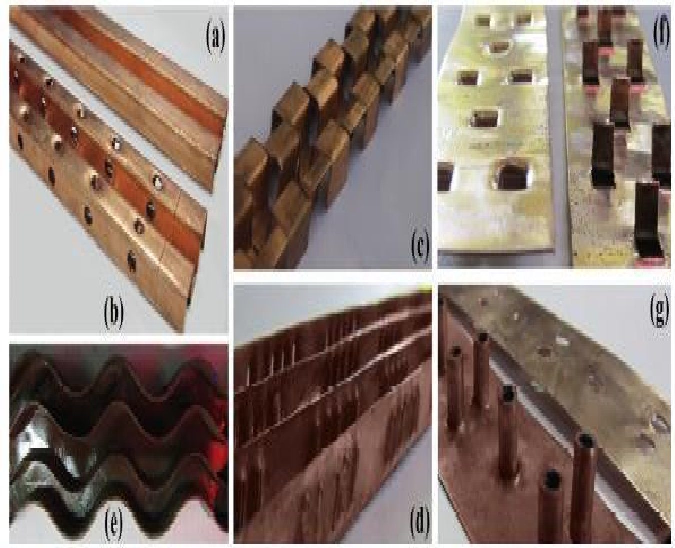

Fig. No. 4: Plate-fin channels: (a) plain (b) perforated (c) offset strip (d) louvered (e) wavy (f) vortex-generator (g) pin [2]

In this paper a technique explained has easy manufacturing and designing process when weigh against to other fin and tube heat exchanger. This are the results obtained from research carried out in this paper. Different performance parameters such as fin pitch, fin length, fin thickness, longitudinal pitch, transverse pitch, waviness amplitude, Coburn factor, friction factor, and pressure drop were analyzed in this paper and comparison in made with obtained results. The implemented method found more efficient than earlier methods.

CONCLUSION:

Following were the major finding from the literature review

1. The wavy surface is designed to avail advantage of increased path for the air flow and thus improves a heat transfer rate.
2. Heat transfer and pressure drop performance can enhance by increasing the longitudinal and transverse pitch.
3. If J and F factor increases the tube rows will increases it’s a clear indication of deterioration of heat transfer performance.
4. For achieving the higher heat transfer bigger waviness can be advantageous.
5. Increase in the fin pitch is observed as friction factor (F) increases.

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