International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

A Review on Plate Finned Heat Exchanger

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Abstract - Fixed plate or plate heat exchangers with extended surfaces (fins) have gained huge popularity over decades. They are referred to as one of the most compact type of heat exchanger to mainly signify its high heat transfer surface area to volume ratio. Due to its small size and high efficiency, they are widely used in cryogenics, aerospace applications, refrigeration, recovery ventilation etc. Fixed plate heat exchanger is a type of heat recovery ventilators which basically extracts waste energy from the outgoing stale air and conditions the incoming fresh air hence decreasing the load on the hvac systems and saving a large amount of energy. This paper is a review on various studies on fixed plate heat exchangers and the different factors that affect their performances

Keywords— plate heat exchangers, fins, ventilation, heat recovery, effectiveness, cross flow.

1.INTRODUCTION

HRV also known as the heat recovery air exchangers or Mechanical ventilation heat recovery (MVHR), are equipped with two continuously running fans. The first one expels indoor stale air (consisting of - smell, smoke, pollutants, pathogens etc.), and the second one supplies fresh filtered air from the outside. The fresh new air and expelled stale air never come into contact with each other; the air is not recycled. This technology absorbs heat or cooled energy and recycles it; it does not generate it. It can recover heat during winter or cool during summer from the expelled stale air, and transfers it to the fresh incoming filtered air. In the article the HRV type to be discussed is a Fixed plate type heat exchanger with extended surfaces (fins). Plate heat exchangers are heat exchangers well-known since the 1940's. They can be used as a sensible heat or energy recovery, and are characterized by high effectiveness, compactness, low weight and moderate cost. They are further divided into cross, counter and parallel flow.

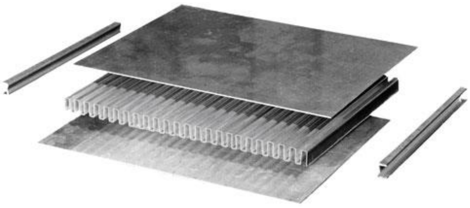

Figure- 1: Plate fin heat exchanger exploded diagram.

1.1 Working principle of PFHE.

The working principle of a plate fin heat exchanger is quite simple. Here is an example of cross flow plate finned heat exchanger. In cross flow the fluids are at an angle of 90°, the two fluids involved in the heat exchange are separated by a parting sheet. Which acts as the primary heat transfer surface. It has side bars which prevents the fluid from spilling. And extended surfaces or fins which are sandwiched between the parting sheets. They act as the secondary heat transfer surfaces.

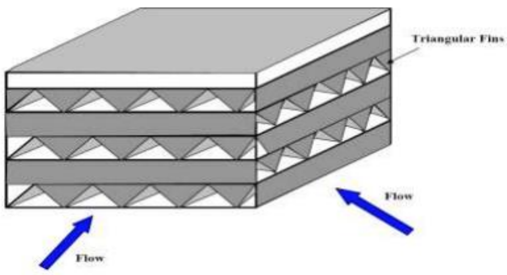

Figure- 2: Cross flow plate fin heat exchanger with triangular fins

As the fluid enters through the channels of the inlet, due to the temperature gradient between the two fluids heat transfer takes place through convection between the fluids and the primary and secondary heat transfer surfaces. This type of fixed plate heat exchangers has superiority to rest of the heat exchangers because of their compactness. Large heat transfer surface area per unit volume (typically 1000 m^2/m^3). It produces a high overall heat transfer coefficient because of the heat transfer associated with the narrow passages and corrugated surfaces.

2. LITERATURE REVIEW

Gabriela Elena [1] concluded from their study of air-to-air plate heat exchanger analysis that theoretical and the measured efficiency obtained showed that the efficiency calculated by NTU method are close to the temperature efficiency and both of the parameters depend on the flow rates and when the air flow is increased, they both decreases

Ewa Zender–Swiercz [2] Concluded that Heat recovery in decentralised devices with a single fan is the one that raises the most doubts due to the sensitivity of devices located in the building facade to the effects of wind and temperature. This type of device, energy storage works best and looks for a substance that has very good accumulation properties, but at the same time it has low thermal conductivity allowing for a quick charging and discharging of the storage. It also had the affects and risks of freezing heat exchangers.

Saffa Riffat and Shiho Zhang [3] Concluded that combination of heat recovery with passive systems of building components can obviously reduce heat losses and inlet air flow. The combination of heat pipe and rotary wheel heat recovery with wind towers would be more compact than normal fixed-plate heat recovery. And heat recovery-assisted dehumidification systems, desiccant material should have low sensible heat effectiveness Meanwhile, for membrane heat recovery, increasing transfer units could be considered as a means to process better heat transfer.

Grosse-Georgeann [4] showed that the enhancement mechanism by transverse vortex generators need unsteady flow and develop reversed flow regimes which further increase the resistance to flow. No enhancement in heat transfer was reported for steady flow in a periodically ribbed channel.

Mariana I Ahmad [5] considered cross-flow arrangement in their air-to-air heat exchanger. he concluded that as the air velocity increases, the effectiveness decreases and transferred heat increases. Also, the effectiveness and transferred heat values reduce with increasing air temperature of exhaust stream. The calculated temperature effectiveness was in good agreement with the results obtained using NTU-effectiveness method.

Turk et al. [6] investigated heat transfer enhancement for laminar flow over a row of rectangular winglet pairs by varying the aspect ratio. The angle of attack was fixed at 20°. It was found that the ratio of span averaged heat transfer coefficient on a Heat Transfer Augmentation flat plate with vortex generator to the corresponding value without vortex generator increased up to 3 at a distance more than 30 chord lengths downstream of the winglets. The study was carried out both for zero and favorable pressure gradients and heat transfer enhancement was found to be more with favorable pressure gradient.

S Premkumar D [7] investigated triangular plate and fin heat exchanger and compared 3 models with their investigated Overall heat transfer coefficient. First one was parallel flow, then counterflow and a counter flow heat exchanger with external fins. He found out that Coefficient of heat transfer of heat exchanger with fins attached to outer surface of copper tube is more than the other two heat exchangers because the fluid in outer tube is subjected to turbulent flow

Abel Jacob [8] concluded from the result that as the l/d ratio increases, the heat transfer also increases up to a certain limit. It was clear that as the pitch of the fins increases the heat transfer to a maximum value and then decreases. In comparison to the conventional fin (rectangular), rate of heat transfer of proposed fin is increased by 28.7%. Triangular fins provide about 5 % to 13% more enhancement of heat transfer as compared to conventional fins. Heat transfer through fin with triangular extensions higher than that of fin with other types of extensions. The effectiveness of fin with triangular extensions is greater than other extensions.

Behrouz Nourozi [9] concluded that the efficiency of the heat exchanger at MVHR is the most decisive factor in frost formation. Higher efficiencies of heat exchanger aim to provide supply temperatures close to return temperature. This would decrease the exhaust air temperature below the dew point for cold outdoor air. Therefore, by preheating the inlet air to MVHR, the efficiency of heat exchanger decreases and this results in higher exhaust air temperature and subsequently, heat exchanger surface temperature.

Shambhu Kumar Ra [10] Concluded that heat exchanger will be improved by mounting protrusion surface like the wavy fins, off strip fins perforated fins etc. they also stated that use of longitudinal vortex generators in the form of winglet with an attack angle of 45° will provide better effectiveness of heat transfer enhancement

3. CONCLUSIONS

It can be concluded from this review paper that there is various factor that can affect the efficiency and effectiveness of the plate fin heat exchanger

- Extended surfaces (fins) play a major role, as we discussed above how triangular fins increases the rate of heat transfer as compared to other types.
- the flow rates and the velocity of the fluid increases, the effectiveness and the transferred heat values reduces with increasing air temperatures.
- Plays a huge role in the indoor quality of air and ventilation processes.
- -energy saving and waste heat recovery which decreases the loads on the Hvac systems and the annual electricity consumptions.

4. FUTURE SCOPE

For the researchers there is humungous scope in the heat recovery systems as with increasing use of renewable energy resources and global warming. The demand for such a system that uses the waste energy and converts it to resourceful and productive matter will be more than ever. So continuous analysis, with these systems and trying to improve its performances will be a boon to the Hvac industries and many others.

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