Review paper on Comparative analysis on Heat Exchanger with Insert

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ABSTRACT:- In this paper we are focusing on the past history of Heat transfer enhancement with the help of different inserts in heat exchangers used by the researcher. The different geometries are used to increased the heat transfer rate in heat exchanger. In heat exchanger the, Reynold's number are the flow parameter used because if the velocity changed the heat transfer rate also changed. The Reynolds number and the heat transfer rate are related to each other with the help of dittus-boelter equation $Nu_s = 0.023.\mathrm{Re}^{0.8}.\mathrm{Pr}^{0.4}$.

Keywords – Heat Exchanger, reynold's number, velocity.

I. INTRODUCTION

Heat exchanger is a device used for effective transfer of heat from one place to another place. The most common example of heat exchanger can be seen in an automobile engine. The heat exchanger is a very significant part of several thermo-mechanical systems and industries, for example, refrigeration system, air conditioning system, solar air heater, solar drier, solar water heater, petrochemical

industries, geothermal energy systems, etc. All of these system comprises of the heat exchanger as an important unit for its effective working.

CLASSIFICATION OF HEAT EXCHANGER

[1] Heat transfer process

(A) Direct contact type:- In this heat exchanger, two different fluid interact directly in order to exchanges their heat, and then separated from each other. Its Common applications also comprises of mass transfer along with heat transfer, example is evaporative cooling; applications with only sensible heat transfer are rare. The enthalpy of phase change in these heat exchangers represents a major part of the total energy transfer. The rate of heat transfer generally enhanced by phase change.

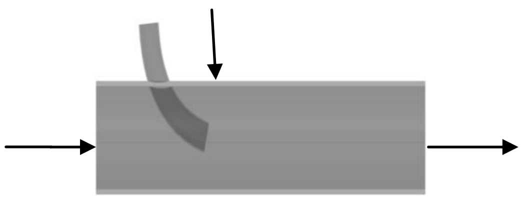

Fig. 1 Direct Contact Type Heat Exchanger

However, it has some restriction and it is applicable for only those fluids, whose direct contact between both the fluid streams is permitted. Like as it is shown in Fig. 1 that fluid A and fluid B from the two sources mixed together in the heat exchanger and exchanges its heat and get separated further.

(B) Indirect contact type:- In this type of heat exchanger, one fluid steam remains separated from other fluid streams and the heat transfer takes place through a dividing wall between the two fluid streams. Hence, there is no direct physical contact between the two thermally interacting fluids streams. This type of heat exchangers also comes in the category of surface heat exchanger, since the heat transfer is between two fluids takes place with the help of surface or wall separating them. As it is shown in Fig.2, warm air enters the heat exchanger from one end and leaves after cooling from the other when it indirectly interacts with cool secondary air stream coming from the opposite end.

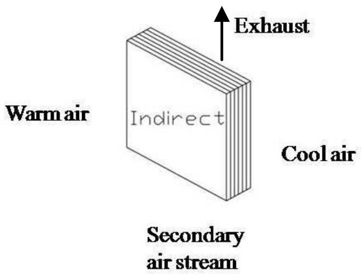

Fig. 2 Indirect Type Heat Exchanger

[2] Parallel Flow Heat Exchanger

(A) Parallel flow type:- In this arrangement [Fig.3], the fluid stream of heated fluid and that of the cold fluid flow is in the same direction. As the direction of fluid flow is the same, hence heat transfer in such an arrangement is minimum.

 DOI : 10.18231/2454-9150.2018.0629

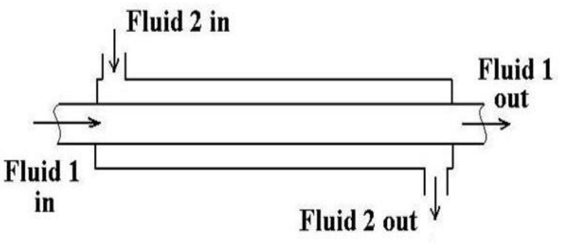

Fig. 3 Parallel flow type heat exchanger

(A) **Counter flow type:-** In this arrangement [Fig. 4], the fluid stream of heated fluid and that of the cold fluid flow is in the opposite direction. As the direction of fluid flow is the opposite, hence heat transfer in such an arrangement is maximum.

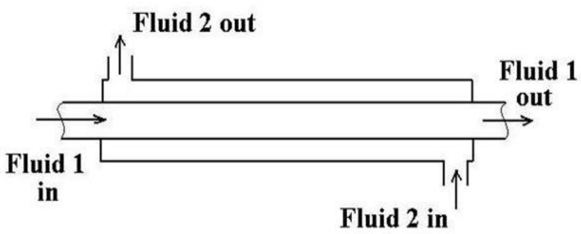

Fig. 4 Counter Flow Heat Exchanger

(B) **Cross flow type:-** In this kind of arrangement, the fluid stream of heated fluid and the direction of the cold fluid flow are perpendicular to each other. As the direction is perpendicular, hence the heat transfer takes place over a large surface area and because of perpendicular flow the rate of heat transfer is very high. This is the most efficient way of cooling or heating in case of heat exchangers.

(C) **REQUIREMENT OF HEAT EXCHANGER**

1. High thermal effectiveness
2. Pressure drop as low as possible
3. Reliability and life expectancy
4. High quality product
5. Material compatibility with process fluids
6. Reliable in use and low cost
7. Convenient size and light weight
8. Easy to maintain
9. **Easy for installation**

APPLICATIONS OF HEAT EXCHANGER

- District heating/cooling
- Intercooler in a heat pump
- Chilled water production in food factories
- Cooling of air conditioning circuits
- Solar heating systems
- Tap water heating
- Swimming pool heating
- Heat recovery (engine cooling)
- Temperature control of fish farms
- Steel industry – furnace cooling
- Power industry – central cooling
- Chemical industry – process cooling
- Refrigeration
- Air conditioning
- Space heating
- Power generation
- Car radiator
- Petroleum refineries
- Natural gas processing

II. LITERATURE REVIEW

According to the literature review, it is observed that different researchers have used different insert geometry and parameters in order to perform their experimental work. The effect of these insert geometries and their parameters showed different effects on the heat transfer and friction factor.

[1] Halit Bas et al. –

- The highest heat transfer enhancements is 1.756 times as compared to plain tube.
- Thermal Performance factor improves up to 1.8 times as compared to plain tube.
- Reynolds number range was 5132 to 24989.

Fig.5 Twisted tape separated from tube wall

[2] SibelGunes et al.-

- The maximum thermal enhancement efficiency of 36.5% is seen with respect of plane tube.
- Reynolds number range was 3500-27,000.

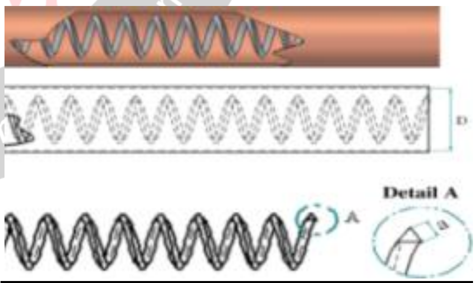

Fig.6 Coiled wire of triangular cross section

[3] V. Kongkaitpaiboon et al.

- 195% improvement in heat transfer can be noticed.
- Thermal Performance factor improves up to 1.07 times as compared to plain tube.
- Reynolds number range was 4000-20,000

DOI : 10.18231/2454-9150.2018.0629

ISSN : 2454-9150 Vol-04, Issue-05, Aug 2018

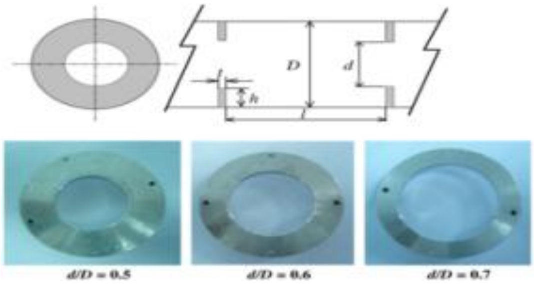

Fig.7 Circular disk

[4] C. Thianpong et al.

- Thermal Performance factor improves up to 1.24 times as compared to plain tube.
- Reynolds number range was 6000-20,000

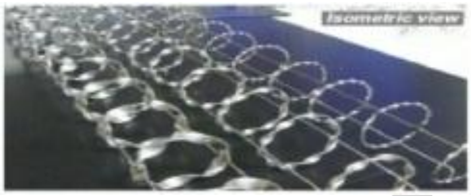

Fig.8 Twisted ring

[5] Smith Eiamsa-ard et al.

- Heat transfer augmentation is up to 1.27 times on the plain tube.
- The correlations show ±7% deviation for both the heat transfer and friction factor.
- Reynolds number range was 4000-20,000.

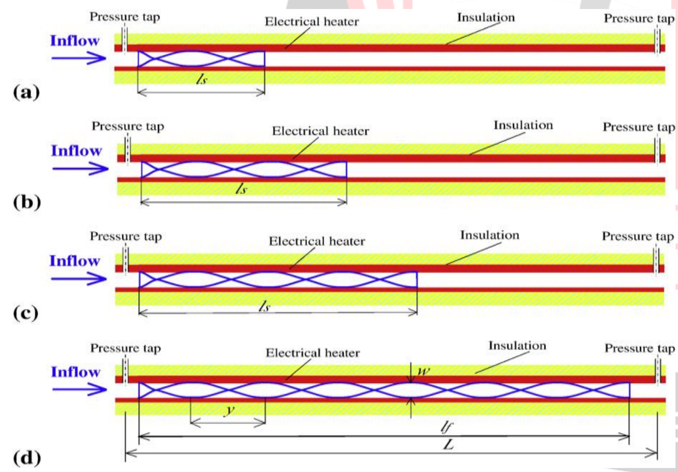

Fig.9 Short length twisted tape

[6] S. Eiamsa-ard et al.-

- Thermal Performance factor improves up to 3.7 % as compared to plain tube.
- Reynolds number range was 4600-20,000.

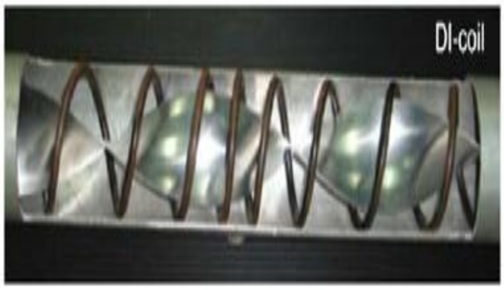

Fig.10 Non uniform wire coiled with twisted tape

[7] ShyyWoei Chang et. al.

- 2.4 times improvement in heat transfer can be observed.
- Thermal Performance factor improves up to 2.5 times as compared to plain tube.
- Reynolds number range was 1000-40,000.

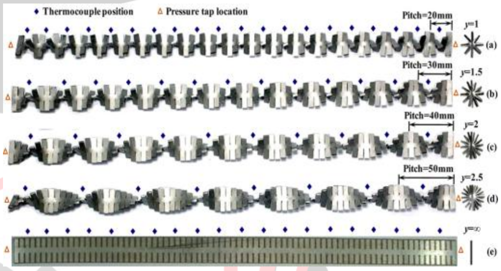

Fig.11 Broken twisted tape

[8] PongjetPromvonge et al. –

- 344% improvement in Nusselt number can be seen.
- Nusselt number in case of divergent ring is greater than compared to convergent conical ring.
- Reynolds number range was 8000-18,000

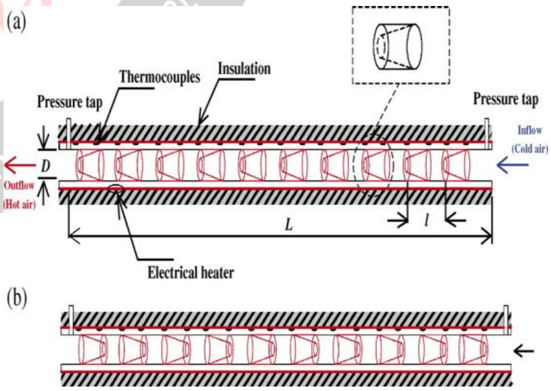

Fig.12 Divergent convergent nozzle

[9] K. Nanan et al.

- 2.08 times improvement in heat transfer can be observed.
- Thermal Performance factor improves up to 1.28 times as compared to plain tube.
- Reynolds number range was 6000-20,000

DOI : 10.18231/2454-9150.2018.0629

Fig.13 Perforated helical twisted tape

[10] S. Eiamsa-ard et al. –

- 270% improvement in heat transfer can be noticed.
- Thermal Performance factor improves up to 1.19 times as compared to plain tube. .
- Reynolds number range was 8000-18,000

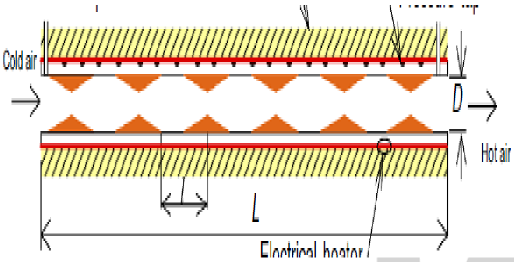

Fig.14 V-nozzle tabulators

[11] M.M.K Bhuiya et al. –

- Nusselt number improves upto 3.85 times as compare to plain tube.
- Thermal Performance factor improves upto 1.44 times with respect to smooth tube.
- Reynolds number range was 8000-18,000

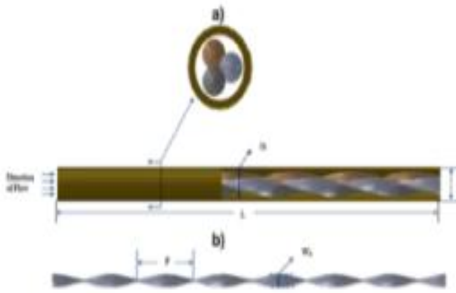

Fig.15 Triple twisted tape

[12]Kongkaitpaiboon et al.

- 185% improvement in heat transfer is observed with respect to the plain tube.
- The thermal performance factorimproves0.92 times as compared to the plain tube
- . Reynolds number range was 4000-20,000

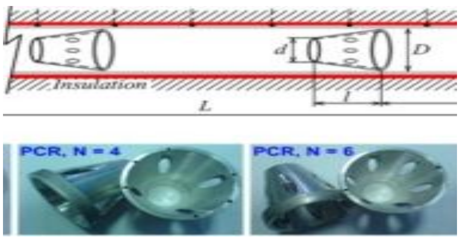

Fig.16 Perforated conical ring

CONCLUSION

- The main purpose of this paper is to present study an focused on the heat exchanger enhancement.
- A lot of work on insert geometries like twisted tape, conical ring, perforated inserts, wire coil, etc. have been completed with significant results.
- For heat transfer, as the value of the Reynolds number increases heat transfer rate also increases and vice-versa.
- At the maximum value of the Reynolds number, the amount of heat transfer was maximum. When compared to the smooth tube, maximum enhancement in heat transfer was obtained for the lower value of Reynolds number.

FORMULATION

This is shown using following relations:

Qcond = Qconv

Qcond = $\dot{m}$Cp (To – Ti)

Qconv = hA(Twm – Tb)

Nusselt number

Nu = hD/k

Reynolds number

Re = ρVD/μ

Dittus-Boelter equation:

$$Nu_s = 0.023.\mathrm{Re}^{0.8}.\mathrm{Pr}^{0.4}$$

Blasius equation:

$$f_s = 0.316 \times \mathrm{Re}^{-0.25}$$

Where:-

C_d Coefficient of discharge

h Convective heat transfer coefficient

k Thermal conductivity

m Mass flow rate of fluid

T_a Ambient temperature

T_i Fluid inlet temperature

T_o Fluid outlet temperature

f Friction factor

R_e Reynolds number

P_r Prandtl number

N_u Nusselt number

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