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Review of Heat Transfer Enhancement in Pipe Flow using Wire Coil

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Abstract - *Heat exchanger is an apparatus which is invented for transfer the thermal energy (Enthalpy) between one medium to another medium (between two or more fluids, or a fluid and solid surface) at different temperature and in thermal contact. Heat exchangers are universally used as the fundamental units in heat extraction and recovery setup in industry. In heat exchanger thermal energy (Enthalpy) transfer from one medium to another medium with or without mixing media. In industry cooling and heating processes heat exchanger are used. Most common example of heat exchanger are automobile radiators, condensers, evaporator, shell and tube heat exchangers, cooling towers and air preheaters. According to design like as number of passé, flow arrangements heat exchanger classified. In heat transfer field heat transfer enhancement technique serve important research assignment and they broadly classified as active, passive and compound technique. Active methods have need external power source to input process and passive no need of additional power supply or energy to improve the heat transfer. Passive methods generally used in both numerical and experimental applications to save energy and cost in heat transfer enhancement and frictional losses. Wire coil (insert), internal threads and Nano fluid comes under passive methods and this is used to improve overall performance of heat exchanger. The present review involves investigation on the heat enhancement of heat transfer using wire coils. Various consequence of different wire coils.*

***Key Words*: Heat transfer enhancement, wire coil insert**

1. INTRODUCTION

The word "Exchanger" really enforced to all types of device in which heat is interchange but it is frequently used special device in which heat is interchanged between two channels or streams, that channel are at different temperature. Heat exchangers are an apparatus design for the heat transfer between one medium to another medium (medium should in solid, liquid or gas) efficiently. Heat exchangers are universally used as fundamental device in heat extraction and recovery setup in industries. Commonly heat exchangers are used for cooling and heating processes. They are widely used in heating large scale industrial process, refrigeration, air conditioning, power plants, chemical plants etc. Heat exchanger perform an important character in various fields such as electric power generation, aerospace industries, chemical engineering, oil and petrochemical industries, metallurgy, sugar industries, chemical sector, pharmaceutical industries etc. recovery of energy is maim important to optimize the energy utilization in industry. The design strategy of heat exchanger is complicated due to it require exact analysis of rate of heat transfer, pressure drop estimations and economic aspect of equipment. The challenging task in designing a heat exchanger is compact size of equipment and obtain high rate of heat transfer using minimum pumping power. Heat transfer augmentation techniques are vigorous tools to improve thermal performance and heat transfer rate. The main objective behind the enhancement is to reduce the size of heat exchanger needed for specified work, to boost capacity of an existing heat exchanger, or lower the pumping power. In addition heat transfer enhancement permits heat exchanger operates at smaller velocity, but still obtain the same or higher heat transfer coefficient. This means that as reduction of pressure drop, corresponding to lower operating cost may be obtained. All these benefits have made heat transfer enhancement technology charming in heat exchanger applications. The heat transfer enhancement techniques perform an important research task in heat transfer field. They can broadly classified into two main categories: active and passive techniques:

a) Active method

b) Passive method

c) Compound method

1.1 Active Technique

In active methods contain external source i.e. power required to rise the rate of heat transfer; for example fluid vibration, surface vibration, mechanical aids, magnetic field to disturb the light seeded particles in a flowing stream, etc.

1.2 Passive technique

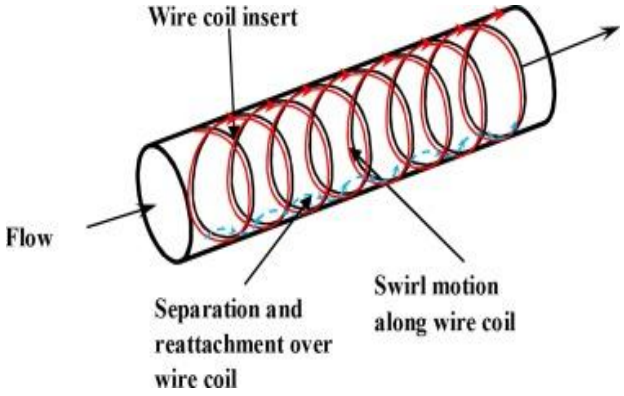
In passive method there is no any requirement of external power source. In this type, there is change in surface texture or geometric modifications; for example rough surfaces, grooves, additive and various inserts. The primary objective of passive methods is to disturb the actual flow of fluid to increase surface areas, residence time etc. The main purpose is to improve the performance of heat exchanger.

2. WIRE COIL INSERT

Coil wire inserts is one of the passive heat transfer augmentation technique adopted in various heat transfer applications like as cooling device, air conditioning, refrigeration system, preheaters etc.

The benefits of wire coil inserts in comparison to other heat exchanger performance enhancement technique are-

1. Lower cost with simple manufacturing process.
2. Easy installation and removal.
3. It doesn't effect on mechanical strength of original tube.



2.1 Wire coil in laminar flow

The important analysis of wire coil in laminar flow are shown in Table 1. Inaba and Ozaki [**1**] published that the turbulent flow induced by wire coil insert increase heat transfer rate. They advanced empirical relation between Prandlt number and Nusselt number and relation is Nusselt number as a function of Prandlt number Also they found pressure drop proportional to length of wire coil. Wang and Suden [**2**] establish that a wire coil insert achieve enhancing the heat transfer in turbulent flow region as compare tape inserted had poor overall efficiency. Inaba and Haruki [**3**] studied heat transfer of flowing water in tube with flow drag reduction additives by inserting wire coils. Also they found that heat transfer coefficient reduces with reduction in flow resistance in tube.

2.2 Wire coil in turbulent flow

The important analysis of wire coil in turbulent flow are shown in Table 2. Ravigururanjan and bergles [4] advanced correlation for the heat transfer coefficient and friction factor thar are generally applied. This covers roughness type and Prandlt number and it also related to Petukov and Popov's[5] correlations. Rahai and Wang [6] conclude that large pitch spacing wire coil increases the mixing, turbulent kinetic energy but decrease the maximum mean velocity. Sams [7] construct the vortex flow with wire coil insert and develop the correlation for friction factor and Nusselt number. Arici and Asn [8] studied the enhancement of turbulent flow with wire coil insert. They conclude that at constant Reynolds number increase in pitch of wire coil decrease the heat transfer for fixing wire coil to wall of tube. In another case i.e. displaced wire coil they observe that increase in pitch resulted increase in heat transfer.

Table- 1: Summary of investigations of wire coil insert in laminar flow

Authors	Fluid	Configuration of wire coil	Type of investigation	observations
Inaba and Ozaki	Water	Wire coil	Experiment in circular pipe flow	High heat transfer and low pressure

[1]				loss and developed empirical relation.
Wang and Suden [2]	Water	Wire coil	Experiment in circular tube	Enhancing heat transfer both insert effective in region other than turbulent
Inaba and Haruki [3]	Water	Wire coil	Experiment in pipe	Heat transfer coefficient reduces with reduction in flow resistance.

Table-2: Summary of investigation of wire coils in turbulent flow

Authors	Fluid	Configuration of wire coil	Type of investigation	Observation
Ravigururajan and Bergles [4]	Water	Wire coil	Experimental study	Develop correlation for friction factor and heat transfer
Rahai and Wong [6]	Air	Coil insert	Experiment in round tube	Coil with large spacing increases mixing, kinetic energy and half width but decrease the maximum mean velocity
Sams [7]	Air	Wire coil	Experiment in tube	Vortex flow can be created through wire coil. Developed correlation for friction factor and Nusselt number.
Arici and Asn [8]	Water	Wire coil	Experiment in tube	Increase the pitch of coil increase the heat transfer

3. CONCLUSIONS

In this review paper priority given to wire coil insert passive heat transfer technique. From this may conclude that all passive technique are used for enhance heat transfer. Also we got performance of wire coil in laminar flow depends on Prandlt number. Wire coil in turbulent flow performs better than any other insert. Increase in pitch length of wire coil increase overall enhancement ratio.

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