iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 Issue: XII Month of publication: December 2015

DOI:

Volume 3 Issue XII, December 2015
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

An Approach for Enhancement of Heat Transfer Using Conical Convergent Ring Inserts In Tube

Ms. Nishidha A. Lokhande[1], Dr. M. Basavaraj[2]
[1,2](Department of Mechanical Engineering, BIT College, Ballarpur, Chandrapur /MS, India)

Abstract :- The development of high performance heat exchangers have gained importance in various engineering application such as in air conditioning, thermal power plant, automotives, space vehicle, heat sink, for electronics and so on. To reduce the cost and size of heat exchanger which may lead to considerable saving in material cost. Passive heat transfer augmentation tools and method can play an important role in design of heat exchanger are twisted tape, wire coil, ribs, baffles, conical ring and helical coil etc. A detailed study analysis of conical ring passive heat transfer augmentation technique is made.

Keywords: - - Conical Convergent Ring, Heat Transfer Augmentation.

I. INTRODUCTION

The concept of Heat transfer techniques in heat exchange using the thermal energy has many applications in several engineering and industrial applications. Accurate analysis of heat transfer rate and pressure drop estimations makes the design procedure of heat exchanger complicated one. Making the equipment compact and achieving high heat transfer rate are main obstacles in designing heat exchanger. Techniques that are used to enhance convective heat transfer by reducing the thermal resistance in a heat exchanger are referred to as the Heat Transfer Augmentation which leads to reduce the cost and size of the heat exchanger. Heat transfer augmentation technology has been developed and widely employed to heat exchanger application such as automotive industries, chemical industries, refrigeration, thermal power plant, process industries, electronics devices, air conditioning equipments etc.

These techniques are listed as:

A. Active techniques.
B. Passive techniques.
C. Compound techniques.

Out of these, passive method of heat transfer enhancement is more effective as it doesn't need external power and the simple insert manufacturing process are now available also these techniques can be retrofitted to existing units. Passive heat transfer augmentation method can play an important role in design of heat transfer. The passive techniques includes used for rough surfaces, treated surfaces, extended surfaces, coiled tube, displayed enhancement devices, swirl flow devices and additives for gases and liquid. Bergles [1] presented a comprehensive survey on heat transfer enhancement by various techniques. S.S. Giri [2] in his paper studied various methods of heat transfer enhancement adopting various types of tube inserts. P.Promvonge [3] studied in this paper the heat transfer in circular tube with conical ring insets. In this experiment three different ratios ring to tube diameter where used for the conical rings. The rings where placed with three different arrangements (divergent conical ring, referred to as DR array, converging conical ring, CR array and converging-diverging conical ring referred CDR array) for Reynolds number in a range 6000-26000 it was used as cold air at ambient condition. Yakut [4] studied the effect of conical ring tabulators on the pressure drop, flow induced vibrations and turbulent heat transfer and also investigated the thermal performances of heat transfer promoters in relation with their heat transfer enhancement efficiency for unchanged pumping power. Alberto Garcia et al [5] their aim was to study the heat transfer rate and frictional characteristics of the helical wire coil insets in transient flow at different prandtl number. D G Khumbar [6] concentrated on the effect of conical shape and conical shape coiled wire spring with various pitches on friction and heat transfer characteristics of air flow in tube as shown in fig (a) and fig (b) Shivlingaswamy B.P. [7] In this paper the effect of circular ring tabulator on three heat transfer and fluid friction characteristics in a heat exchanger tube. This can be done by insertion of conical ring tabulators with various shape containing 3 different diameter and 2 different pitch ratios. M.A. Rashid Sarkar [8] focused on experimental as well as numerical investigation in a horizontal circular tube by the effect of conical ring insert on turbulent flow heat transfer. Pramod S. Purandare [9] in this paper the heat transfer and pressure drop synthesis of conical coil heat

Volume 3 Issue XII, December 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

exchanger with different diameters, fluid flow rates and cone angle. Different coils of cone angle are manufactured with same average coil diameter and tube length by various tube diameters by using hot and cold water with flow rate of 10 to 100 lph and 30 to 90 lph. The temperature and pressure are calculated across the heat exchanger at various mass flow rate of hot and cold water. The various features like transfer coefficient, friction factor, Nussle number are calculated by using temperature, mass flow rate, and pressure drop across heat exchanger. Durum [10] experimentally investigated the effect on heat transfer rate by placing in a heat exchanger tube and cutting conical tabulators using four different types of tabulators and different conical angles.

II. TECHNICAL DETAILED FOR CONICAL RING INSERTS

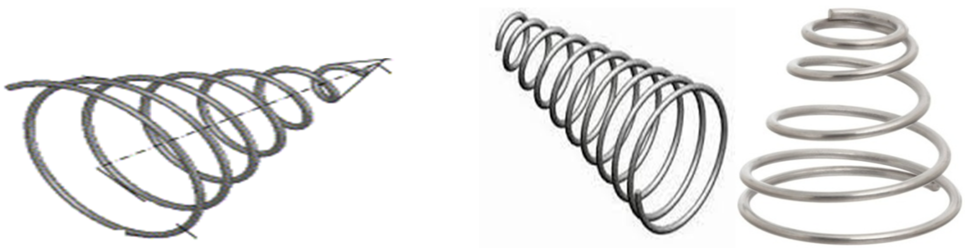


Fig 1: conical insert

As aluminum material ribs can be easily bend in desired angle and shape also these are light in weight and easily available, these are used for experimental set-up. Five conical spring inserts are manufactured are equal length and equal diameter are used for experiment purpose. Also experimental purpose with five conical spring inserts and different arrangement and its performance is also compared.

Maximum diameter (D) = 22.22mm
Diameter of wire (d) =3mm
Material = Aluminum
Length of spring =100mm

III. EXPERIMENTAL SET-UP

Conical spring inserts are made from aluminum due to its easy availability and easy manufacture. Figure shows the experimental setup. Water is used as a working fluid, the length of tube is 1 m with 1mm thickness and diameter of tube is 22.22mm. For uniform heat exchange of wired coil heater of nicrome & to prevent the heat leakage at external surface due to convection and radiation glass wool insulation is coated. Five numbers of Thermocouples are placed at different place of heating surface and one thermocouple at inlet and one thermocouple at outlet for measuring the bulk temperature. Centrifugal pump is used; measuring the flow rate rotameter is used range of 0-25 lpm. With the help of valve flow rate of Water is controlled and by measuring the pressure manometer is used. It consists of following components:

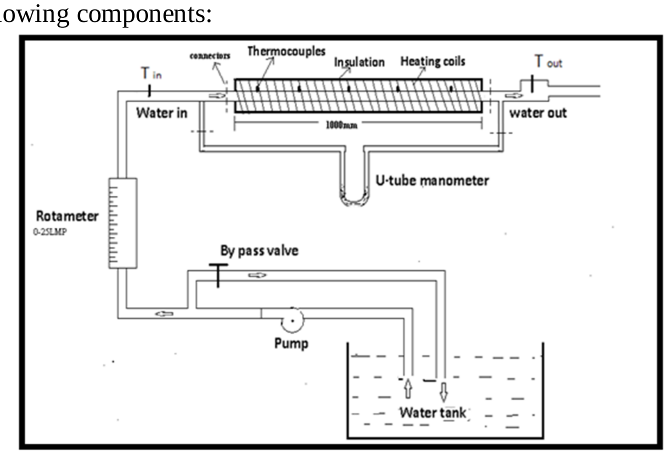


Fig 2: Front View of Experimental Setup.

Volume 3 Issue XII, December 2015
ISSN: 2321-9653

A. Pump

Pump is adapted to water flow inside the tube. Pump carries the water at such a high pressure to pass the water through the tube.2800 RPM, 0.5 H.P pump is used in this project.

B. Rotameter

An instrument employed to measure the mass flow rate of water is known as rotameter .the rotameter with the range of 0-25 LPM is used in this experiment set-up.

C. Thermocouple

The mass flow rate of water is regulated used in control valve. It is located in path of water and is having the handle with graduation in degrees. The mass flow rate of water can be increased or decreased by varying the regulator and various readings can be noted down accordingly.

D. U-tube manometer

An instrument employed to measure the pressure drop across the duct is called U-tube manometer.

E. Control-valve

The mass flow rate of water is regulated used in control valve. It is located in path of water and is having the handle with graduation in degrees. The mass flow rate of water can be increased or decreased by varying the regulator and varies readings can be noted down accordingly.

F. Digital temperature indicator

An instrument that shows the temperature reading at different places of tube is called digital temperature indicator.

G. Ammeter and Voltmeter

Instruments used to measure the current and voltage is called as ammeter and voltmeter respectively.

IV. EXPERIMENTAL PROCEDURE

After complete the fabrication of experimental set-up, the tap water is used to fill the water tank and then start the pump .Ammeter and Voltmeter are set up to the current and voltage range which gives the uniform heat flux to the tube ranging 39^{o}c to 41^{o}c at wall temperature. After setting the working fluid flow rate at 12 LPM, 14 LPM, 16 LPM, 18 LPM for steady state the set-up would be run continually. Take the temperature reading at inlet and outlet of tube after obtaining the steady state without using any inserts called as smooth tube. By using digital temperature indicator take the reading of tube surface wall temperature. Take the reading of pressure drop by using U-tube manometer. Repeat the experimental procedure by changing the valve of the inlet working fluid at different flow rate, till the steady state obtain. After obtaining the steady state in smooth tube repeat the experimental procedure for conical spring inserts. In the conical spring was inserted and its end were adjusted so that it remain fixed and pipe is not chocked. And then compare the test sectioned with smooth tube.

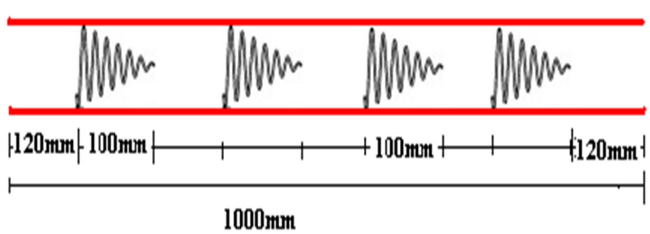


Fig 3: conical convergent spring insert in tube

At equal distance five conical springs are inserted in tube and these are contact with heated tube surface. Figure shows the systematic arrangement of conical spring used in a tube for investigation.

V. RESULT AND DISCUSSION

The experiments were carried out on the smooth tube without using any inserts and the different heat transfer characteristics were calculated. Then, for the same set up is used conical spring inserts. The experiment is dividing in two cases.

Cases I: Experiment on test tube without using any inserts.

www.ijraset.com
IC Value: 13.98
Volume 3 Issue XII, December 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Cases II: Experiment on test tube with conical convergent spring inserts (Number of inserts were five). In this experiment following parameters are calculated:-

A. Mass flow rate for 2 cases
B. Heat transfer coefficient
C. Nusselt number for 2cases
D. Reynolds number for 2 cases
E. Pressure drop for 2 cases
F. Frictional factor.

VI. GRAPH

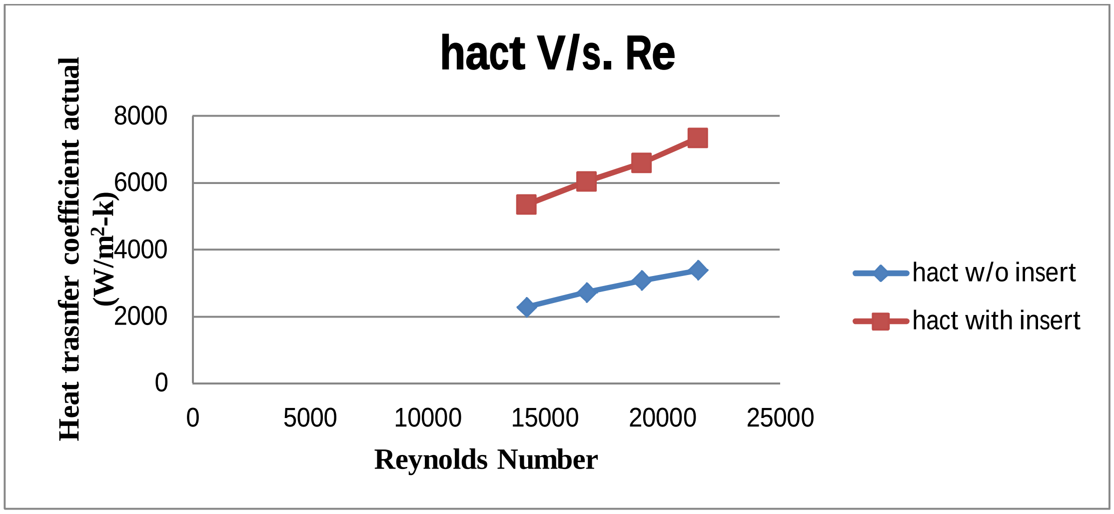


Fig 4: Heat transfer coefficient vs. Reynolds number

From above graph it is observed that Reynold number is increased with increased the Heat transfer coefficient. As Reynolds number increases, the water flows with more turbulence. From graph it is observed less heat transfer coefficient than conical spring inserts in tube when using without any inserts. Conical spring inserts create more turbulence in tube which increased heat transfer coefficient. As compared to smooth tube conical inserts gives maximum heat transfer coefficient.

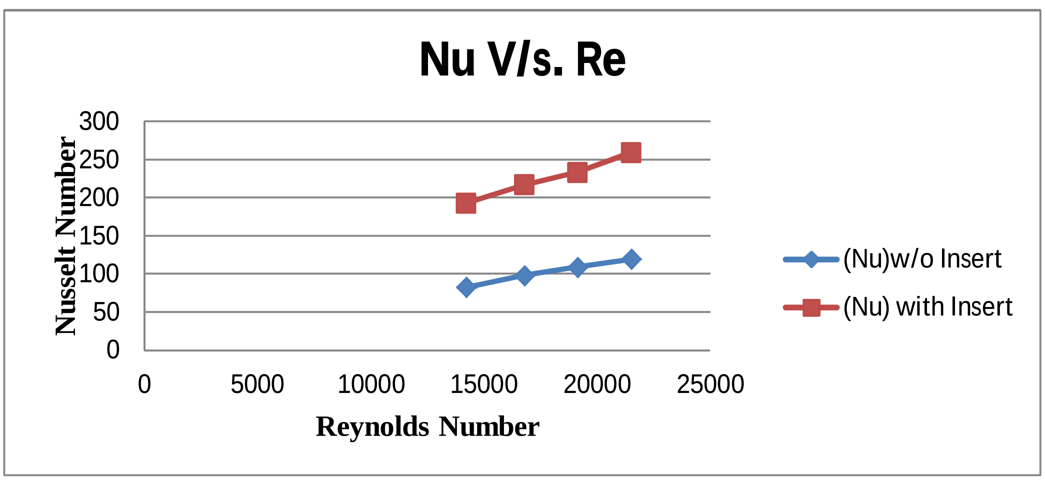


Fig 5: Nusselt number vs. Reynolds number

From graph it is observed that when nusselt number is increased the Reynolds number is also increased and when Reynolds number increased water flow more turbulence and due to which heat transfer rate will be increased. Heat transfer coefficient is directly proportional to the nusselt number i.e. increased with nusselt number heat transfer coefficient also increased. Minimum nusselt

Volume 3 Issue XII, December 2015
ISSN: 2321-9653

number is obtained in smooth tube without using any inserts and maximum nusselt number is obtained with using conical spring inserts.

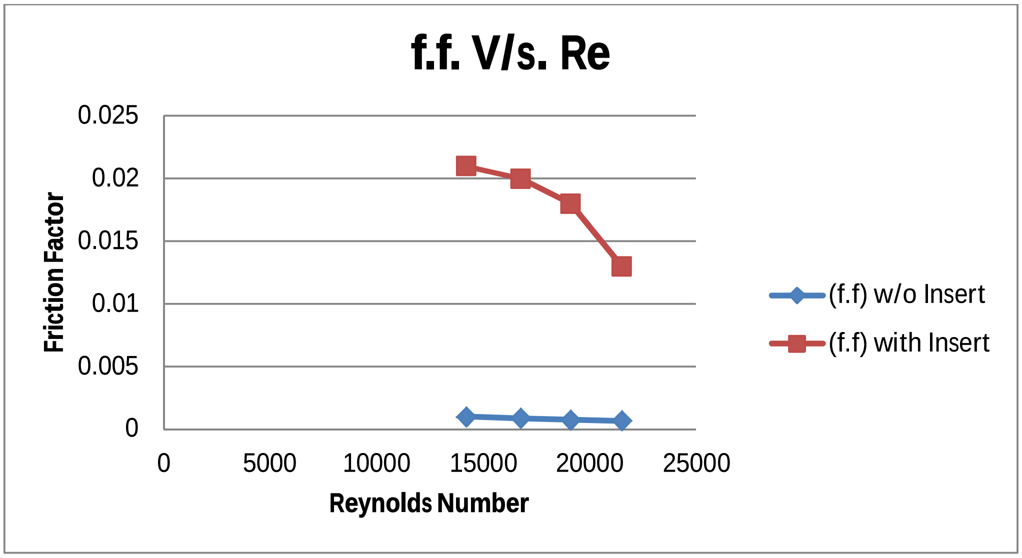


Fig 6: Friction factor vs. Reynlods Number

From graph it is observed that friction factor is decreased when the Reynolds number is increased because friction factor is inversely proportional to the velocity. Hence velocity is increased i.e. Reynold number is also increased and friction factor will decresed. In conical spring inserts friction factor is more and due to these pressure drop is maximum in tube. From graph it is observed that less friction factor is obtained in smooth tube.

VII. CONCLUSION

Experimental investigation hane been carried out in the circular tube to study the effect of conical spring inserts on heat transfer enhancement, friction factor. From graph following conclusion are made.

The heat transfer in tube with conical spring inserts is found to be more as compared to smooth tube i.e,without using any inserts.the increase in heat transfer coefficients of water 77.88% higher for conical spring inserts, over when number of inserts are use in tube.the increase in heat transfer occurs because more turbulances are generated within the tube by using diffferents shaped of inserts as compaerd to without using inserts.

As the reynolds number increse the friction factor will be reduced.as the reynold number increase ,velocity is also increses and the friction factor is inversely proportional to the velocity and hence it decreses.in smooth tube less friction factor is obtained as compaerd to conical spring inserts. In conical spring more friction factor is obtained,in tube when number of inserts is used more than 4,then it gives more heat tranfer coefficient.anda lso in tube pressure drop increses and due to this maximum friction factor is obtained.

Percentage increse in average values of heat transfer coefficient of inserts as compaerd to smooth tube without using any inserts is given as:

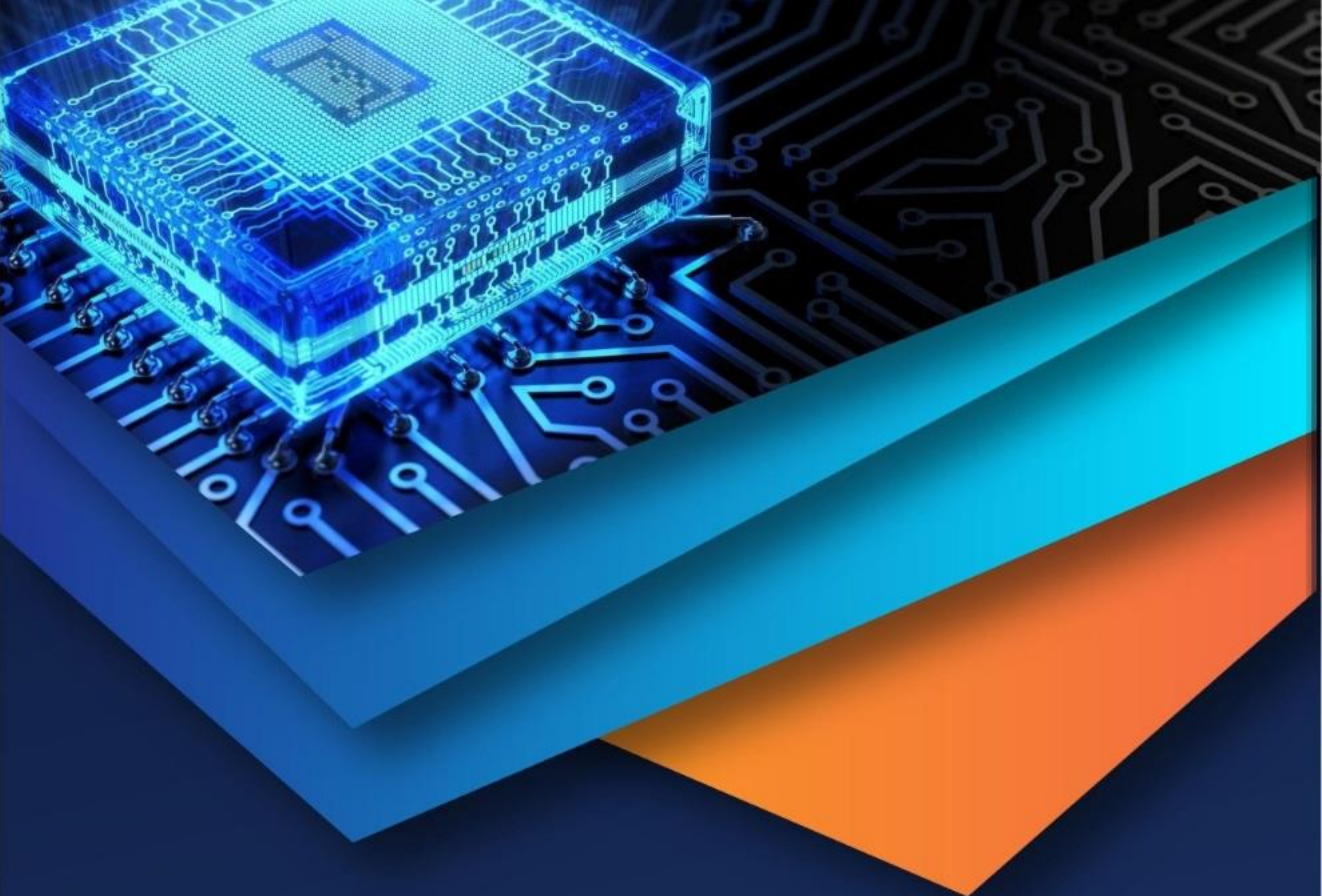
Table 6: Comparison of heat transfer enhancement for all cases:

Sr. no	Arrangement	Avg. heat transfer coefficient	Increase % of heat transfer coefficient
1	Without using any inserts	2876.35	------
2	Conical spring inserts	6340.05	54.63

Volume 3 Issue XII, December 2015
ISSN: 2321-9653

REFERENCES

[1] A.E.Bergles, techniques to augment heat transfer, in: W.M.Rohsenow.J.P.Heatnett, E.Ganie (Eds), Handbook of heat transfer application, MC Graw-Hill, newyork, 1985.
[2] S.S.Giri, V.M.Kriplani,"Heat transfer characteristics using inserts in tube; a review". International journal of engineering research and technology (IJERT), Vol.3, issue 2, February 2014.
[3] P.Promvonge,"Heat transfer Behaviors in round tube with conical ring inserts ". Energy conversion and management 49(2008)8-15.
[4] Yakut k,sahin B,canbazoglu S.performance and flow induced vibration characteristics for conical ring turbulators.appl energy2004;79(1):65-76.
[5] Alberto Garcia, jaun.p.salano, pendro G. Vicente, Antonio viedma."Enhancement of laminar and transient flow of heat transfer in tubes by mean of wire coils inserts "international journal of heat and mass transfer 50(2007)3176-3189.
[6] Mr.kumbhar D.G, Dr.sane N,"Heat transfer behaviors in a tube with conical wire coil inserts".
[7] Shivlingaswamy B.P, Narahari G.A,"Experimentalinvestigation on heat transfer and frictional characteristics of wire coils in transient flows at different prandtl number". An International journal of science and journal publications (IJSRP), vol4, issue 4, April 2014.
[8] M.A. Rashid, sarkar, saddam Husain khan, and sajib saha," heat transfer in turbulent flow through tube with conical ring". An International journal of arts and sciences. 07(03):257-269(2014).
[9] Pramod S. Purandare, Mandar M..Lele, Rajkumar Gupta,"Experimental Investigation of heat transfer and pressure drop of conical coil heat exchanger with parameters tube diameter, fluid flow rate and cone angle"
[10] Durmus A. heat transfer and energy loss in cutout conical tabulators, energy converse manage 2004; 45(5); 785-96.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY