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Heat Transfer and Pressure Drop Investigation in a Circular Tube by the use of Various Kinds of Inserts

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The ability of a traditional heat exchanger in transferring heat requires improvement for conveying a considerable proportion of energy at cheaper rate and amount. For augmenting the heat transfer coefficient, different means have been employed. However, the use of inserts has become an assured method in enhancing heat transfer through endurable escalation of frictional losses. The grinding factor improvement proportions are observed to be in the scope of 2.68-3.43, 3.14-4.14, 4.30-5.34, 5.22-6.18 and 6.53-6.96 for the previously mentioned configurations of additions.The objective of the investigation is the examination of a circular tube fitted with multiple inserts with regard to its characteristics related to fluid flow & heat transfer; these inserts are organized in co-swirl and counter-swirl directions.

Keywords: Nusselt number (Nu), Reynolds number (Re), F, Twisted tape (TT) inserts

Introduction

Heat exchangers

Heat exchanger (HE) is a fundamental component of intensity and cold storage cycles which encourages the exchange of vitality starting with one medium then onto the next by ideals of temperature distinction[1,2]. The temperature of every liquid changes as it goes across the exchanger, and subsequently the temperature of the isolating divider between the liquids additionally differs along the whole span of the exchanger[3,4]. The capacity of warmth exchanger to move heat from the worm liquid to the chilly liquid administers the warm presentation of the framework[7,8]. It is in this way expected to move the ideal measure of warmth vitality as fast as would be advisable[6]. Warmth move upgrade procedures are partitioned into two sorts initially is a functioning technique which needs an outer power source[9-11]; the second one is a uninvolved strategy which does not need any outside power source[12].

Experimental Section

The examinations exploratory test office whose schematic diagram (figure-1) is demonstrated as follows. The test arrangement comprises of copper test cylinder having an internal dia. (d) of 25.0 mm, thickness (t) 1.50 mm and length (L) of 1 mm. In the investigation the test cylinder is embedded of single, twin counter/co and set of four counter/co contorted tapes along the whole span of the cylinder. In the analysis we are using water as working liquid, which is persistently pinched from the steady head water tank arranged at 2.50 m range starting from the earliest stage. The glove valve controls the liquid stream rate according to the prerequisites of the trial. The rotameter that can gauge the stream rate put soon after the stream control valve to keep up the ideal stream rate[13-14]. The quieting segment comprises of electrifies iron pipe has a span of 1.5 m is given to show the stream to trial segment with no passage impact[16-17]. The leave end of the warmed trial cylinder is connected to the blending segment where the warmed liquid is permitted to get blended altogether before achieving the thermocouple put at the exit end.

Experimental methodology

Different types of geometry for tube inserts are illustrated in table-1. The examinations is executed on round weight contoured with single and diverse turned tape embeds over a large degree of Re (4000 to 14000) with water as a working liquid to gather the fundamental information, relating to the sparkle move rate and weight drop. Experiment is other than

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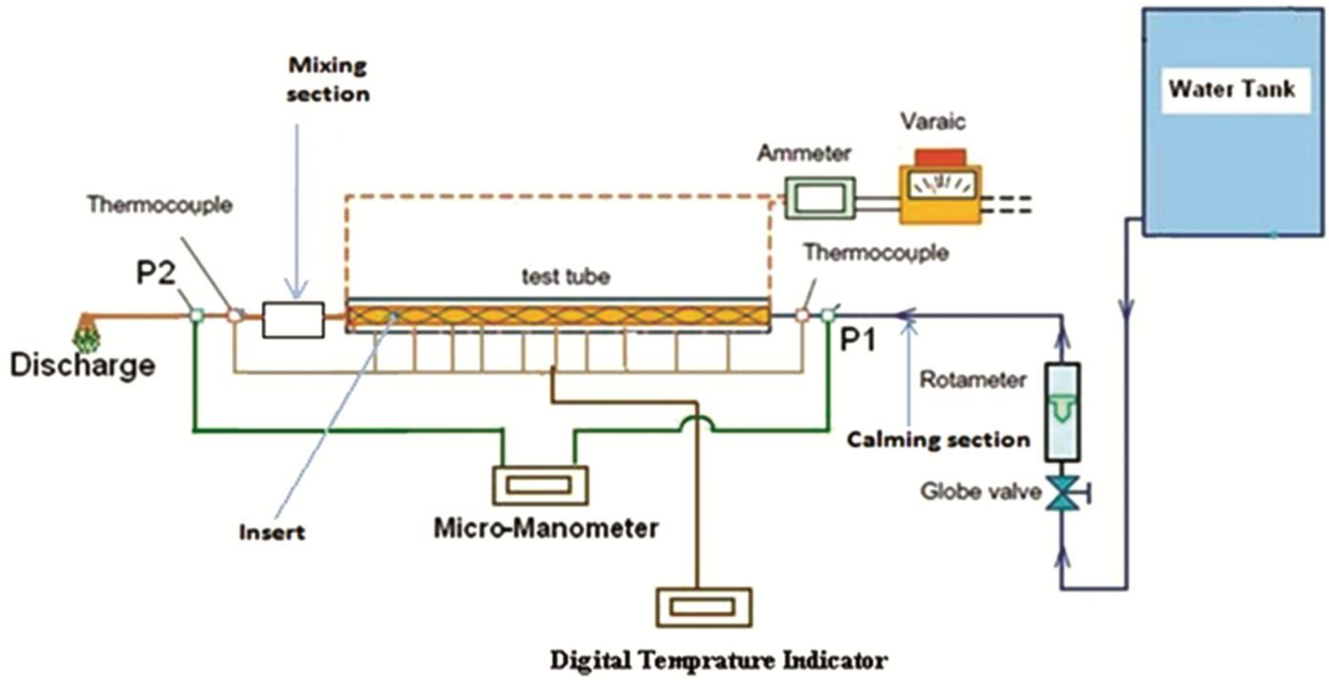

Fig.1 — Schematic diagram for investigations of heat transfer and pressure drops

Table 1 — Geometry of tube inserts (All dimensions are in mm)

Twisted tapes	ST (single twisted tapes)	CoTs (twin co-swirl twisted tapes)	CTs (twin counter-swirl twisted tapes)	4CoTs (four co-swirl twisted tapes)	4CTs (four counter-swirl twisted tapes)
Tape width (w)	24.0	12.0	12.0	6.0	6.0
e pitch (P)	84, 72 and 60.0	42, 36 and 30.0	Just like Co Ts	21, 18 and 15	Just like 4CTs
Twist ratio (y=P/w)	2.50, 3.0 and 3.5	Just like ST	Just like ST	Just like ST	Just like ST
Tape thickness (t)	0.60	Just like ST	Just like ST	Just like ST	Just like ST
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum

completed on unwrinkled chamber to check the presentation of different damage tape exhibited chamber. At that point the all the additionally sweltering gives a uniform warmth improvement over the chamber surface. In the wake of setting the radiance change and liquid stream rate, the temperatures of the trial chamber surface and the liquid under control and exit are seen. At first the chamber surface and leave liquid temperature perusals are questionable and ways to deal with oversee control higher qualities with the time. It has been seen that around following half hours; the temperature at all the spaces winds up free of the time which perceives that the structure is bored the dependable position derivative. Not long after the achieving the suffering position derivative, the chamber surface temperature at eight (08) regions, cove and leave liquid temperatures are registered. The refinement of weight head over the test chamber is investigated by the guide of humbler scale manometer. The hard and fast structure is underlined by changing the stream rate to accumulate the information for warmth move and beating over the degree of examination. Sorted out approach of turned tape redesigns are endeavored over the whole degree of structure and working parameters by following the above system.

Validation of experimental setup

The credibility of test detail is affirmed by social occasion the details on heat move and pressure drop for the unwrinkled chamber without enhancement and the Nu and scouring segment estimations of the unwrinkled chamber are differentiated and the outcomes got from the standard associations. The quality data on warmth move and grinding component for the course through the unwrinkled test chamber is gotten from the Dittus Boelter and Blasius associations, as given in equation (i) and (ii)[15].

Dittus Boelter correlation

$$Nu=0.023Re^{0.8}Pr^{0.4} \quad \ldots (1)$$

Blasius correlation

$$f=0.316\ Re^{0.25} \quad \ldots (2)$$

Here Nu, Re and Pr are Nusselt, Reynold and Prandtl numbers respectively.

Results and Discussion

The exploratory information are utilized to acquire the dimensionless parameters relating to heat move and grating in a cylinder with single and various contorted tape embeds. So as to think about the impact of bent tape geometrical parameters on the heat move and contact, the Nu and grating variable plots are talked about for the whole scope of parameters by fluctuating the stream Re from 4000 to 14000. The warmth move upgrade brought out by the utilization of various curved tape embedded cylinder is talked about by plotting the Nu improvement proportion (Nu/Nus). The frictional misfortunes caused by the turned tapes embedded cylinder is additionally inspected with the assistance of contact factor improvement proportion (f/fs) variety over the whole scope of stream Re. The thermo-water driven execution factor is additionally contemplated for various contorted tape arrangements to know the genuine upgrade in the presentation.

Effect of Reynolds number

Figures 2(a) and 2(b) demonstrate the variety of Nu with the adjustment in Re for a smooth roundabout cylinder with various kinds of turned tape supplements having turn proportion (y) of 2.5 and with no addition. From these figures, it very well may be seen that the Nu increments and rubbing variable declines with an expansion in the Re for all cases. The Nu and grinding element drew nearer to the most extreme incentive for four counter-whirl wound tape embeds (4CTs) at all the estimations of the Re.

Effect of twist ratio (y)

The plots of Nu and rubbing element appeared in figures 2(c) and 2(d) uncover that both Nu and the grinding element are expanded with the decrease in the estimation of curve proportion paying little respect to the estimation of Re in all cases. With the decrease in the wind proportion, the area influenced by the radial powers expands up and subsequently advances the tempestuous force of the liquid close to the divider. The plots appeared in figures 5.6 to 5.10 affirm that the

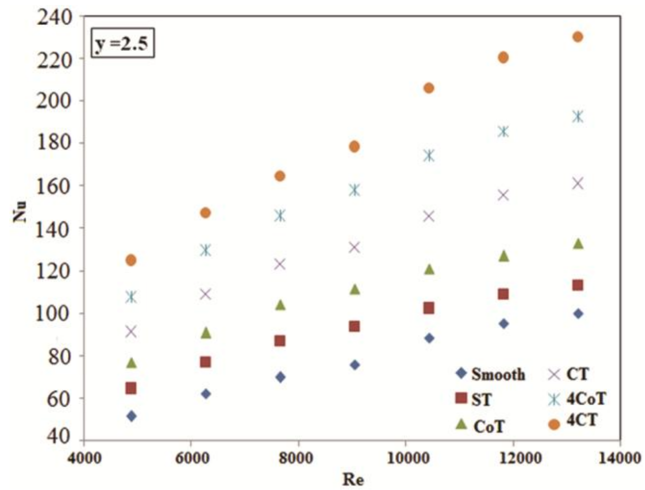

Fig. 2a — Variation of Nusselt number for different types of twisted tape inserted with respect to Reynolds number (y=2.5)

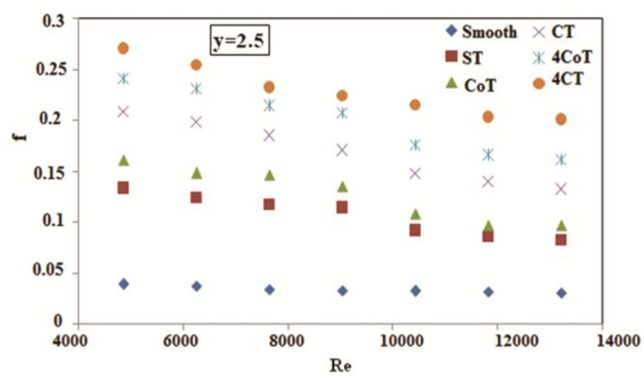

Fig. 2b — Variation in friction factor with respect to Reynolds number for different types of twisted tapes inserts (y=2.5)

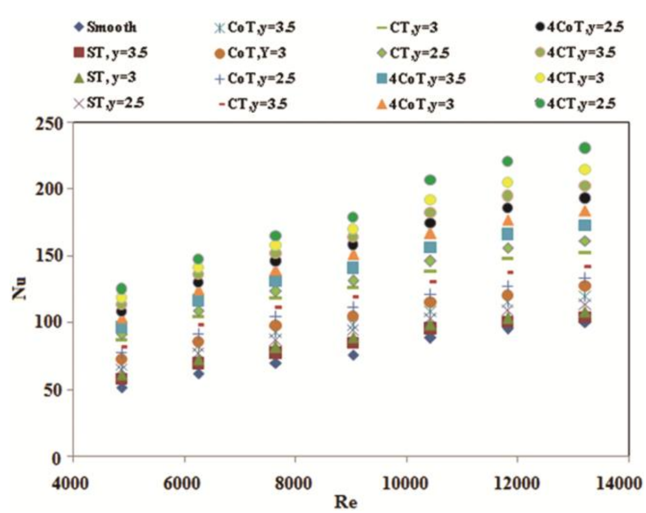

Fig. 2c — Nusselt number as function of Reynolds number for different twisted tapes

(*Contd.*)

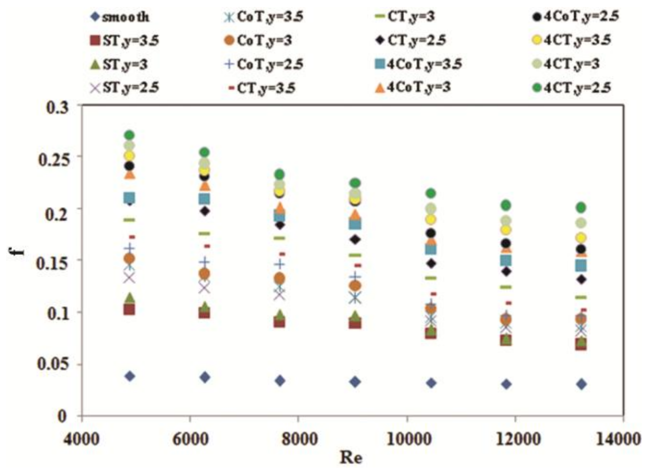

Fig. 2d — Friction factor as function of Reynolds number for different twisted tapes

best outcomes relate to four counter-twirl wound tape supplements having turn proportion of 2.5.

Conclusion

The conclusions drawn from the above research are:

- For the different types of twisted tapes, the increase in Re causes increases in the Nu and decrease of friction factor. Both the Nu and friction factor are affected by the Re owing to increase in the number of TT inserts.
- As the Re expands the upgrade proportions of Nu and grating element decline in all cases. Improvement proportions of nussult number lie between 1.13-1.25, 1.33-1.49, 1.61-1.77, 1.92-2.09 & 2.3-2.42 for (ST), (CoT), (CT), (4CoT) and (4CT), individually, while the wind proportion is remains as 2.50. The grinding factor improvement proportions are observed to be in the scope of 2.68-3.43, 3.14-4.14, 4.30-5.34, 5.22-6.18 and 6.53-6.96 for the previously mentioned configurations of additions.
- With decrease in the twist ratio (y) of the twisted tapes, there is increase in the Nu and friction factor values regardless of the variation in Re.

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