helical arrangement can be said as self cleaning heat exchanger.

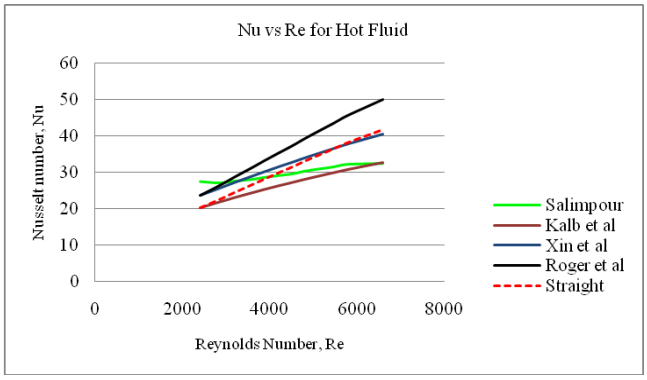
2) No Secondary turbulence – due to absence of curvature there is no secondary turbulence in straight tube-in-tube configuration. As stated earlier, this gives poor mixing of fluids and hence heat transfer is affected.

5. Results and Discussions

Based on observations, the effectiveness for all the flow arrangements are calculated and it is found that Counter flow arrangement with cold water flowing through inner tube and hot water flowing through annular space is most effective. It gives the effectiveness of 0.6767 for the mass flow rate of 210 lph.

5.1 Effect on Nusselt number

Next two graphs show the effect of Reynolds number on Nusselt number. Correlations given by different scientists consider various parameter while calculating Nusselt number. Hence, four different curves for each correlation were plotted.



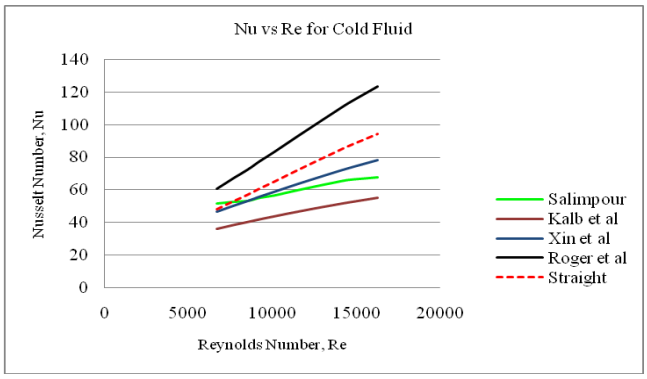


Figure 2: Nusselt number, Nu Vs Reynolds number, Re

From above graphs it can be seen that, for same Reynolds number, value of the nusselt number given by Roger for helical tube in tube arrangement is higher than straight tube arrangment. As the Roger considered curvature ratio for calculation of nusselt number, it results into increased heat transfer due to secondary turbulence. Thus, values given by Roger are considered for comparison.

5.2 Effect of Pressure drop

Next two graphs compare the effect of pressure drop on heat transfer coefficient for both straight and helical arrangements. With gradual increase in mass flow rate, pressure drop increases more rapidly in tube-in-tube helical coil heat exchangers as compared to straight tube-in-tube arrangement. Pressure drop acts like driving force for heat transfer. These graphs highlight this. The ratio of pressure drop to heat transfer coefficient for helical tube-in-tube arrangement is comparable with straight tube-in-tube arrangement. Pressure drop curve for straight tube-in-tube is steeper than helical tube-in-tube arrangement.

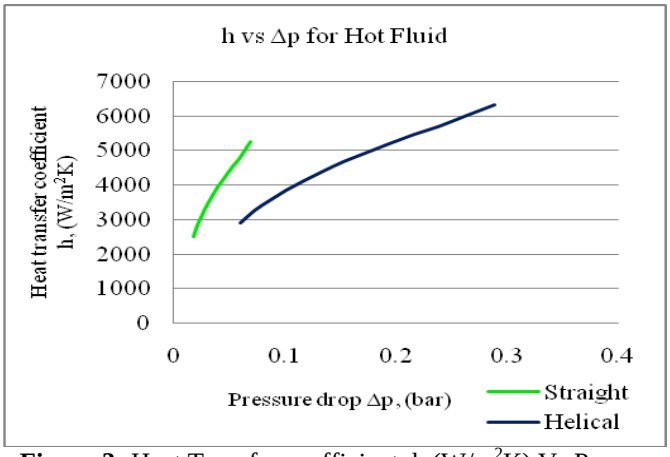
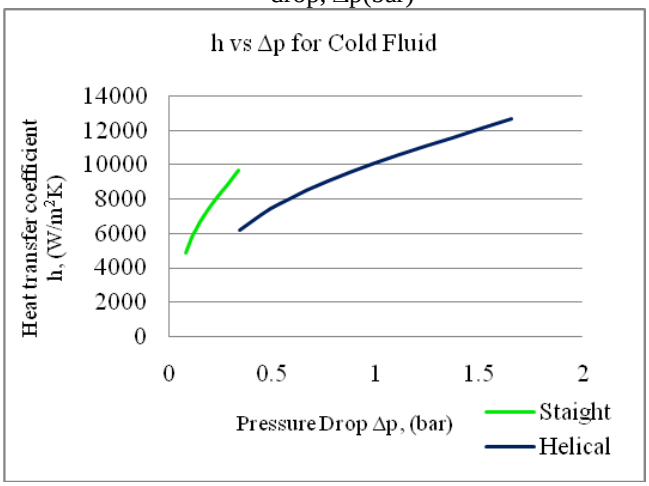


Figure 3: Heat Transfer coefficient, h (W/m^2K) Vs Pressure drop, Δp(bar)



6. Conclusion

Comparative experimentation and analysis is carried out between tube-in-tube helical coil heat exchanger and straight heat exchanger. The results of this analysis showed that previously published correlations yield similar results to the one obtained in this work. Based on the experiments, the following conclusions are drawn:

1) Intensity of secondary flow developed goes on increasing with increase in curvature ratio. This increase in turbulence causes significant mixing of fluid inside the tube which resultantly increases heat transfer coefficient.

2) The heat transfer coefficient in helical heat exchanger increased with flow rate and approached a maximum value at higher flow rates. It is observed that the heat transfer coefficient for helical tube-in-tube arrangement is approximately 10 to 20 times that of straight tube-in-tube arrangement.
3) This heat transfer is obtained on the expense of pressure drop which is 200-300% higher than straight tube in tube heat exchanger, which is within permissible limits as per earlier research in similar field.
4) For the same surface area, the heat energy absorbed by helical tube is more than that of straight copper tube. For same heat transfer rate of these heat exchangers, straight tube-in-tube heat exchanger is large in size and thus bulky. Thus compact size provides a distinct benefit of tube-in-tube helical coil heat exchanger.

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