6. Results and Discussion

6.1 Steady State Tube Side Numerical Analysis [With Fins]

Table 6.1: The values of Re and Nu

Sl.No	Mass flow rate (kg/s)	Reynolds number	Nusselt number
1	0.25	1086	4.364
2	0.5	2155	4.364
3	0.75	3266.7	18.4553
4	1.00	4296.5	33.962

Table 6.2: Pressure drop and friction factor

Sl.No	Mass flow rate(kg/s)	Pressure drop(kPa)	Friction factor
1	0.25	0.015655	0.0589
2	0.5	0.03255	0.0407
3	0.75	0.08727	0.0338
4	1	0.18634	0.029

Table 6.3: The heat transfer rate with and without fins

Sl.No	Mass flow rate(kg/s)	Heat transfer rate (with fin) (kW)	Heat transfer rate (without fin) (kW)
1	0.25	7.12	5.22
2	0.5	7.3	5.3
3	0.75	8.4	7.5
4	1	8.6	8.1

6.2 Graphical Representation of Obtained Results

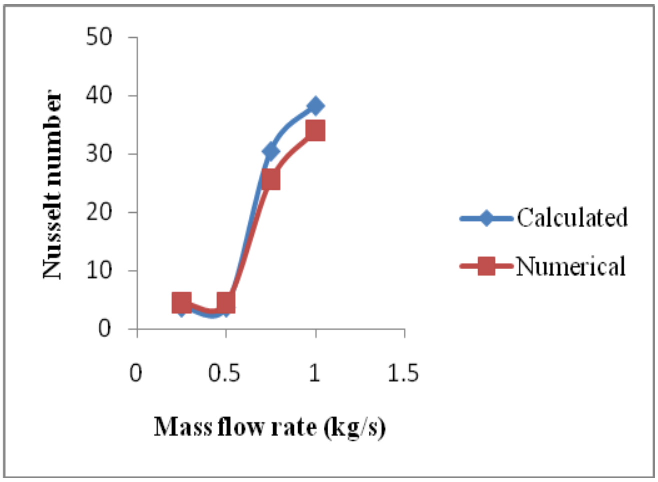

Figure 6.1: Mass flow rate vs Nusselt number

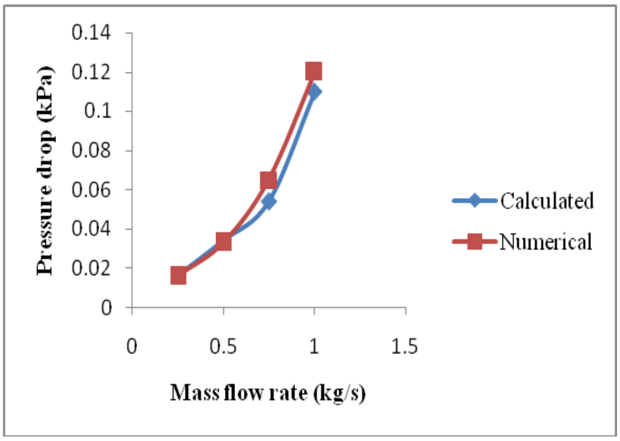

Figure 6.2: Pressure drop vs Mass flow rate

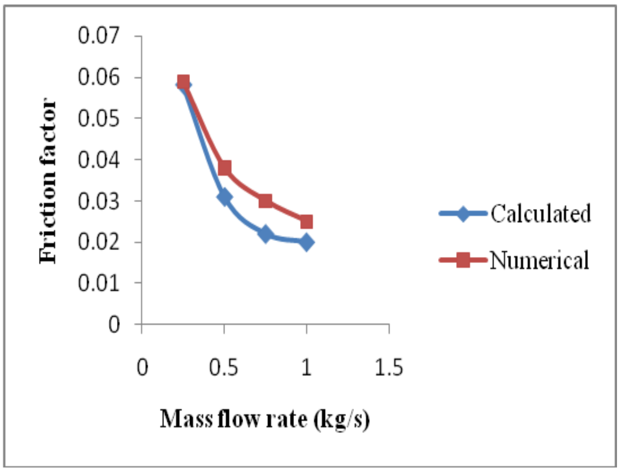

Figure 6.3: Mass flow rate vs friction factor

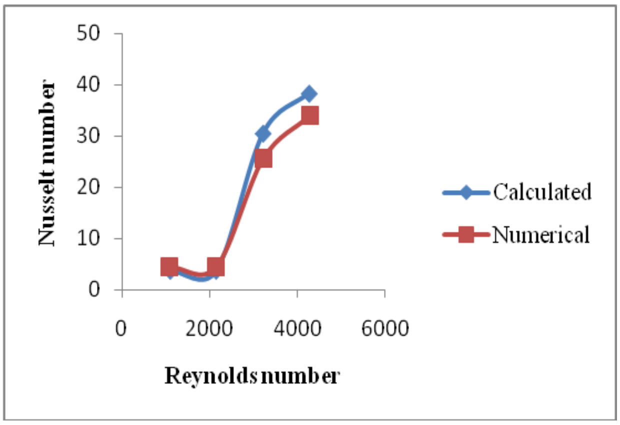

Figure 6.4: Reynolds number vs Nusselt number

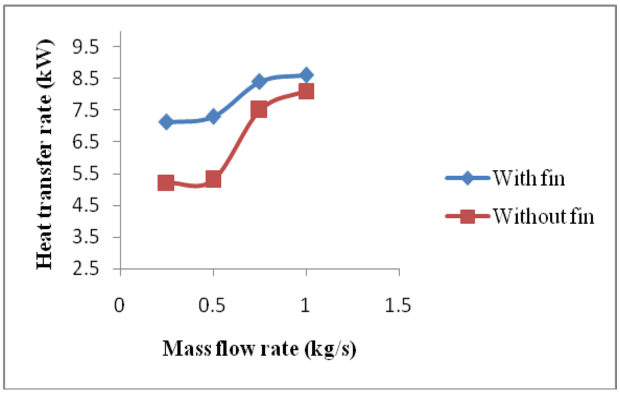

Figure 6.5: Mass flow rate vs heat transfer rate

Figure 6.1 shows the variation of Nusselt number for the different mass flow rates. From the graph it is cleared that with increase in the mass flow rate on tube side, Nusselt number also increases. This indicates that convection is predominant; this results in the enhanced heat transfer.

Figure 6.2 shows the variation of pressure drop with different mass flow rates. From the graph it is seen that pressure drop increases with the increase in the mass flow rate. So designers have to think about optimum mass flow rate while designing the compact heat exchanger.

From figure 6.3 it is seen that with the increase in the mass flow rate at the tube side, friction factor gradually decreases. This results in the increased heat transfer rate.

Figure 6.4 shows the variation of Nusselt number with respect Reynolds number. With the increase in the Reynolds number of the tube side, Nusselt number also increases. This shows that convection is predominant. From this it is cleared that heat transfer rate can be increased by increasing Reynolds number.

Figure 6.5 shows variation of heat transfer rate with respect to varying mass flow rate at the tube side. As the mass flow rate increases at the tube side, heat transfer rate also increases. It is seen that tubes with fins gives higher heat transfer rate as compared with the tubes having no fins.

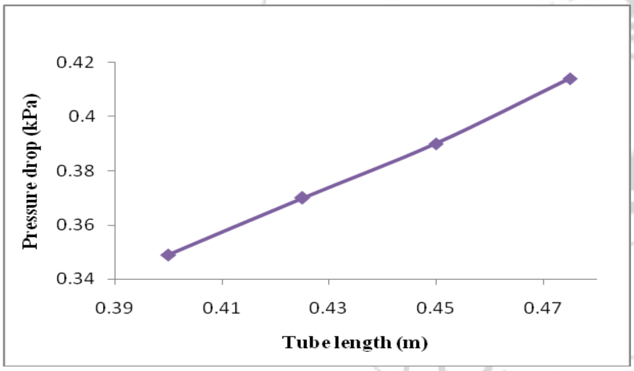

Figure 6.6: Tube length vs pressure drop

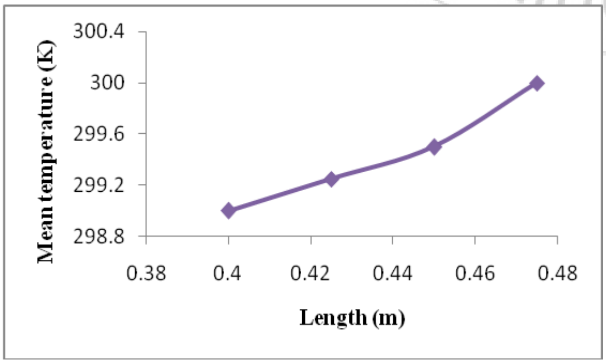

Figure 6.7: Tube length vs mean temperature

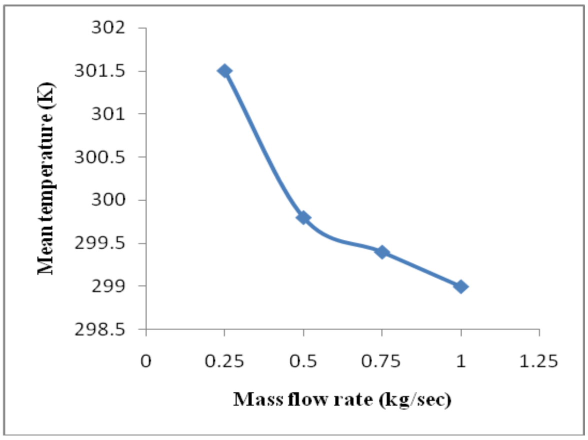

Figure 6.8: Mass flow rate vs mean temperature

Figure 6.6 shows the variation of pressure drop with respect to the tube length. From the above graph it can be noted that with the increase in tube length, pressure drop also increases. Therefore pumping power is more required.

Figure 6.7 shows the variation mean temperature with the tube length. From the above graph it can be seen that mean temperature increases gradually with the increase in tube length, as a result heat transfer rate increases. But designer should take care of pressure drop also.

Figure 6.8 shows the variation of mean temperature with the mass flow rate at the tube side. The graph shows that with increase in the mass flow rate at the tube side, the mean temperature of the fluid gradually decreases.

7. Conclusions

The present study mainly involves heat transfer characteristics of shell and finned tube heat exchanger. Finned tubes are used for the present study in order to improve the heat transfer rate of the heat exchanger.

- Reynolds number of the flow play a vital role in the heat transfer enhancement in a heat exchanger. From the numerical analysis it is concluded that with the increase in the Reynolds number, Nusselt number also increases. Hence heat transfer rate increases. The magnitude of heat transfer coefficient is proportional to the Reynolds number of the flow.
- The heat transfer coefficient for the turbulent flows (Re >2500) is more than laminar flows (Re <2500).
- The pressure drop is evaluated along the tube length. Pressure drop curve shows that pressure drop increases with increase in tube length.
- With the increase in the velocity of the tube side fluid Nusselt number increases and hence convective heat transfer coefficient increases; this enhances the rate of heat transfer.
- Steady state analysis shows that mean temperature increases gradually with the increase in tube length, as a result heat transfer rate increases.
- The numerical and analytical results are compared and they are in close agreement to each other.

8. Scope for Further Work

i. The vortices or eddies play an important role in enhancing the heat transfer in a heat exchanger. Because the turbulent flows gives better heat transfer as compared to laminar flows. The turbulent flow is due to formation of set of vortices.

ii. At a given Reynolds number the flow can be made more turbulent by introducing artificial eddies in to the flow.

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