# Experimental Investigation of Spiral Fin Tube Heat Exchanger with Different Fin Thickness

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**Abstract-** The demand for compact heat exchangers is continuously increasing in the automotive industry, refrigeration and air-conditioning applications has necessitated the use of various interrupted surfaces to augment air-side heat transfer. Fins are normally used to increase heat transfer coefficient and increasing efficiency of heat exchanger. Spiral fins are most widely used by industry. In this study spiral fin performance is investigated with different fin thickness (0.5, 0.6, 0.7 mm) at different Reynolds number

**Index Terms-** Spiral fin, heat transfer coefficient, fin performance

## 1. INTRODUCTION

Heat exchanger is a basic component in industrial system involving the process of heat transfer. Improved design fins are used as a effective way to improve the performance of heat exchanger. Heat exchangers are widely used in air-conditioning, refrigeration, processing industry. Compact heat exchangers are also used in automobile industries, radiators, evaporators, condensers, and charge air coolers. In these applications, the heat transfer performance is normally limited by the thermal resistance on the air side of the heat exchangers. Fins are also used in cooling of electronic components and gas turbine blades. In these applications, fins are used in simple designs such as rectangular, triangular, parabolic, annular, and pin rod fins or complicated designs such as spiral fins.

## 2. EXPERIMENTATION:

In the experiment, heated air is forced to flow through the tube with the help of blower. The test section consists of aluminum pipe with externally spiral fins of material aluminum. The air inlet temperature, outlet temperature and temperature at four intervals of the test section was measured by thermocouples. The uncertainty of these thermocouples is ±0.05°C.

The system was allowed to approach a steady state before any data was recorded under the experimental conditions. The capacity of heater is 0.5 kW. The manometer connected across the orifice meter is used to calculate the air flow rate. Input power of test section is controlled with voltage regulator.

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Table 1.Geometric description of test set up

| | |
|---|---|
| Material of tube | Aluminum |
| Material of fin | Aluminum |
| Type of thermocouple | K type |
| Tube inside diameter | 25.4 mm |
| Tube outside diameter | 32.4 mm |
| Tube length | 365 mm |
| Fin pitch | 4.23mm |
| Fin thickness | 0.5mm,0.6mm, 0.7mm |
| Fin diameter | 37 mm |
| Orifice diameter | 15 mm |
| Pipe diameter | 30 mm |

Fig. 1.Experiment set up of spiral fin tube heat exchanger

Table 2.Observation table:

| **Fin Thickness ($f_t$)** | **Fin pitch ($f_p$)** | **Inlet temperature (°C)** | | |
|---|---|---|---|---|
| | | **Low velocity** | **Medium velocity** | **High velocity** |
| 0.5 | 4.23 | 41 | 39.5 | 36.6 |
| 0.6 | 4.23 | 41.5 | 38.5 | 36.5 |
| 0.7 | 4.23 | 41.5 | 39.5 | 37 |
| | | **outlet temperature (°C)** | | |
| | | **Low velocity** | **Medium velocity** | **High velocity** |
| 0.5 | 4.23 | 36.5 | 35.8 | 34.3 |
| 0.6 | 4.23 | 37.1 | 34.9 | 34.1 |
| 0.7 | 4.23 | 36.3 | 34 | 34.3 |

## 3. DATA REDUCTION

$$Re = \frac{\rho v d}{\mu}$$

Re is Reynolds number at particular velocity of air.

$\dot{m}c_p (T_{out} - T_{in}) = hA(T_s - T_{mean})$

$T_{mean} = (T_{out} + T_{in})/2$

$$Qact = \frac{a1 \times a2 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{(a1^2 - a2^2)}}$$

Where h is manometer difference in m of air

$$Nu = \frac{hLc}{k}$$

Nu is Nusselt number at particular value of heat transfer coefficient h.

Validation of result from Gnielinski correlation

$$Nu = \frac{(Re - 1000)Pr\left(\frac{fi}{2}\right)}{1 + 12.7\sqrt{fi}(Pr^{0.66} - 1)}$$

friction factor f= $(1.58\ln Re - 3.28)^{-2}$

## 4. RESULT

From the experiment it can be conclude that the value of heat transfer coefficient h inside tube increases with the fin thickness. The heat transfer coefficient is maximum for 0.7 mm fin thickness as shown in fig 2.

The value of Nusselt number inside tube also increases with the increase in Reynolds number as shown in fig 3.

The friction factor of a tube is inversely proportional to the square of velocity and it will be minimum at high Reynolds number as shown in fig 4.

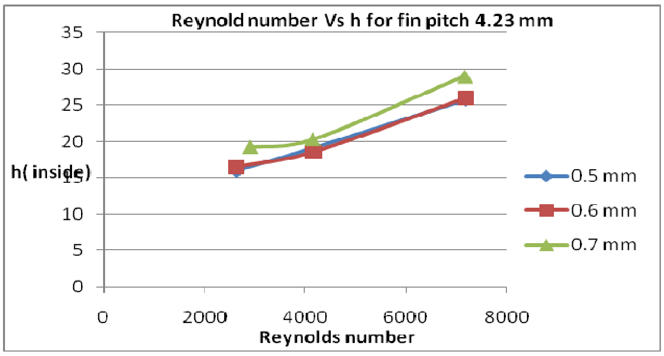


Fig. 2.Variation of h with Reynolds number for different fin thickness

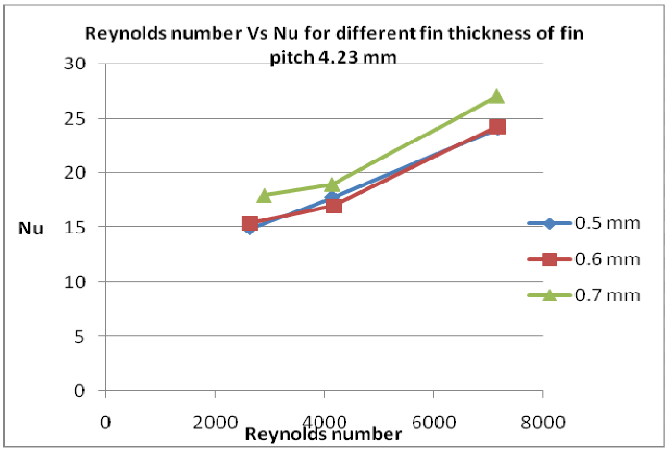


Fig. 3.Variation of Nu with Reynolds number for different fin thickness

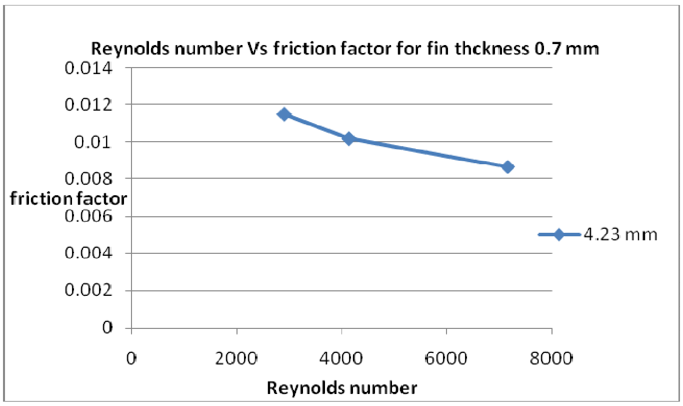


Fig. 4.Variation of friction factor with Reynolds number for different fin thickness 0.7 mm

## 5. CONCLUSION

In this experiment heat transfer coefficient, Nusselt number, friction factor investigated. The calculation have been carried out by well verified and validated rating. The corresponding mathematical formulation has been briefly described within the paper. Now as we increases the air velocity heat transfer rate of finned tube heat exchanger is increases because the Reynolds number is increases the Nusselt number is also increases because Nusselt number is directly proportional to the heat transfer coefficient. So, heat transfer rate is increases.

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