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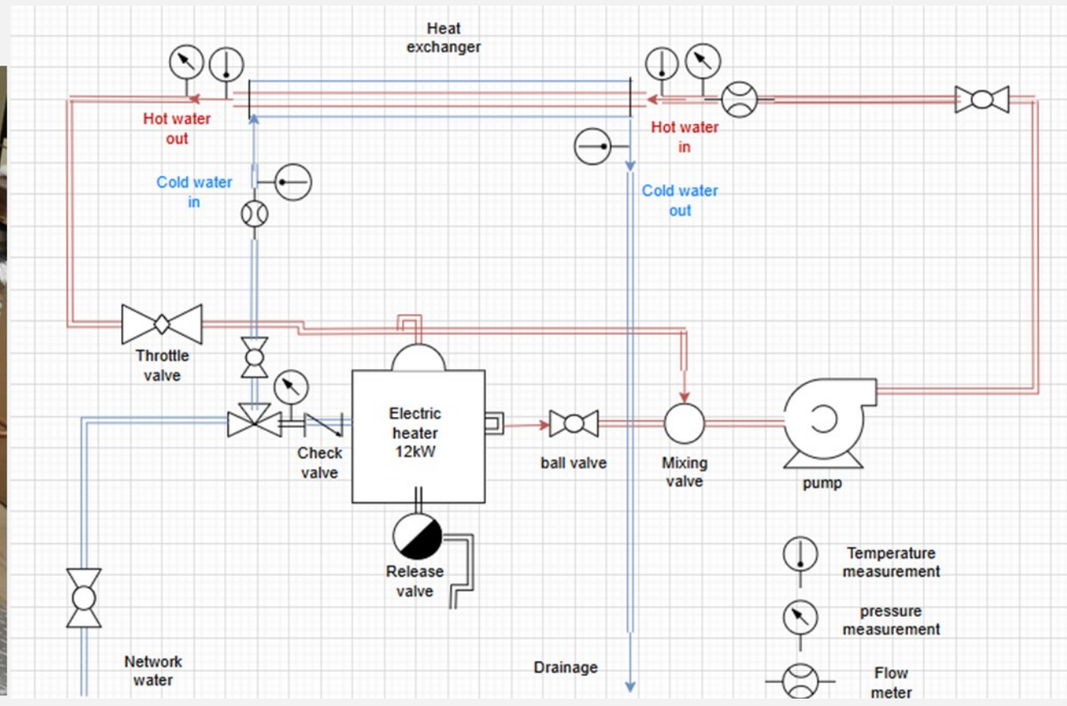
Experimental determination of heat transfer in a double pipe heat exchanger with internally grooved tubes

OBJECTIVE

The objective of this study is the design and analysis of an experimental closed-loop forced-flow system with controlled temperatures, supplying hot water to a double-pipe heat exchanger in counterflow configuration. This setup enables the performance comparison between smooth tubes and tubes with internal grooves. The experimental investigation involves measuring the temperature difference at the inlet and outlet of the tubes, the pressure drop across the tested tube, and the mass flow rates under different flow conditions, in order to assess the impact of the grooves on the heat exchanger's performance. For the analysis of the results, empirical correlations from the literature were employed.

EXPERIMENTAL SETUP

The experiments were conducted within a Reynolds number range of 9,800 to 29,800, with mass flow rates varying between 0.034kg/s and 0.1 kg/s, and hot fluid inlet temperatures ranging from 58°C to 63°C.

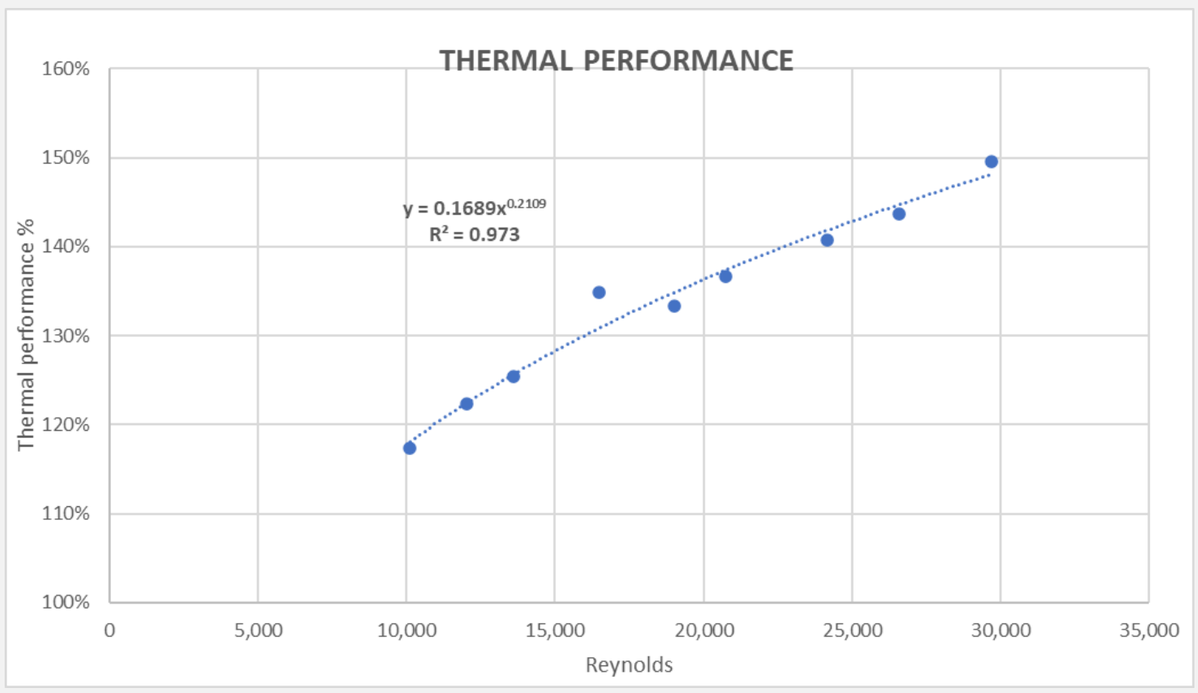


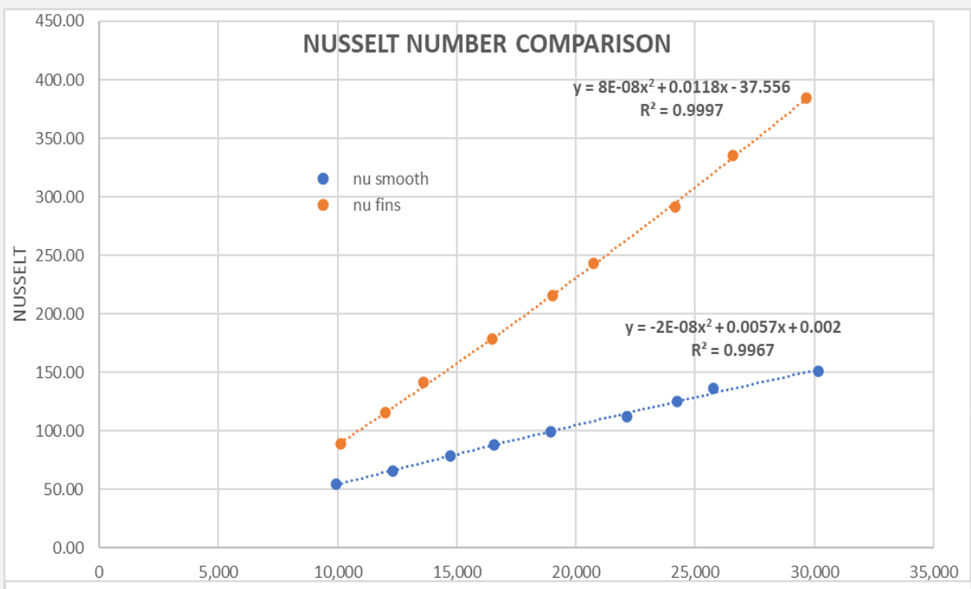
CODENAME	OUTER DIAMETER (mm)	INNER DIAMETER (mm)	WALL THICKNESS (mm)	FIN HEIGHT (mm)
IGT B60	9.52	7.92	0.6	0.2
ACR 9.52	9.52	8.72	0.8	–

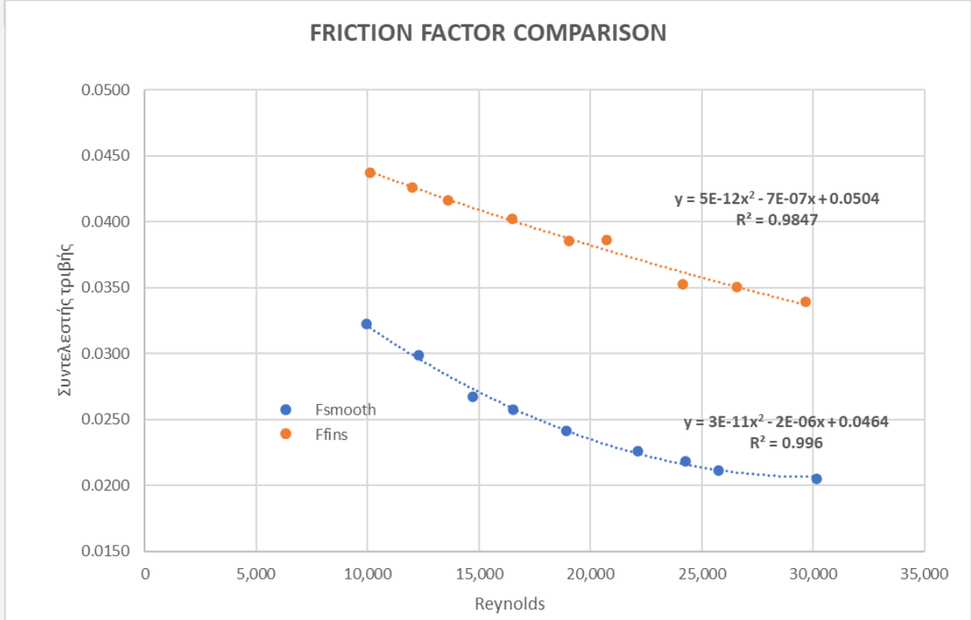
The experimental setup consists of a double-pipe heat exchanger operating in a counterflow configuration. The inner tube used is either smooth (Halcor : ACR 9,52 mm) or internally grooved (Halcor: IGT B60).

RESULTS & DISCUSSION

The implementation of internal grooves resulted in a 38% - 60% increase in the Nusselt number (orange) compared to smooth tubes with a 26% - 40% increase in pressure drop. However, the thermal performance of the grooved tube compared to the smooth one increases consistently from 1,2 to 1,5 with the increase of the Reynolds number.







CONCLUSIONS

Internally grooved tubes significantly enhance heat transfer as indicated by the higher Nusselt number. However, the increased pressure drop may reduce overall energy efficiency. Optimizing groove geometry can help balance performance gains and pressure losses for improved system efficiency. The thermal performance results proved the grooves' effectiveness.

The experimental setup demonstrated adequate performance and reliability, providing consistent and accurate measurements of temperature, flow rate, and pressure drop. The design effectively captured the impact of internal grooves on heat transfer enhancement and pressure losses, validating the expected trends. The results confirmed that the experimental methodology is suitable for evaluating heat exchanger performance under varying flow conditions.