## Nanoscale physics

# Study on heat transfer of nanofluid flow inside a corrugated tube

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In this study, heat transfer characteristics of water/$TiO_2$ nanofluid flow inside corrugated tubes are investigated, experimentally. The boundary condition of the tubes is uniform wall temperature. For this purpose, a test apparatus was designed and assembled. The length of test section was 93 cm with internal diameter of 7.71 mm and outer diameter of 9.52 mm. First, the data were obtained for pure water flow in the plain tube. Later, various test runs were performed for different nanoparticle concentrations, different corrugation depths, different corrugation pitches, and different corrugation widths in a wide range of Reynolds number ($3000<Re<15000$). Experimental results show that:

1. The experimental values of the Nusselt number for the plain tube are in good agreement with the values predicted by empirical equation and the average deviation is about 3.25% and 7.3%, respectively.

2. For pure water and nanofluid flows, Nusselt numbers are enhanced with increasing Reynolds number and with adding nanoparticles. As found, the nanofluids with 0.1% and 0.5% volume concentrations of $TiO_2$ give mean Nusselt numbers higher than the base fluid by around 1.6 and 3.4%, respectively.

3. The Nusselt number is enhanced with the increase of corrugation depth to diameter ratio and corrugation width to diameter ratio (especially in larger Reynolds numbers) and decrease of corrugation pitch to diameter ratio. It is observed that the effect of nanoparticles on heat transfer of corrugated tube with higher corrugation depth and corrugation width and lower corrugation pitch is more pronounced.

4. The thermal performance factor is better at higher corrugation depth to diameter ratios, corrugation width to diameter ratios and lower corrugation pitch to diameter ratios. This factor for all corrugated tubes is more than unity. Also, the highest performance is about 2.45 which was achieved for 0.5% of nanoparticles concentration inside the corrugated tube.