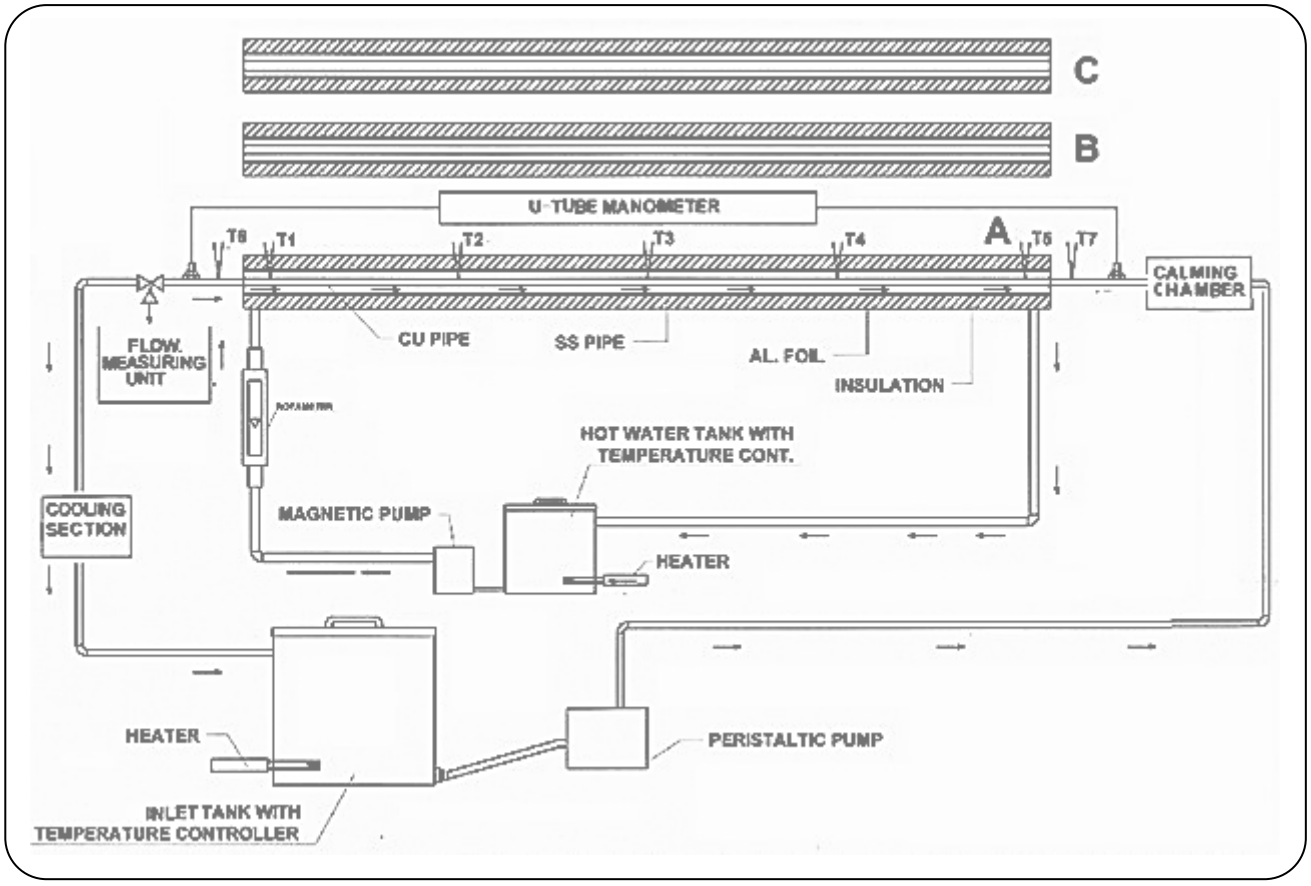
Supplementary Information

The test experimental setup for the straight tube is shown below. It consists of a tank with a temperature controller, peristaltic pump, a calming chamber, a test section, a cooling unit, several temperature indicators, and a flow measuring unit. The Test section was a concentric chamber, consisting of an inner copper tube and an outer section of stainless steel. Three copper tubes (inner) were used with different inner diameters of 12.96 mm, 15.9 mm, 22.24 mm, and 1.5mm as thickness. The stainless tube used had a fixed outer diameter of 38mm. Test fluid flows inside the inner tube while the hot fluid enters the annular section, which creates constant wall temperature boundary conditions at the outside surface of the inner tube. To control the temperature of the test fluid, a cooling section is provided after the test section so as to keep the temperature constant at the inlet conditions. Five (k –type) thermocouples are welded on the outer surface of the copper tube at equal distances so as to record the temperature. Two (k type) thermocouples are inserted at the inlet and outlet of the test section for measuring the bulk temperature of the test fluid. Data acquisition was used to record the thermocouple readings. The maximum precision of these thermocouples was 0.1 °C and was calibrated before carrying out the test run. The mass flow rate was measured by noting down the time required to fill a certain amount of mass. The test section is insulated by thick glass wool followed by aluminum cladding in order to minimize heat loss to the surroundings. Experiments have been conducted for straight tubes at different flow rates and temperatures so as to cover a wider range of Reynolds numbers. Each measurement corresponding to a single rpm (mass flow rate) has been repeated at least thrice so as to verify the reproducibility of data.



Schematic diagram of an experimental setup

Uncertainty analysis for independent quantities.

Quantity	Uncertainty	Quantity	Uncertainty
dt (m)	± 1.00E-05	t (s)	± 0.01
L (m)	± 0.001	m (kg)	± 0.01
T (°C)	± 0.1	ρ (kg/m^3)	± 0.1

Uncertainty analysis for derived quantities in the straight tube

Quantity	Maximum uncertainty	Minimum uncertainty
$\dot{m}$ (kg/s)	±1.77E-03	±1.64E-03
Q (m3/s)	±1.65E-06	±1.59E-06
v (m/s)	±4.26E-03	±4.09E-03
U (W/m2K)	±3.301	±3.073
h (W/m2K))	±5.285	±4.660
Re	±21.378	±14.187
Nu	±0.360	±0.307