Heat Exchanger Performance Analysis

The objective of this brief report is to present the findings from the testing of the finned and tube heat exchanger, which will serve as the air preheating unit for the solar-thermal air preheater project prototype. The heat exchanger, with dimensions of 23 cm by 25 cm, consists of three stages of copper tubes, each stage containing eight tube passes, making a total of 24 passes. The copper tube has a diameter of 9.5mm and Aluminium fins are attached to the copper tubes to enhance heat transfer. The system uses a shaded pole AC refrigerator fan motor as an induced draft fan, which draws air through the heat exchanger and directs it into a drying chamber.

For this experiment, water was heated using an electric heater and circulated through the heat exchanger by a pump. The inlet water temperature and flow rate were monitored and recorded along with the ambient air temperature and the pre-heated air temperature throughout the test. The air velocity was measured using an anemometer, from which the airflow rate through the heat exchanger was calculated.

To analyse the performance of the heat exchanger, three key variables were systematically varied:

1. Inlet water flow rate (0.6 L/min, 1.0 L/min, 1.4 L/min),

2. Inlet water temperature (50°C, 60°C, 70°C),

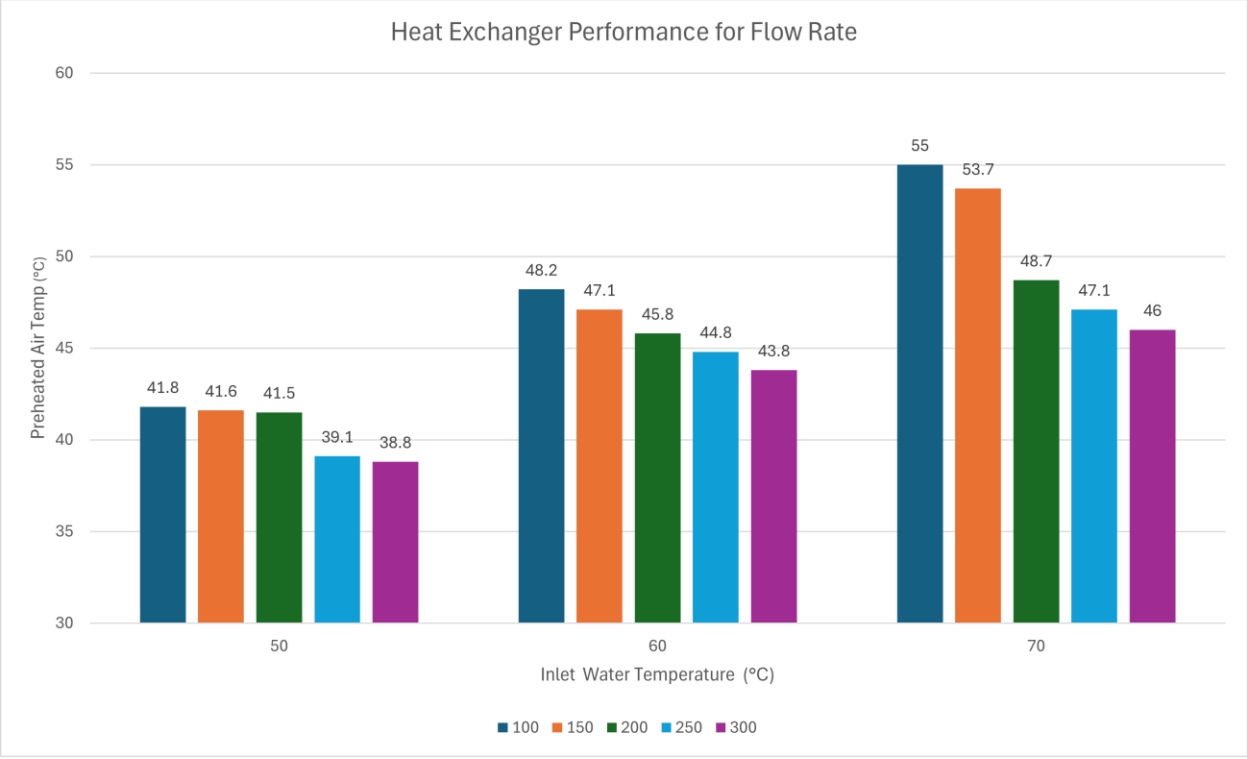
3. Airflow rate (100 CFM, 150 CFM, 200 CFM, 250 CFM, 300 CFM).

The corresponding pre-heated air temperatures were recorded for each set of conditions to assess the performance of the heat exchanger in pre-heating air using heated water. The results of this testing provide insights into the heat exchanger's performance under different operational settings.

Heat Exchanger Testing Results

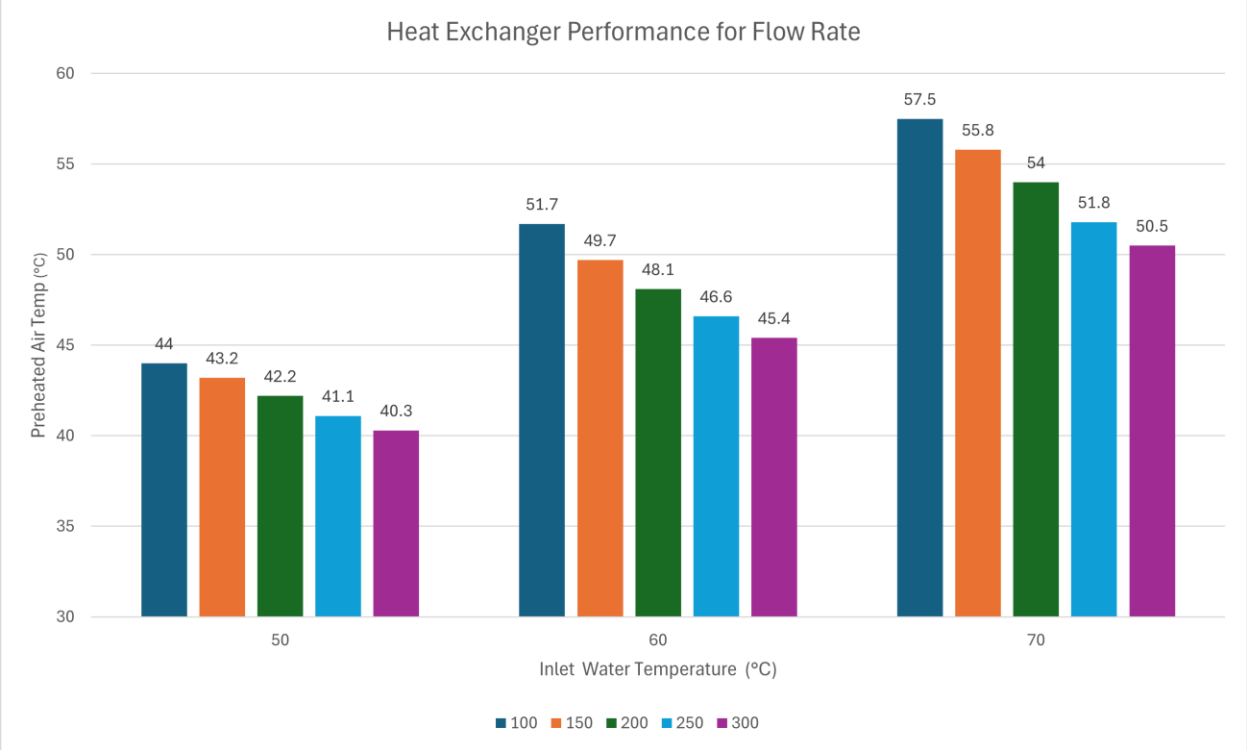
Water flow rate of 0.68 l/min (Ambient air temperature - 31°C)

Flow Rate (l/min)	Inlet Water Temperature (°C)	Air Velocity (CFM)	Preheated Air Temp (°C)
0.68	50	100	41.8
		150	41.6
		200	41.5
		250	39.1
		300	38.8
	60	100	48.2
		150	47.1
		200	45.8
		250	44.8
		300	43.8
	70	100	55
		150	53.7
		200	48.7
		250	47.1
		300	46



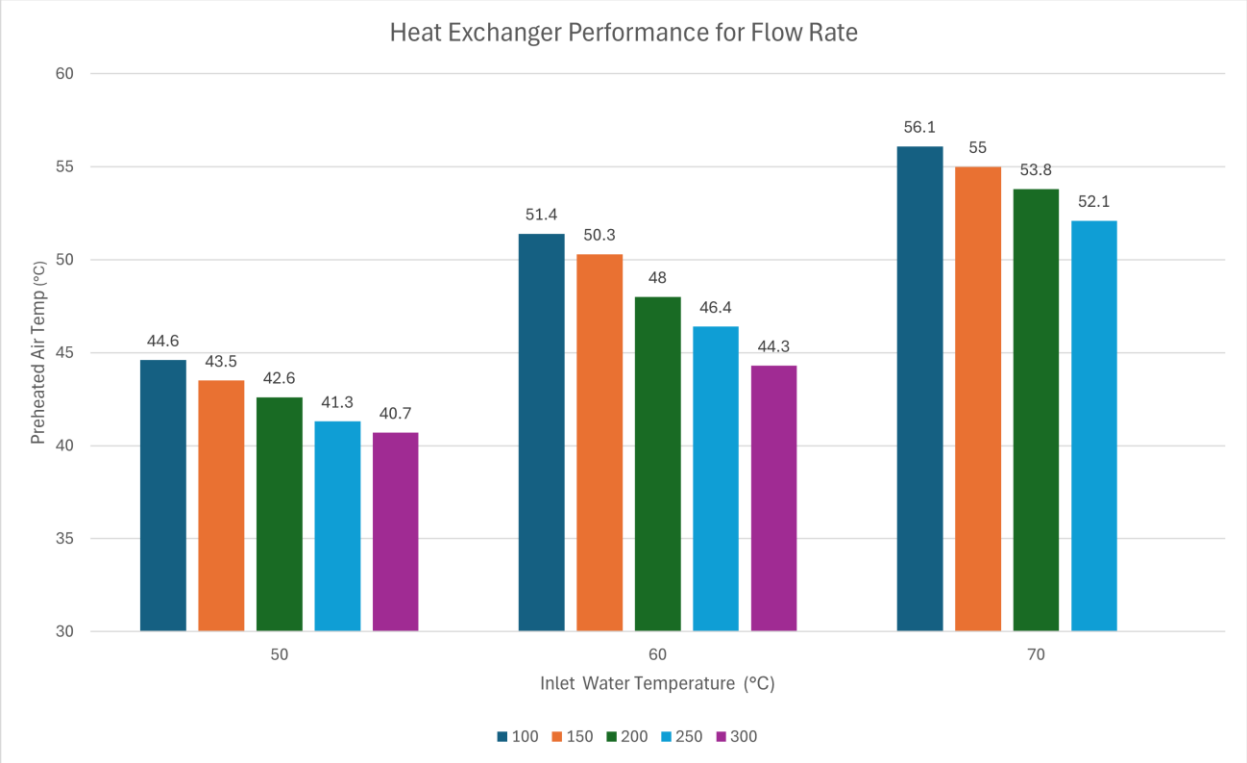
Water flow rate of 1.01 l/min (Ambient air temperature - 31.7°C)

Flow Rate (l/min)	Inlet Water Temperature (°C)	Air Velocity (CFM)	Preheated Air Temp (°C)
1.01	50	100	44
		150	43.2
		200	42.2
		250	41.1
		300	40.3
	60	100	51.7
		150	49.7
		200	48.1
		250	46.6
		300	45.4
	70	100	57.5
		150	55.8
		200	54
		250	51.8
		300	50.5



Water flow rate of 1.41 l/min and ambient air temperature of 30 °C

Flow Rate (l/min)	Inlet Water Temperature (°C)	Air Velocity (CFM)	Preheated Air Temp (°C)
1.41	50	100	44.6
		150	43.5
		200	42.6
		250	41.3
		300	40.7
	60	100	51.4
		150	50.3
		200	48
		250	46.4
		300	44.3
	70	100	56.1
		150	55
		200	53.8
		250	52.1
		300	



Heat Exchanger Testing Setup