

Axial Oil Scoop Seal Plate Design

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Objective

Goal: Design the internal channels of a seal plate that allow more heat to be conducted away from the seal interface than the current design allows. The design will consist primarily of changes to the internal flow path of the oil through the part to increase the time the oil spends cooling the channel. This geometry change will reduce the temperature at the interface, allowing for a longer lifetime of system seals.

Specifications

Design must:

- Be 1 continuous piece made using additive manufacturing
- Increase Heat Transfer efficiency
- Be a novel idea
- Fit the size constraints defined by P&W
- Show uniform heat transfer across the seal face

Concept Selection

7 preliminary designs were evaluated using the following criteria:

- Cost
- Cooling
- Flow Restriction
- Thermal Uniformity
- Test Ability

Work continued on the 4 highest rated designs

Testing Rig Design

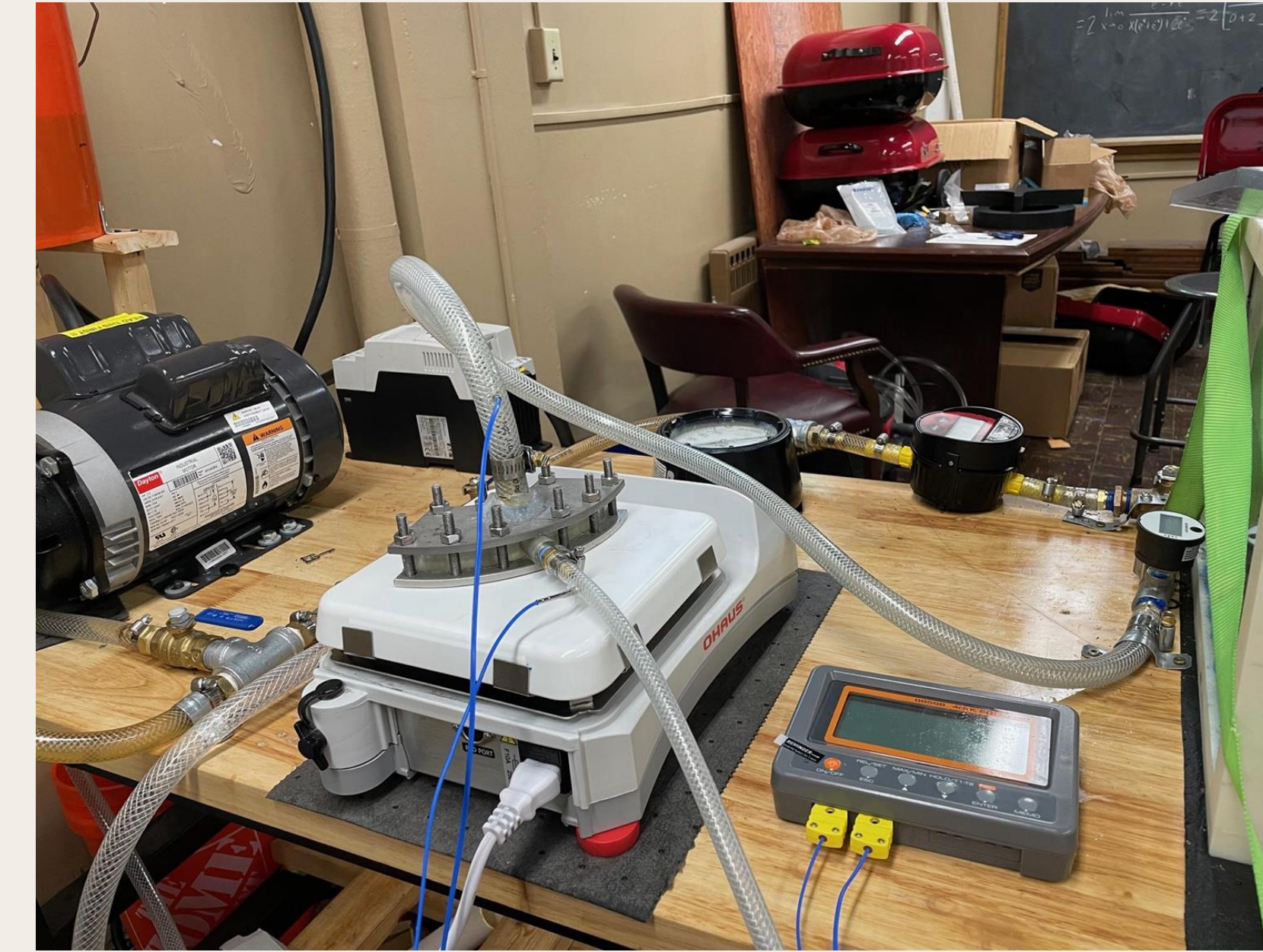
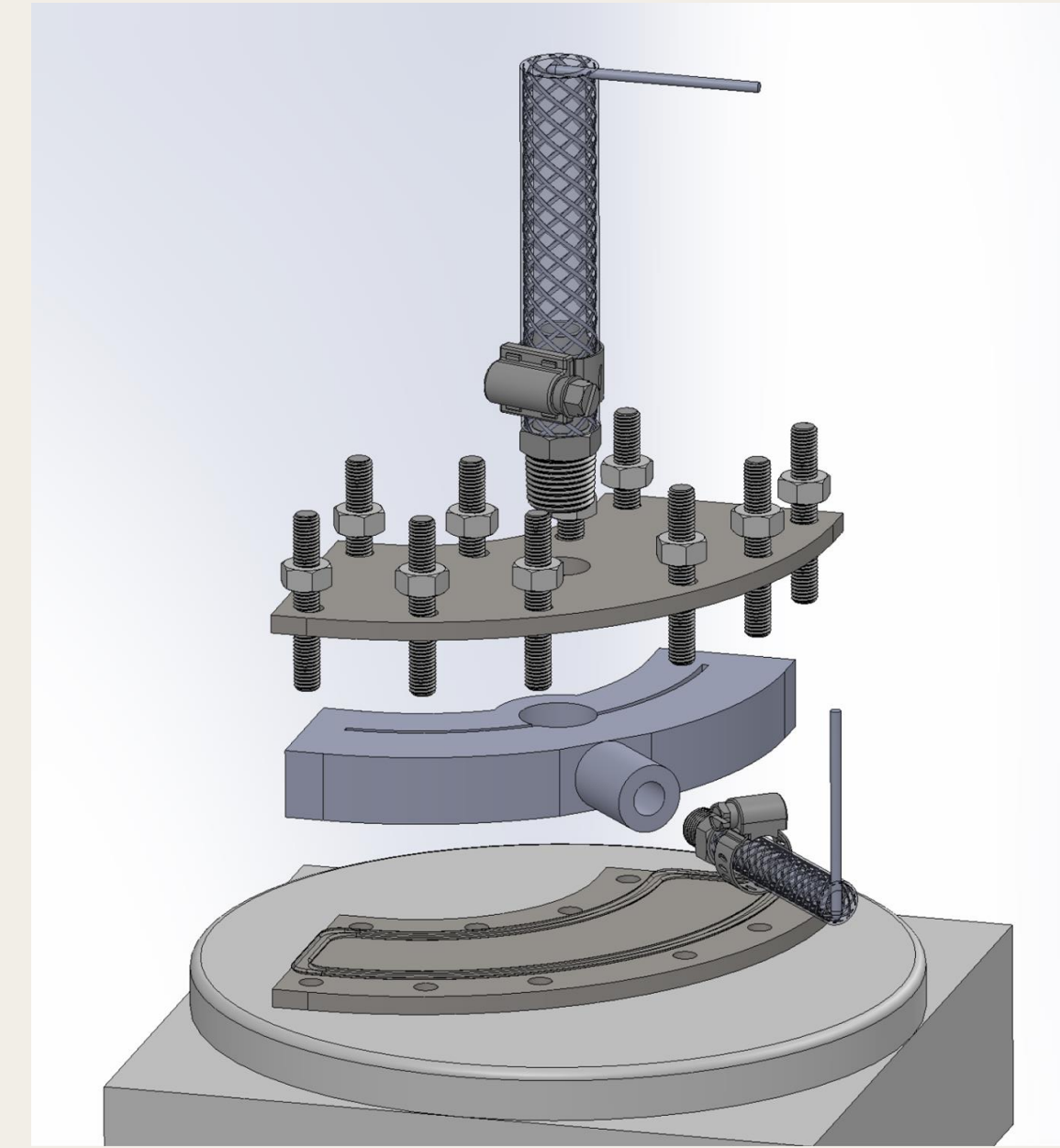


Figure 1: a) Rig assembly, exploded, b) Final Rig design

Data Collection Methods:

- Overall Heat Transfer:
 - thermocouple probes placed at inlet and outlet of test piece
- Thermal Uniformity:
 - Flir A35 camera used to take images of base plate upon heating 80°C
- Flow restriction:
 - comparison of pressure changes in system for each design

Testing Procedure:

- Hot plate set to 80°C
- Turn on camera, temperature probes, and pressure gauge
- Once oil is started through the system start tracking the inlet and outlet temperatures, the flow rate, and the pressure drop
- After 5 minutes take an image of the bottom plate with the FLIR A35 to see temperature profile

Results

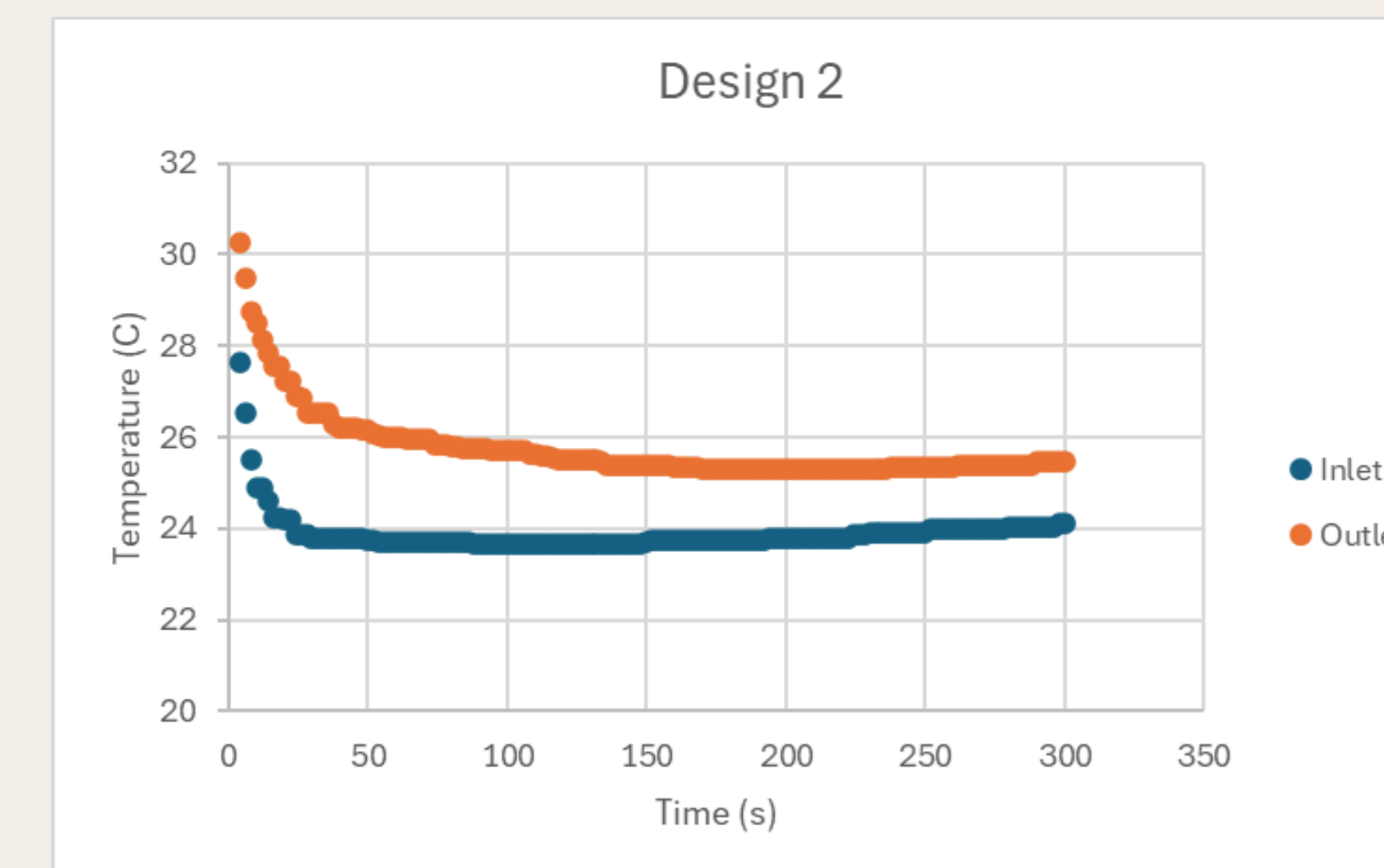
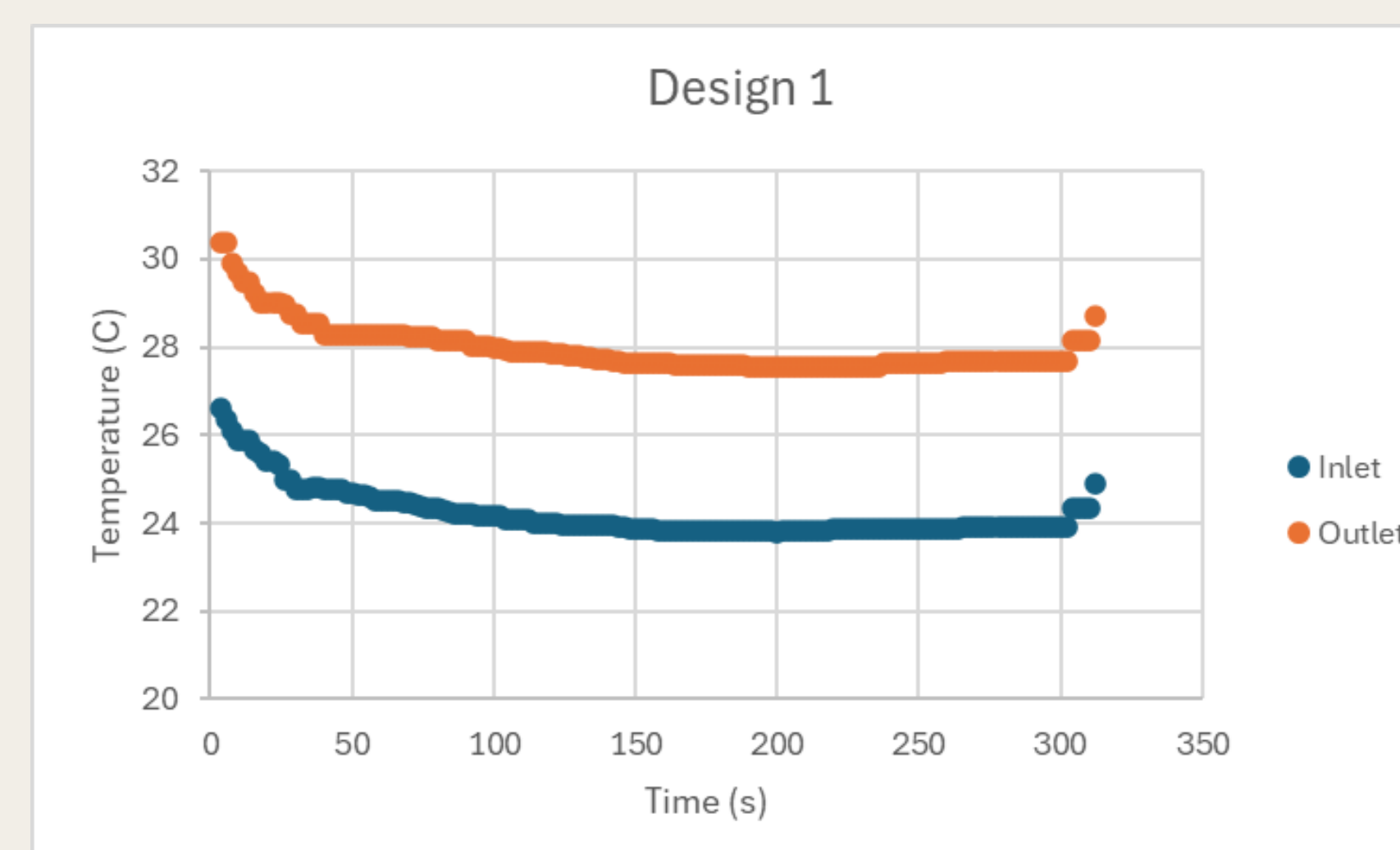


Figure 2: Graph of Temperature Inlet and Outlet for a) Design 1 & b) Design 2

Table 1: Average pressure and ΔT

Design	Pressure (psi)	ΔT (C)
Baseline	6.7	0.4
1	18.4	3.76
2	15.8	1.57

Simulations

Approximations

- Seal plate design broken into approximately 60 segments.
- Modified thermal resistance approach used to compute temperatures.

Mathematical Modeling

- Created a mathematical model based on known temperatures and oil flow path volumes
- Design 1's mathematical result for total heat transferred to oil is comparable to lab results

Simulation Results

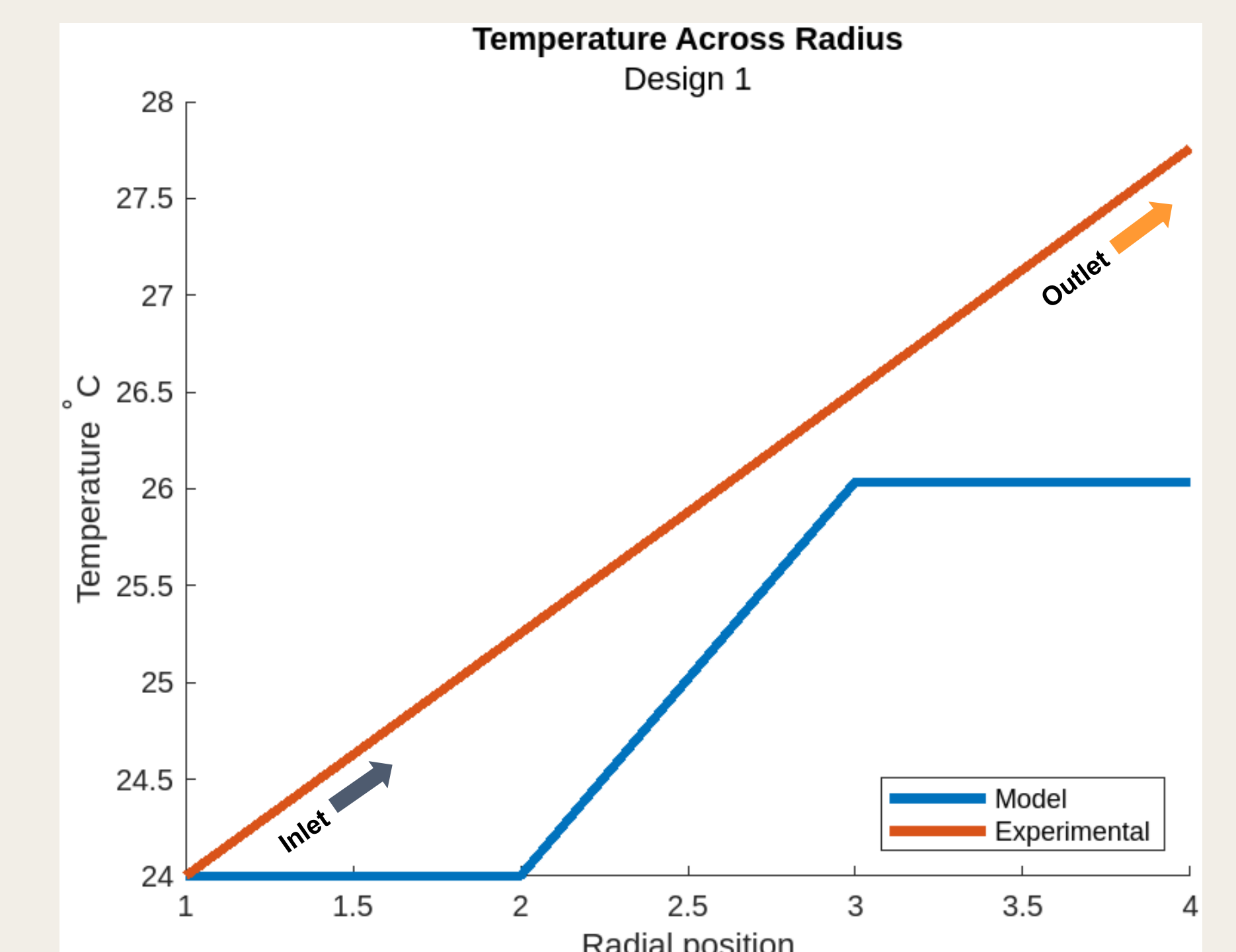


Figure 3: Temperature vs. position graph of the mathematical model of a design

Standards

- NPT ASME B1.20.1 - Pipe Threads, General Purpose, Inch
- Pressure Gauge ASME B40.1 - Creating Pressure Gauges
- GD&T ASME Y14.5 - Dimensioning and Tolerancing