Sensor Time Response Testing

Introduction

The DPG can be adapted to into a multi flow bench, reconfiguring the internal air systems to provide parallel flows with different properties produces a test bench ideal for measuring response time. Moving a temperature sensor between a cold and heated flow path is a quick way to record the time response.

In the example below two flow paths one at ambient and one at 100C were created to test the response of different thermocouples. The configurability of the DPG allows a wide range of space velocities and temperatures to be tested.

Instead of a temperature difference, NOx, H2O or Soot concentration differences could be created between the parallel air flows. Allowing the response time of all associated sensors to be measured in a controlled and realistic way.

DPG Configuration

The DPG produces a controlled mass flow and temperature in every air system using mass flow meters and electrical heaters. The mass flow was adjusted to match the space velocities in both channels. The space velocity was confirmed using a pitot pressure measurement across the swept path.

A pneumatically controlled actuator with a linear resistor to feedback position physically sweeps a sensor across the two flows. The DPG is configured to control this pneumatic valve and logs the position. The DPG comes with multiple thermocouple inputs which are always logging.

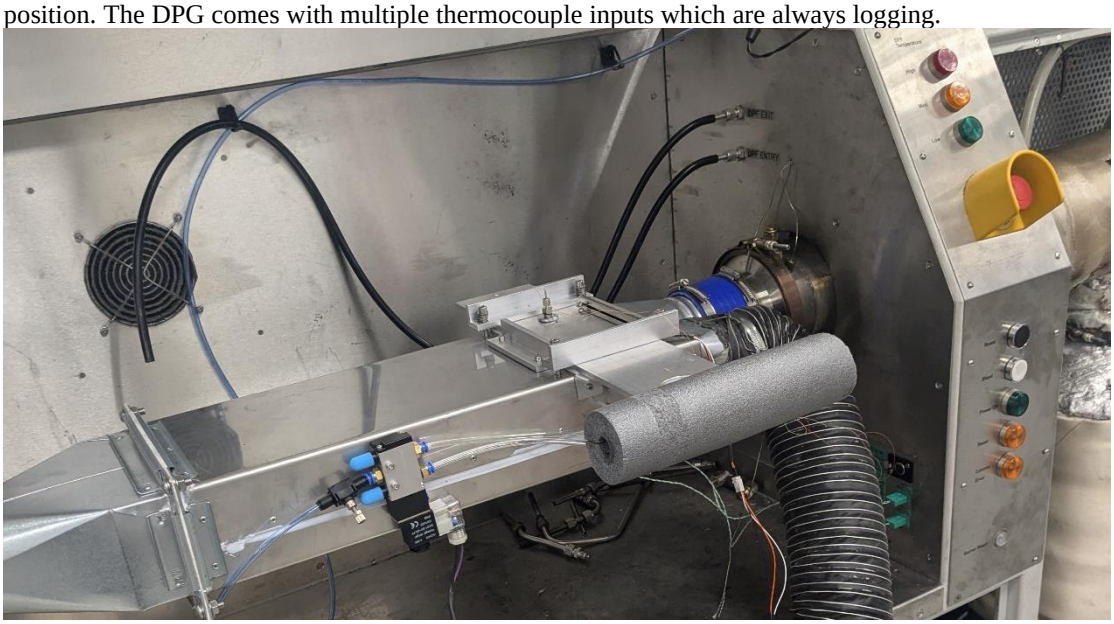

Figure 1 - Sensor Sliding Rig

The sliding plate has an adaptor fitting, the stainless steel k-type thermocouples under test include a ultra thin wire, 0.5mm, 1.5mm, 3mm and 6mm diameter.

Results

The results shown below compare the different diameter thermocouples, the space velocities of 2, 5 and 10 meters/s were tested.

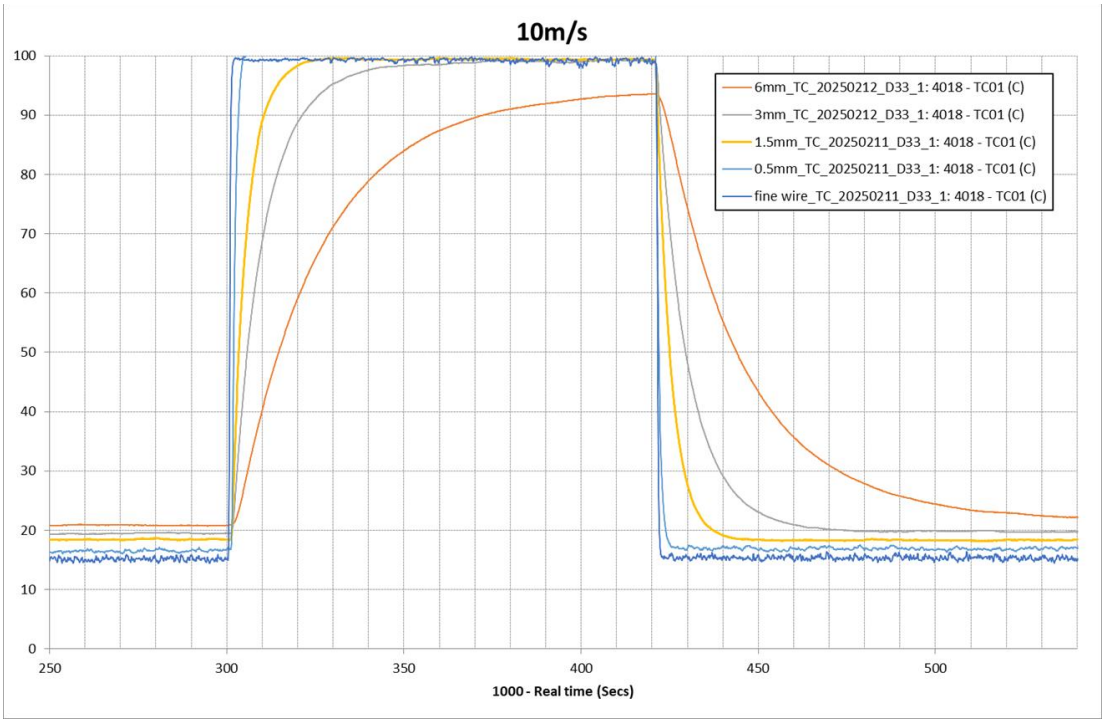

Figure 2 - Thermocouple response time at 10m/s

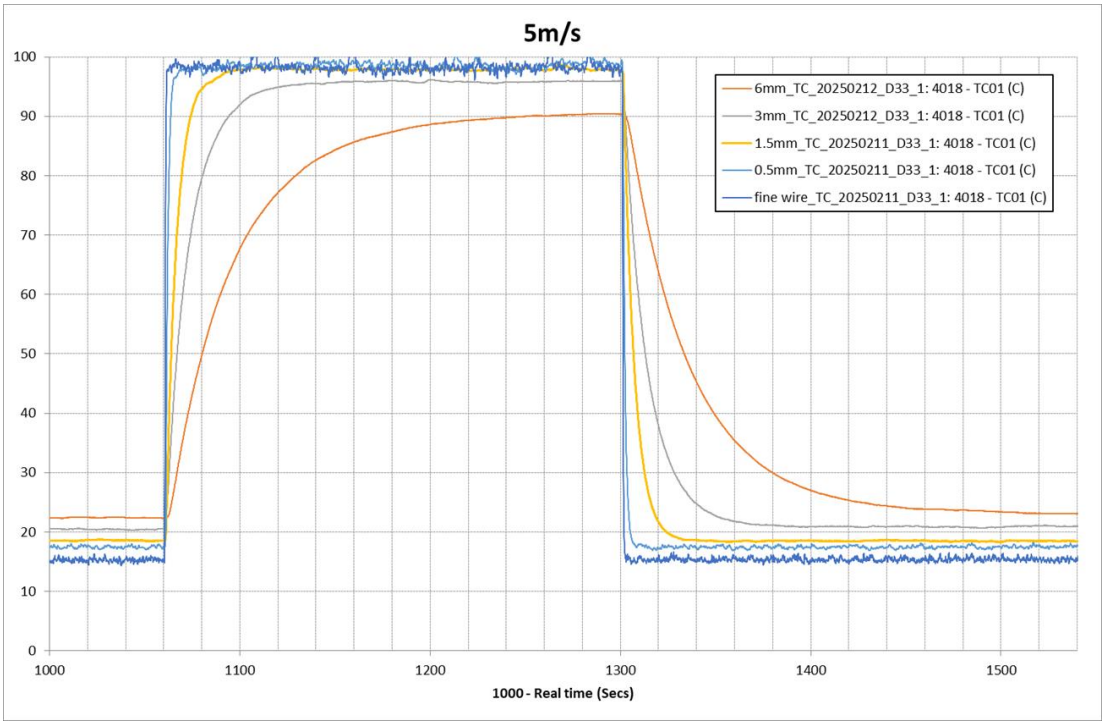

Figure 3 - Thermocouple response time 5m/s

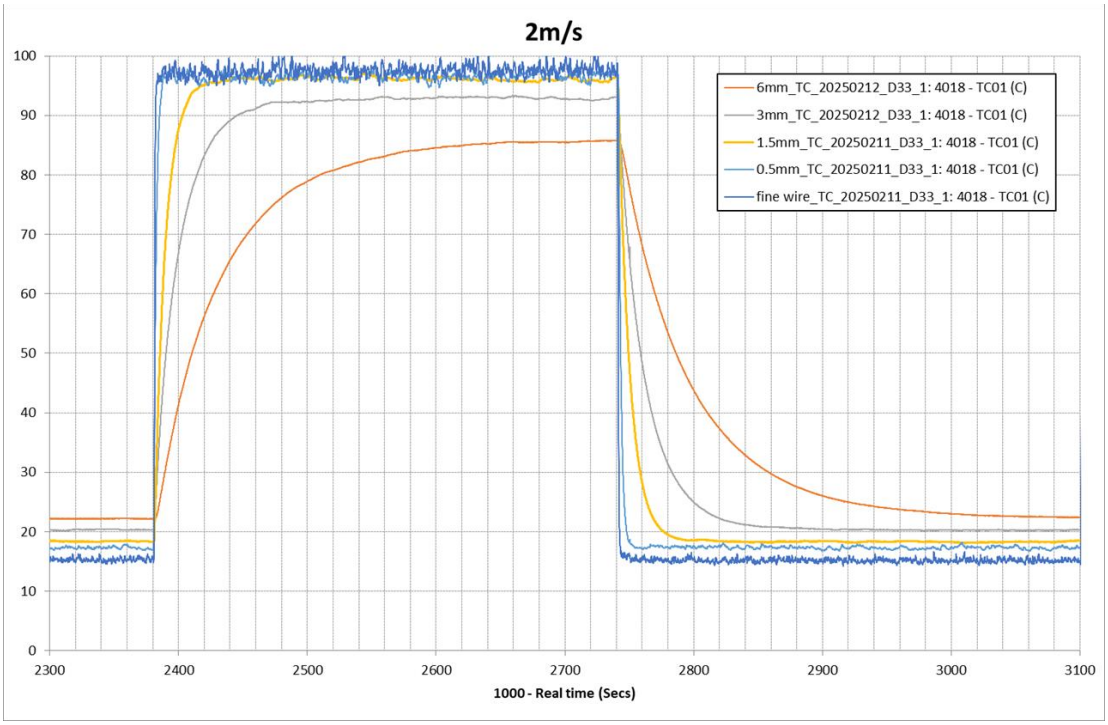

Figure 4 - Thermocouple response time 2m/s

Below is a chart displaying the T^{36} response time:

Table 1 - Response times

Response time (s)		TC Diameter (mm)			
		0.5	1.5	3	6
Space Velocity (m/s)	10	1.4	4.6	9	28.3
	5	1.219	5.957	13.3	43.8
	2	1.73	9.454	21.921	73.925

In graphical form:

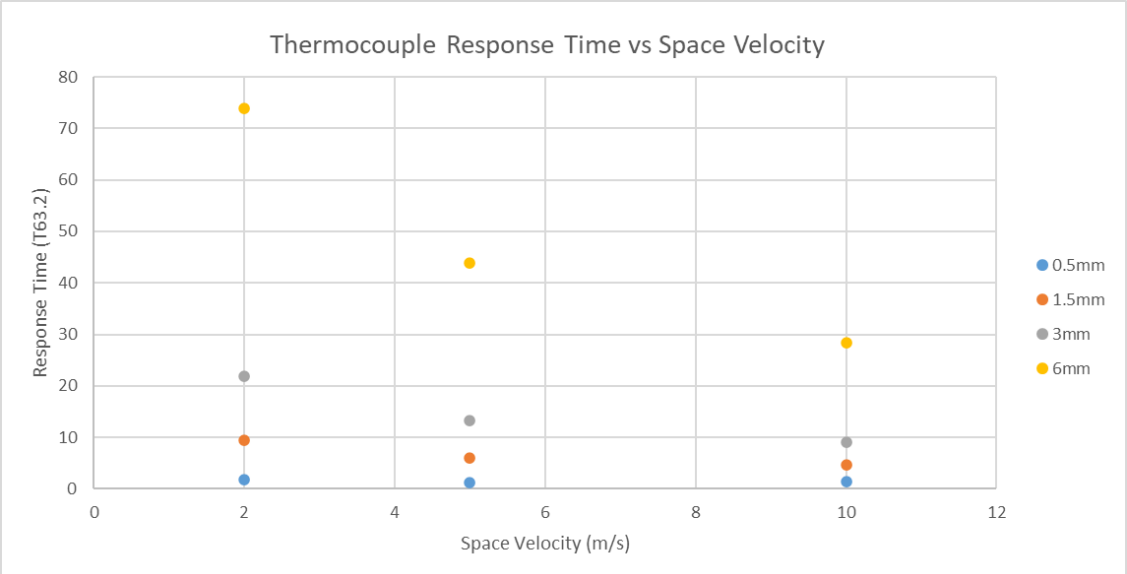

Figure 5 - Response time vs Space Velocity Summary

The results show a predictable increase in the response time with thermocouple diameter. The response time decreases with the space velocity over the probe. A difference in the steady state measured reading of the hot gas gets worse with diameter. Conduction along the length of the probe could be a factor in this error.

The main aim of this application note is to highlight the DPG ability to be re-configured to produce two controlled air streams with different properties, this sliding rig allows us to sweep a sensor between two environments giving us the potential to measure the real-world response time of sensors.