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The Wolfson Centre

Providing cost-effective solutions to industry's problems

Experimental Measurement Technique To Detect Self-Heating In Biomass

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Presenter:

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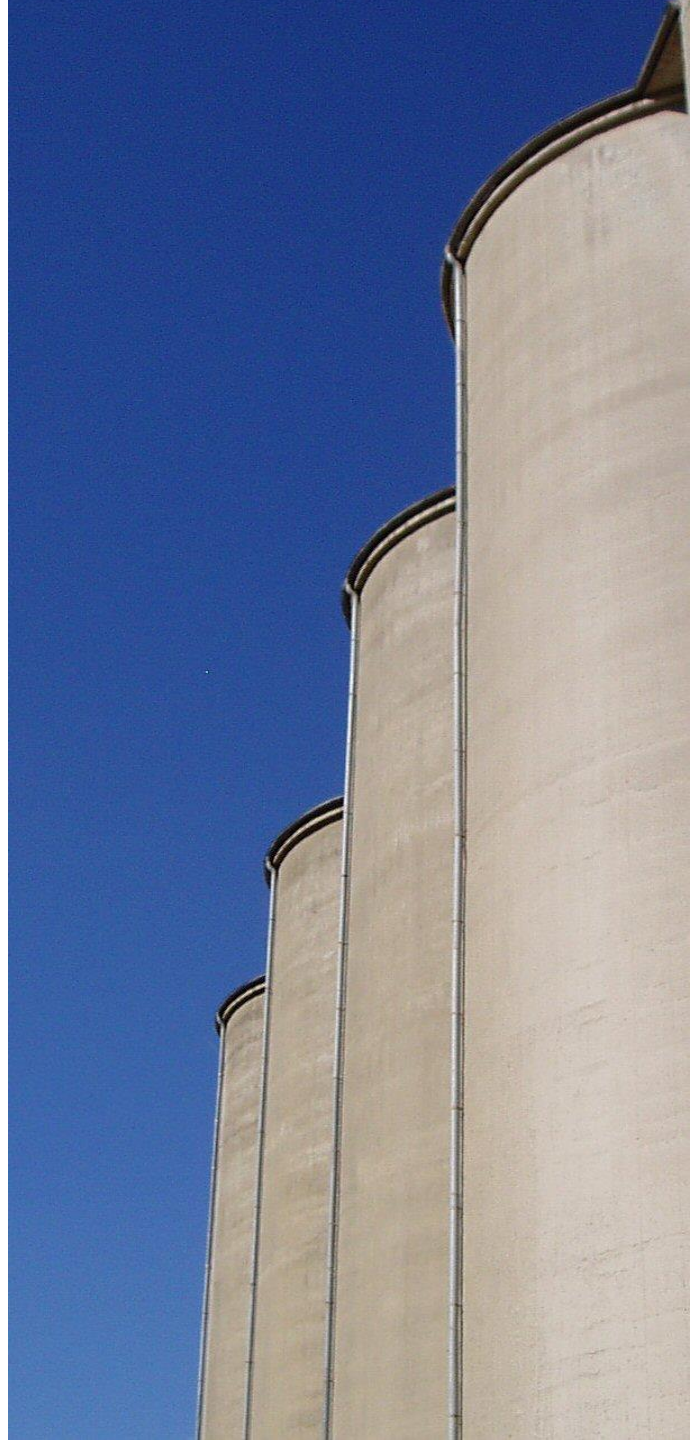


The Wolfson Centre for Bulk Solids Handling Technology

50 Years

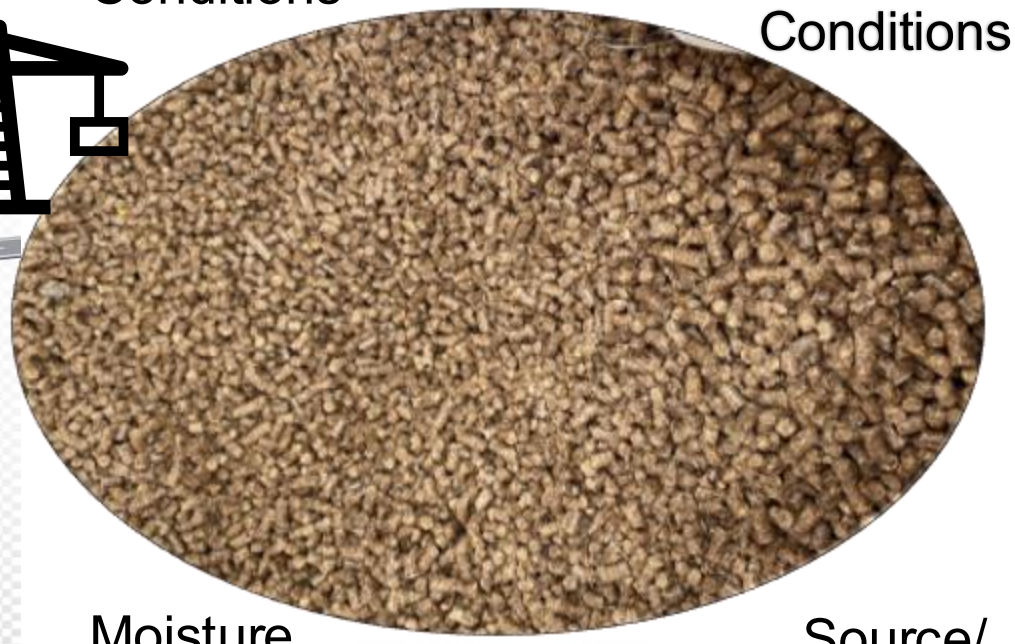
Providing cost effective solutions to industrial problems.

Activities

Pellets to Piles:
How to Decode Self-Heating?

Storage Conditions

Environmental Conditions



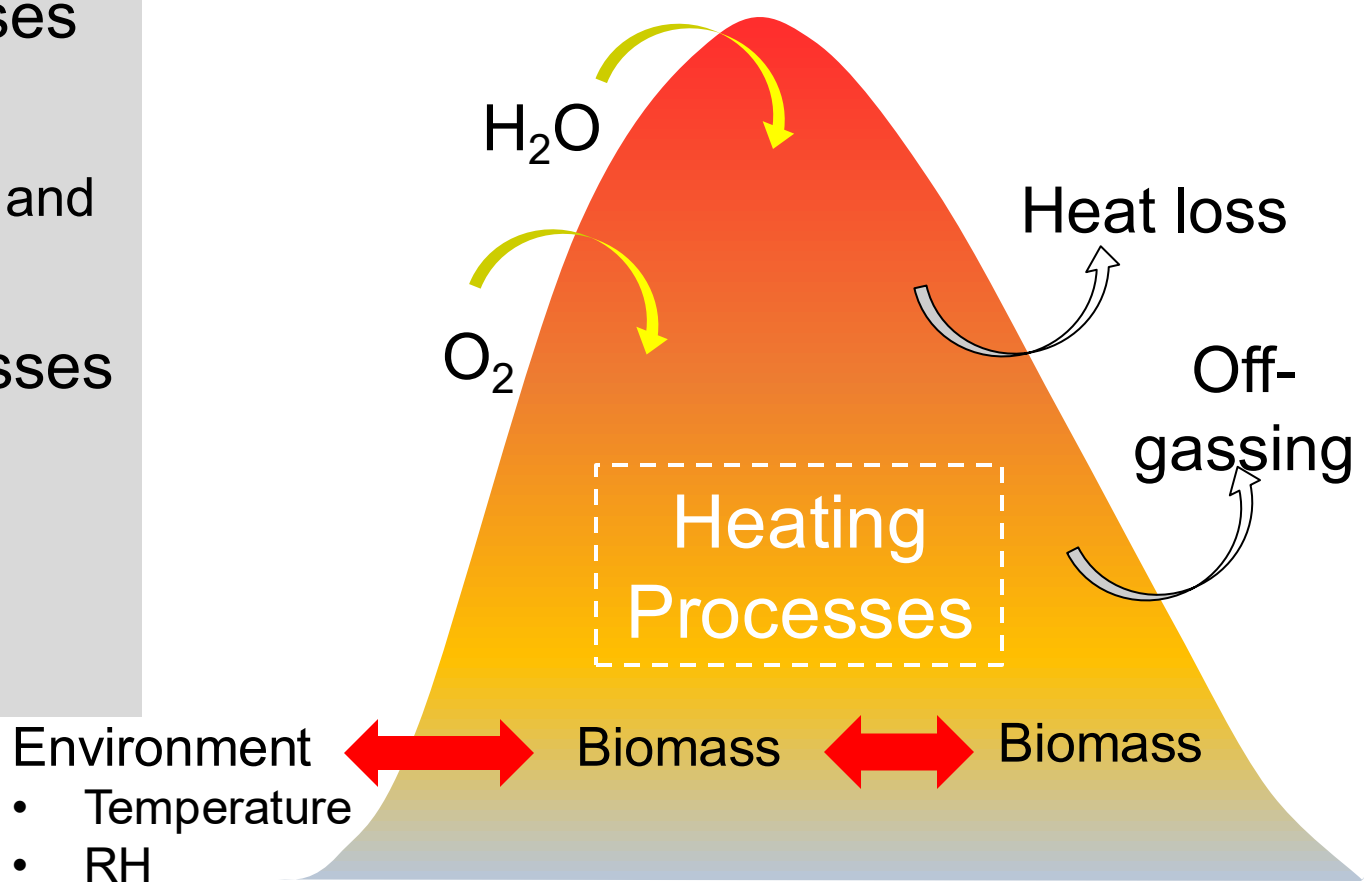
Moisture Content

Age

Source/ Species

Dynamics in Stored Biomass

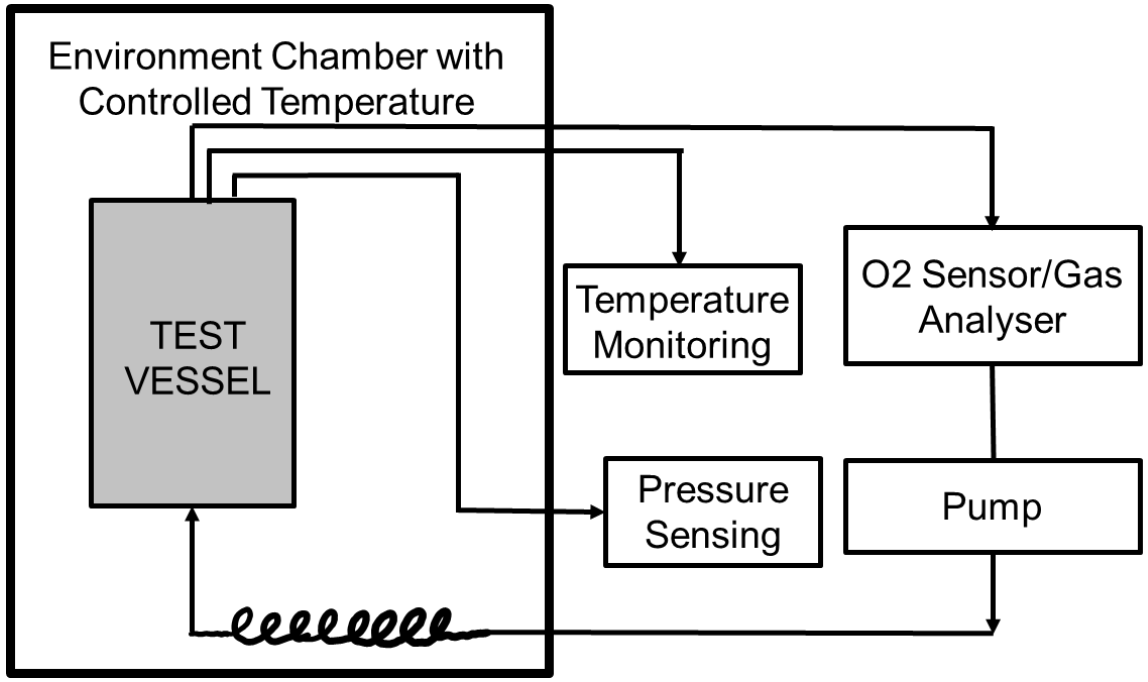
- Water associated physical processes
  - Water catalyses chemical reactions
  - Thermophysical properties of material and gases
- Microbiological degradation processes
- Chemical oxidative processes
  - Reaction between O_2 and Terpenes



Measuring Self-heating Tendency

- Moisture Content Analysis
  - Water absorption and condensation due to sudden increase in humidity does cause a sharp rise of pile temperature → Self-ignition
- "Basket Test" for Thermal Stability
  - Established Standard: **BS EN 15188**
- Off-gassing Analysis

Off-gassing Measurement & Detection



A schematic to analyse off-gassing at lab-scale.

Commercially available hand-held multi gas analyser.

Courtesy: www.safetygearstore.co.uk

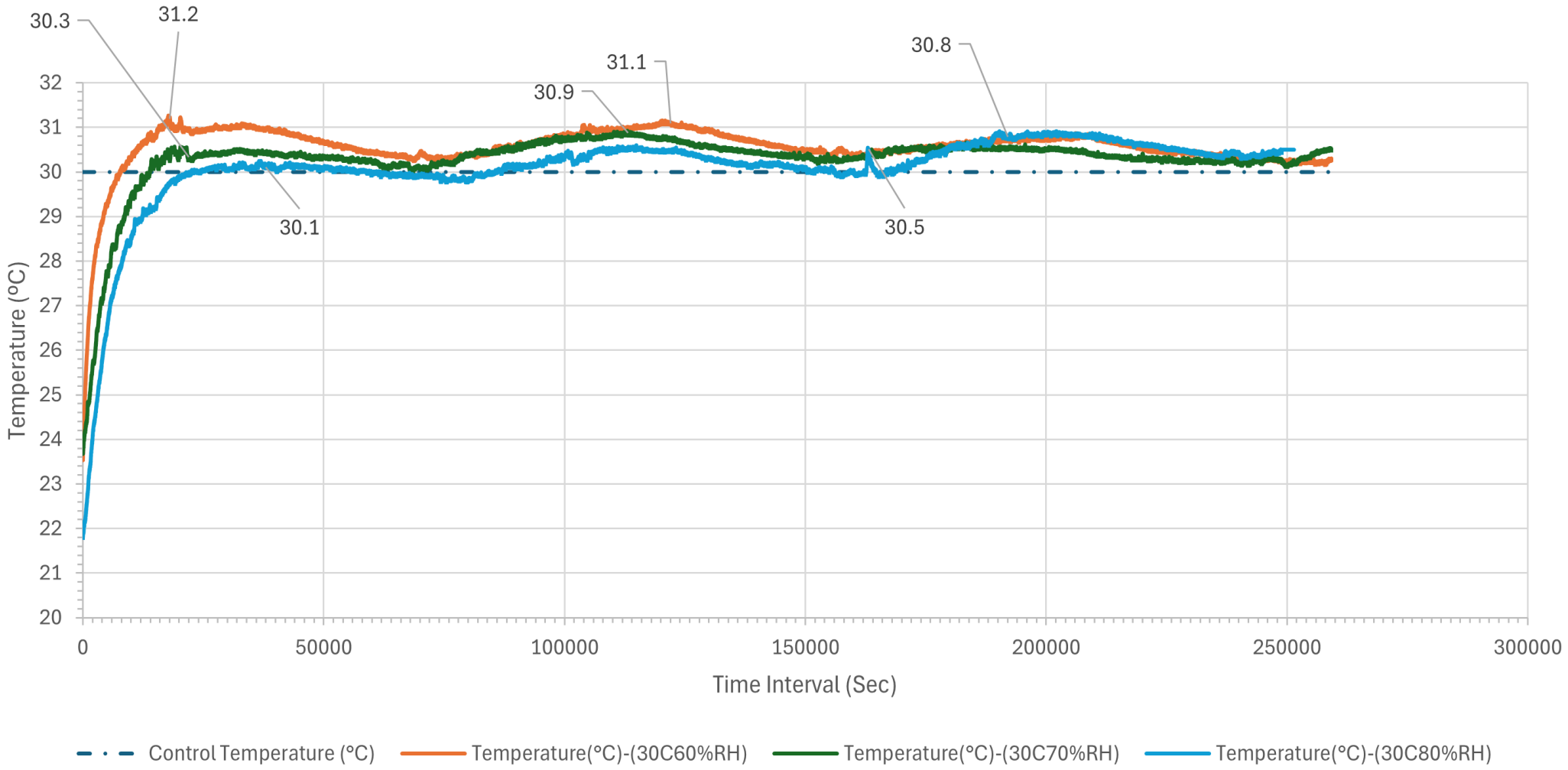
Self-Heating Experimental Setup

- Environmental Chamber
  - Temperature range -40°C to +180 °C
  - RH range 5% to 95%
- Pressure Vessel –
  - to contain the gasses & pressure within the vessel
- K-type Thermocouple
  - -75 °C to +250 °C
- Pressure Sensor
- Pump to circulate air
- Gas analyser: O_2, VOC and CO
- National Instruments CDAQ-9171

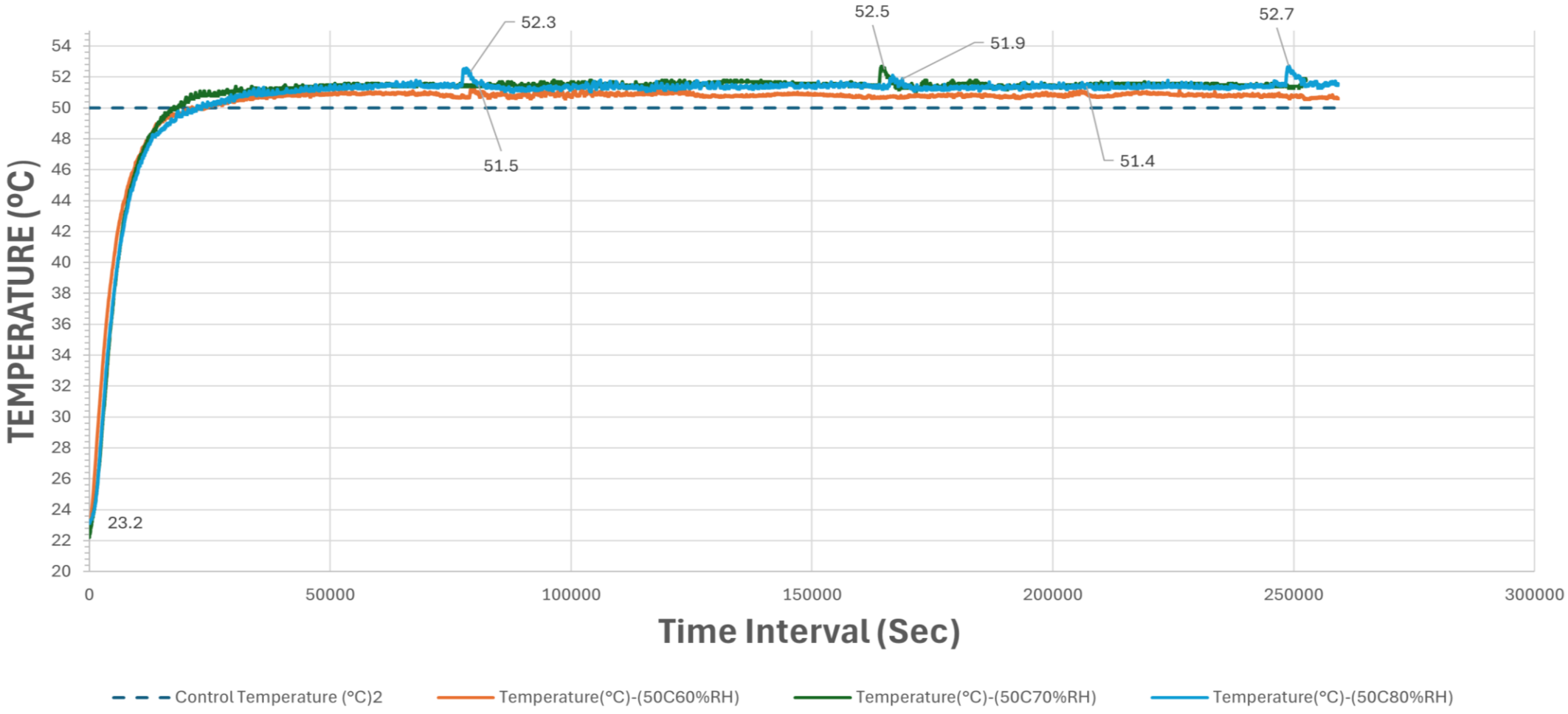
Experimental Plan and Setup
Wood Pellets

	Temperature	Relative Humidity
Trial 1	30°C	60%, 70% & 80%
Trial 2	50°C	60%, 70% & 80%
Trial 3	70°C	60%, 70% & 80%

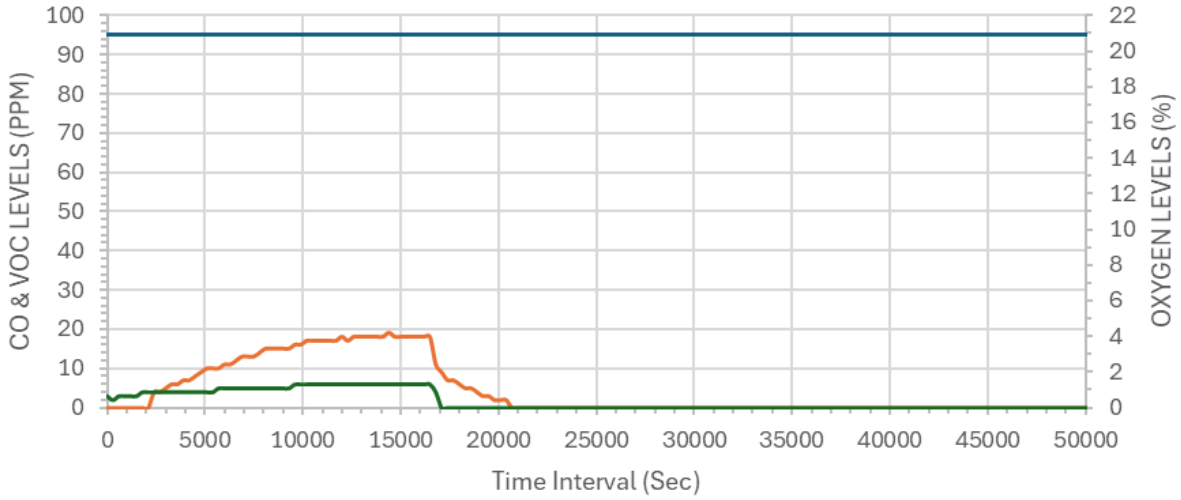
Temperature Profile at 30°C and Varying RH



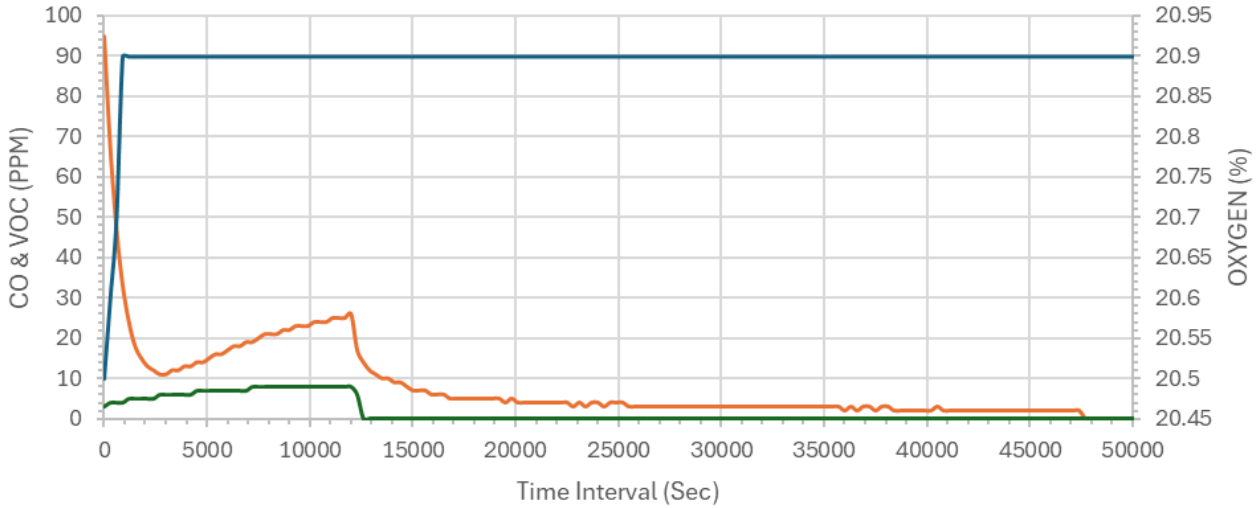
Temperature Profile at 50°C and Varying RH



Offgassing at Different RH



Off-gassing at 50°C and 60% RH



Off-gassing at 50°C and 80% RH

Mathematical Modelling and Predictions

- Multi-Physics model to consider the interaction
  - Heat transfer
  - Mass transfer
  - Reactions
- “What-if” scenarios to test the effect of different parameters
- “Digital Twin” approach based on real-time monitoring of data:
  - Manage wood pellet handling
  - Predict likely problems
  - Advise on avoiding developing risks from escalating.

What Next?

- Explore the combined effect of temperature and RH on self-heating tendencies for variety of bulk materials
- Establish a set procedure for experimental measurements
  - Suitable for on-site implementation
  - Using a simplified tools
  - Quick and easy
- Develop a mathematical approach to compliment the experimental measurements.

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