Characterisation of Self-Heating Events at Meso Scale

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Biomass Pellet Storage

• State of the art developed by Drax Power
• Biomass pellets typically produced in US or Canada
• Transported to the UK in 50,000 ton 5 vault ships
• 80,000 tons stored in large storage domes, 50 m high in inert atmosphere
• Domes include 5 thermocouples arrays to measure pile temperature in real time
• Gas monitors measure CO, CO2 and oxygen depletion in head space
Biomass pellets often heat during shipping

Self-heating in large quantities of biomass pellets is a complex phenomena

Measurement of conditions in piles is difficult

Generally involve hard wired devices placed inside the piles

Ideally want a device which can measure conditions throughout the whole life cycle of a biomass pellet


Remote Measuring Devices

• RFiD sensor tags offer an opportunity to provide real time monitoring of temperature and moisture in bulk materials

• University of Nottingham are developing RFiD sensor tags and data collection systems to measure real time conditions in transport

• Developing flexible rig to analyse different types of RFiD tag with biomass, coal and refuse derived fuels

• Developing gas monitoring sensor tags for early detection of spontaneous combustion
Radio Frequency Identification (RFID) are a type of tracking system which use smart barcodes to identify items or for payment purposes (contactless credit cards).

RFID tags utilise radio waves to transmit data from the tag to a reader, which then transmits the data to a computer.

2 main types:
- Active RFID – include on board battery power supply
- Passive RFID - uses electromagnetic energy transmitted by the reader to power the tag
RFID sensor Tags

• Newer RFID tags include sensors such as moisture, temperature, pressure

• Passive RFID sensor tags available – 2 antennas – 1 for powering system and 1 for data transmission

• Reliability and usability is not as proven as RFID tags – issues with communication distances and logging sensor data

• Active RFID tags need to be avoided in biomass pellet storage due to fire risk associated with batteries

ON Semiconductor’s fully integrated sensor tag measures pressure and moisture by detecting impedance changes in the built-in stimulus loop.
UoN Biomass Storage Measurement Rig

- 45 litre biomass storage rig with 15 thermocouples contentiously monitoring via TC-08 box linked to a pc was constructed to monitor temperature conditions for biomass pellets
- Container filled with white wood pellets
- Compressed air supplying 16 l/min air to storage container
- Compressed air line connected to heater to provide hot air up to 60 °C
- Experiments conducted by MEng student Jaideep Sunnar in February-March 2019
Temperature Variation at Atmospheric Conditions

![Graph showing temperature variation over time for different channels.](image-url)
Temperature Variation at Atmospheric Conditions
Temperature Variation at 60 °C
Temperature Variation at 60 °C
Temperature Variation at 60 °C
Findings and Next Steps

- Biomass pellets heated up slowly within the box

- Further experiments required to look at impact of air moisture content on heating rates

- Calibration of RFID tags in storage rig – new electrical engineering PhD student Amjad Ali

- Incorporate gas sensors into the rig to measure O2 content

- Assess heating potential of other fuels such as RDF
Applications beyond Biomass Storage

- Pressure sensors
- Gas sensors
- Dust control
- Battery temperature monitoring
- Moisture
Thank you for listening.
Questions?

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