INITIATION OF SMOULDERING COMBUSTION IN BIOMASS

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SMOULDERING IS A TYPE OF SLOW, LOW-TEMPERATURE COMBUSTION OF RELEVANCE TO BUSHFIRES. IT OCCURS BOTH IN PRE-FIRE AND POST-FIRE STAGES. MANY FIRES ARE CAUSED BY SMOULDERING FIRE; ONCE IGNITED, SMOULDERING OFTEN LASTS FOR DAYS OR WEEKS AND CAN TURN INTO FLAMING COMBUSTION.

BACKGROUND

- Smouldering combustion plays an important role in bushfire initiation and spread, as many forest biomass fuels are prone to smoulder during a bushfire.
- Additionally, smouldering combustion also poses fire hazards in many other workplaces, including landfill, farm, and factories.
- Smouldering combustion normally requires less energy for ignition than flaming combustion. For example, smouldering combustion can be initiated by the radiation from the fire front during bushfires.
- The initiation of smouldering combustion is difficult to detect or predict, because it normally does not have obvious indications, such as a visible flame, high temperature or high product gas emissions.
- Hence, it is critical to know whether smouldering combustion starts, as it will be beneficial to find and extinguish smouldering combustion before it turns to flaming combustion.

RESEARCH QUESTIONS

- What metrics are appropriate for identifying the initiation of smouldering combustion in biomass fuel and the transition to flaming combustion?

METHODOLOGY

- In order to investigate the initiation of smouldering combustion in biomass, an experimental apparatus has been developed (Fig. 1).
- The experimental apparatus is designed to initiate smouldering combustion by radiation.
- The experimental apparatus can take the measurements of temperature, mass-loss and emissions, which are used to indicating the initiation of smouldering combustion in biomass.

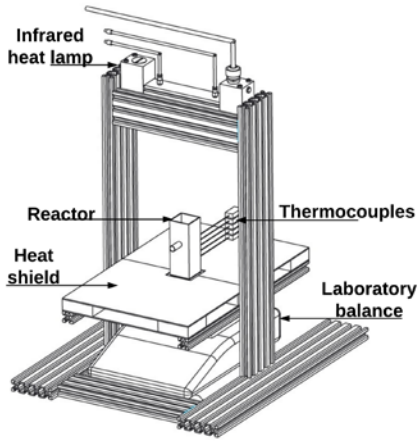

Figure 1: *The experimental apparatus*

PRELIMINARY FINDINGS

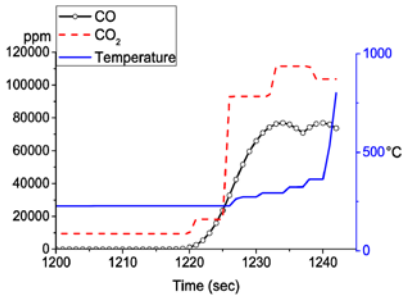

Figure 2: *Temporal CO, CO_2 and temperature profile during the transition from no ignition to flaming combustion. Radiant heating flux = 11.2 kW/m^2). Air flow rate = 7.0 grams/min.*

Temperature measurements

Based on the temperature measurements (Fig. 2), the time and the position of exothermic reactions can be observed.

Gas emissions

The concentrations of CO and CO_2 (Fig. 2) indicate the initiation of oxidation reactions. When the exothermic reaction occurs, the concentrations of CO and CO_2 rapidly increase.

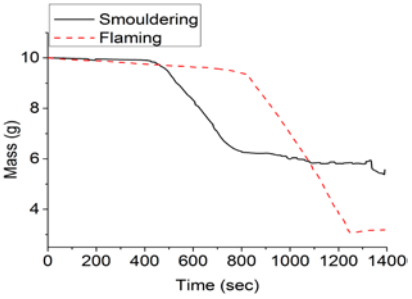

Figure 3: *Mass loss profile for smouldering and flaming combustion. Initial mass: 10 grams.*

Mass-loss measurements

The mass-loss profiles of smouldering and flaming combustion are shown in Figure 3. The final mass in flaming combustion is less than smouldering combustion.

CONCLUSIONS & FUTURE RESEARCH

A method based on temperature mass-loss and gas emissions has been developed to indicate the initiation of smouldering combustion in biomass fuel.

Future work will look at the required conditions for the initiation of smouldering combustion, and transition from smouldering to flaming combustion. The effects of different factors, including heating rate, air flow rate, oxygen concentration, fuel particle size on the smouldering ignition and transition to flaming combustion will be investigated.

END USER STATEMENT

This research is of value to end users as a better understanding of this combustion process has implications for fire behaviour and suppression. Work using realistic fuel samples is likely to have implications for spot fire ignition, conditions leading to flare ups in smouldering fuels, suppression options in fuels prone to prolonged smouldering (e.g. peat), as well as pollution emission under different burning conditions. ***Belinda Kenny, Fire Science Interpretation Officer, NSW National Parks & Wildlife Service***