CHARACTERISATION OF AIDED AND SELF-SUSTAINED SMOULDERING COMBUSTION OF BIOMASS

Houzhi Wang[1], Paul R. Medwell[1], Cristian H. Birzer[1], Philip J. van Eyk[2], Zhao F. Tian[1], Malcolm Possell[3]

[1] School of Mechanical Engineering, The University of Adelaide, Australia
[2] School of Chemical Engineering, The University of Adelaide, Australia
[3] Department of Environmental Sciences, The University of Sydney, Australia

SMOULDERING IS A TYPE OF SLOW, LOW-TEMPERATURE COMBUSTION OF RELEVANCE TO BUSHFIRES. SMOULDERING COMBUSTION CAN BE DIVIDED INTO TWO TYPES ACCORDING TO THE DEPENDENCE OF THE EXTERNAL HEATING; AIDED (UNSTEADY) AND SELF-SUSTAINED SMOULDERING COMBUSTION.

BACKGROUND

- Smouldering combustion plays an important role in fire initiation and spread, as many forest biomass fuels are prone to smoulder during bushfires or hazard reduction burnings.
- There are two types of smouldering combustion: aided and self-sustained smouldering combustion.
- Aided smouldering will slowly decay and extinguish without an external heating, while self-sustained smouldering is independent of external heating.
- In previous studies, aided smouldering is often treated as no ignition; however, there are distinctive differences between aided smouldering and no ignition.

RESEARCH QUESTIONS

- How to characterise the differences between aided and self-sustained smouldering combustion?

METHODOLOGY

- Heating time and oxygen concentration were used as the controlling factors to achieve different combustion regimes.
- Smouldering combustion were initiated in a reactor (Fig. 1) using an heat lamp. The temperatures inside the reactor, flue gases concentration were recorded.
- The radiant heat flux is *27.5 kWm^{-2}*, and the oxidizer velocity is *20 mms^{-1}* for all cases.

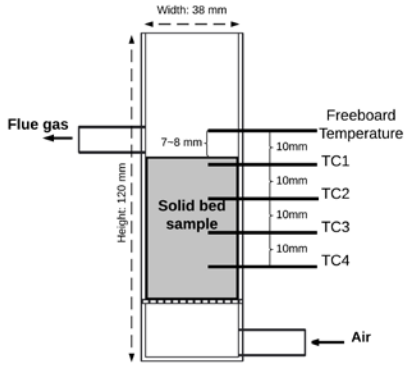

Figure 1: *Smouldering combustion reactor schematic diagram*

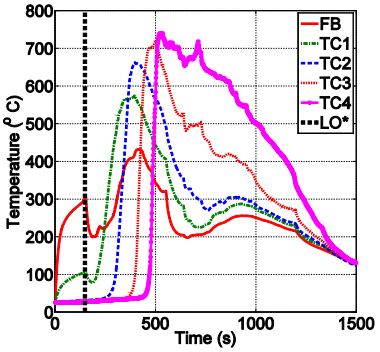

Figure 2a: *Temperature profiles of self-sustained smouldering combustion. LO-lamp off. Oxidizer: Air.*

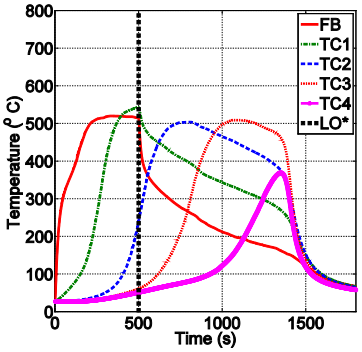

Figure 2b: *Temperature profiles of aided smouldering combustion. LO-lamp off. Oxidizer: nitrogen diluted air (10 % O_2)*

Temperature measurements

As shown in Fig. 2a & 2b, the peak temperature of self-sustained smouldering is higher than that of aided smouldering. The smoulder propagating velocity of aided smouldering is much lower than that of self-sustained smouldering combustion.

CO_2 concentration measurements

The temporal CO_2 profiles (Fig. 3a & 3b) show that self-sustained smouldering has a higher peak CO_2 concentration than aided smouldering; the peak CO_2 concentration is independent of heating time in self-sustained smouldering, but depends on heating time in aided smouldering.

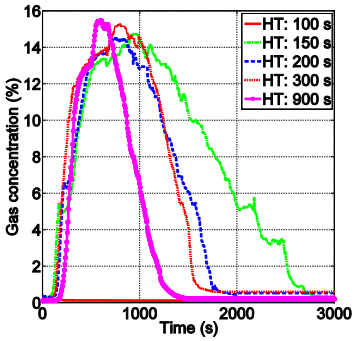

Figure 3a: *Temporal CO_2 concentration profile of self-sustained smouldering combustion. HT-heating time. Oxidizer: Air.*

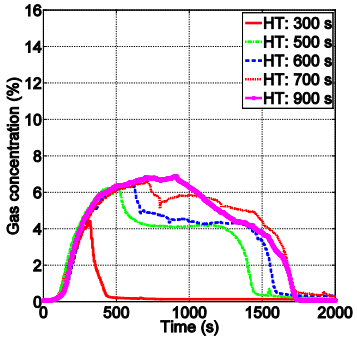

Figure 3b: *Temporal CO_2 concentration profile of aided smouldering combustion. HT-heating time. Oxidizer: nitrogen diluted air (10 % O_2)*

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.