Ignitability of eucalyptus litters

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The propagation of fire inside a typical forest canopy is heavily dependent on the amount of oxygen present during the fire propagation, fire intensity, and ignitability of surface fuels which is generally composed of forest litter, shrubs, etc. In eucalyptus vegetation the forest litter predominantly contains eucalyptus leaves, twigs, and bark. The present work discusses experimental observation for the ignitability of forest litter composed of eucalyptus leaves.

INTRODUCTION

Ignitability of a material is defined as the capability to ignite and cause flaming combustion. It is one of standard method of assessing fire risk of the material.

In a bushfire context, the ignitability of a forest fuel can have a significant impact on the fire danger rating of a particular vegetation.

In bushfire scenario, the number of variables affecting the fire behaviour is significantly large which pronounces significant differences in predicting rate of spread [1]

The physics-based fire model which solves fundamental mass, energy and momentum conservation equations are significantly slow for real-time prediction. However, they are able to deduce the variables which could have significant impact on fire behaviour.

The physics-based fire model such as FDS/WFDS has shown their capability in simulating Australian grassfires [2]. The prediction of rate of spread is dependent on pyrolysis sub-model.

In FDS/WFDS, there are two pyrolysis sub-models: (a) Linear, (b) Arrhenius. The accuracy of these models are not yet tested. The linear sub-model shows good accuracy at milligram scale such as in thermogravimetric analyser [3].

Hence, accuracy of the above model should be tested at higher scale before relying on physics-based model result.

METHODOLOGY

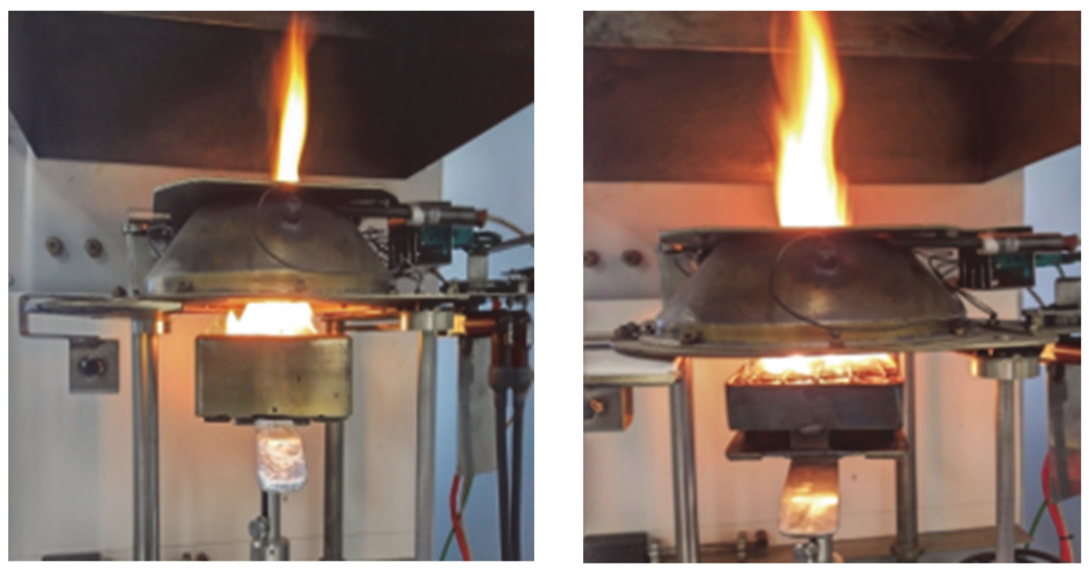
In the present work, the experiments are conducted using cone calorimeter apparatus. The detail and working principle of the apparatus can be found in AS 3837.

The eucalyptus forest litter material composed of eucalyptus leaves were tested. The fuel was exposed to a static radiant heat flux in the range of 10-60 kW/m². Two situations and two different sources of ignition are considered in this work.

Fig. 1 shows the two situations; closed and open. The closed situation has only the top part of the fuel which is exposed to radiant heat flux open to provide oxygen for combustion. In the open situation the bottom is also open to provide oxygen flow through the fuel bed for combustion.

Two sources of ignition are considered in this study, (a) autoignition (ignition of fuel from radiant heat flux), and (b) ignition by firebrand (ignition of fuel with the introduction of single 12mm cubiform firebrand of mass 0.4g introduced at 1s of heat exposure). Ignition is defined as successful only when it sustains flaming combustion for more than 6s (AS 3837).

Each experiment was repeated 3 times to show the reproducibility and account for the effect of intra-species variation. 10g of eucalyptus leaves fuel are exposed to radiant heat flux and the time to sustained flaming combustion is noted.



(a) closed (b) open

Fig.1: Two situation considered for autoignition

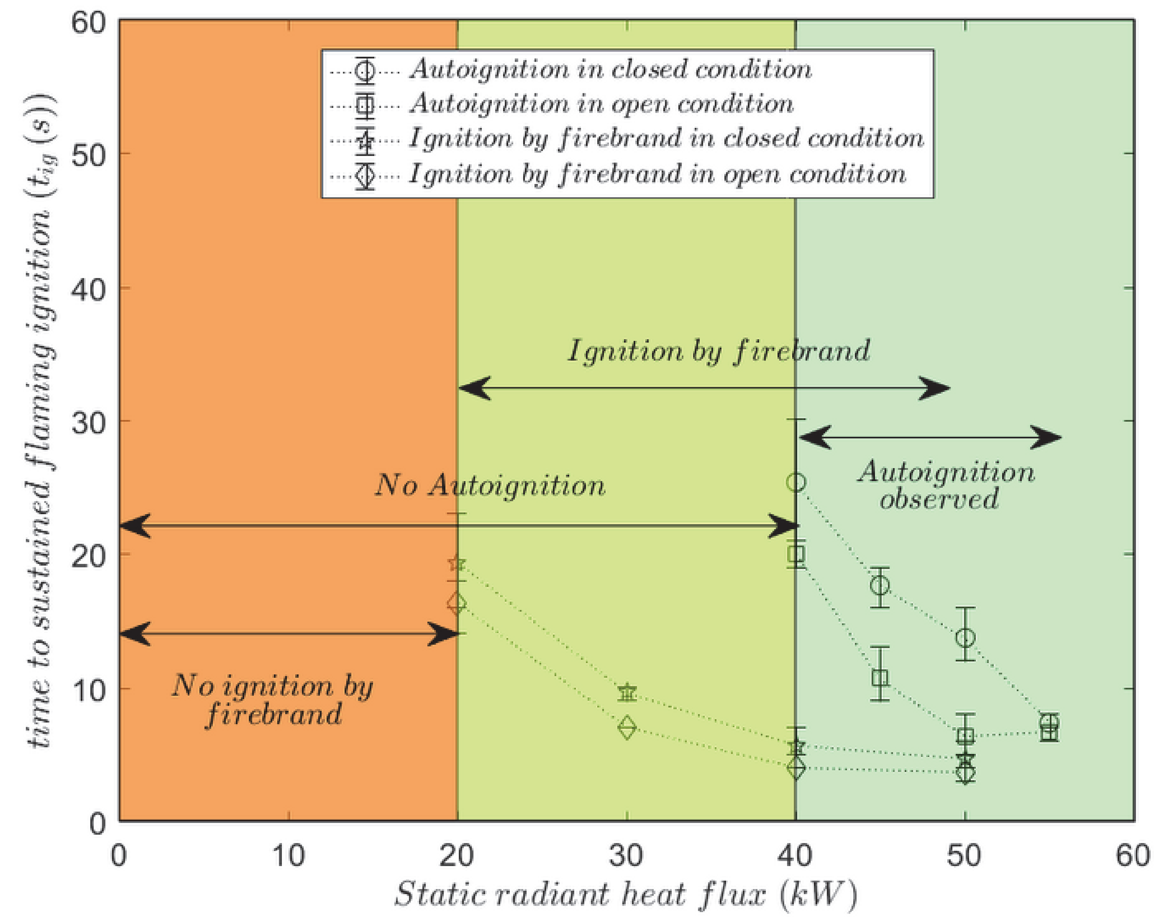


Fig.2: Time to sustained flaming ignition for eucalyptus leaves at different heat flux

RESULT AND CONCLUSION

Fig.2 shows the experimental observation for eucalyptus leaves in different conditions. The fuel shows

- no ignition potential below 20 kW/m².
- ignitability between 20-40kW/m² only when an external source of ignition (eg firebrand or sparks) are present.

The volatile gases released are not dense enough to cause flaming ignition.

Exposure to oxygen through the fuel bed in the open situation shows faster time to ignition.

FUTURE WORK

The physics-based modelling of the above experimental situation should be required to validate the pyrolysis sub-model of FDS/WFDS. The dependency of fuel combustion when exposed to more than one firebrand is required to be tested. The above test shows significant dependency on air flow through fuel bed which should be explored in detail.

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