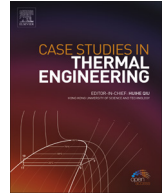




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# Case Studies in Thermal Engineering

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## Influence of thermal contact on heat transfer from glowing firebrands

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### ABSTRACT

The influence of thermal contact between a glowing firebrand and the target fuel bed on the resultant heat transfer into the fuel bed was investigated in this study. A zero dimensional (0-D) model for the firebrand coupled to a transient two dimensional (2-D) explicit finite difference model for the fuel bed were used to simulate transient heat transfer from a firebrand deposited on a fuel bed. Two firebrand shapes, a disk shaped firebrand in contact with the fuel bed and a cylinder shaped firebrand with a protruding node in contact with fuel bed, were considered. A model was proposed to estimate the thermal contact resistance between the firebrand and the target fuel bed. Heat transfer from a cylinder shaped firebrand with two contact points was also investigated. The model developed in this study provided detailed information on the temperature distribution and thermal penetration depth in the target fuel bed. Predictions made by the model were in qualitative agreement with experimental data reported in the literature. The firebrand thermal contact resistance model presented in this study can be a useful tool to account for variations in firebrand shape and surface irregularities in both the firebrand and the target fuel bed.

### 1. Introduction

Ignition of surrounding fuel elements by wildland fire generated firebrands or firebrand spotting is a dominant mechanism for the spread of both wildland and wildland-urban-interface (WUI) fires [1]. Firebrands or embers generated by wildland fires are transported over significant distances downwind and can ignite secondary fires far from the fire front [2]. The deposited firebrands heat up the surface of the fuel bed, resulting in the formation of flammable air/fuel mixtures above the fuel bed. Continued heat supplied from the firebrands leads to ignition [3]. A better understanding of how these transported firebrands ignite fuel beds can help mitigate fire spread in communities that are in the wildland-urban-interface.

Ignition of various fuels by firebrands has been extensively studied through experimental measurements by researchers at the National Institute of Standards and Technology (NIST) [1–6]. Experiments were performed for both flaming and glowing firebrand impact. Several shapes and sizes of firebrands such as disks, cylinders and cubes as well as fuel beds of common materials in and around homes/structures were investigated. In general, their data suggests that exposure to flaming firebrands almost always results in ignition, while glowing firebrands may or may not lead to ignition. In addition, flux of firebrands, the size of firebrands and the magnitude of air flow were important parameters in the ignition propensity of a fuel bed. Three types of ignition events were reported: 1) Smoldering ignition, 2) Flaming ignition and 3) Smoldering to Flaming ignition transition. Other experimental studies with metal particles have also been reported [7].

Several models have been developed to calculate trajectories, combustion rates, and lifetimes of metal particles and burning

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