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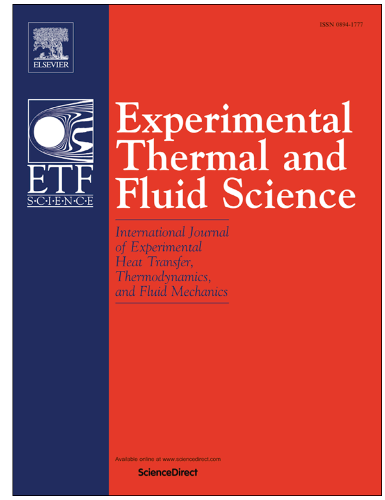

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N. Hernández, A. Fuentes, J.L. Consalvi, J.C. Elicer-Cortés

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SPONTANEOUS IGNITION OF WILDLAND FUEL BY IDEALIZED FIREBRANDS

N. Hernández[a], A. Fuentes[a,*], J.L. Consalvi[b], J.C. Elicer-Cortés[c]
andres.fuentes@usm.cl
[a]Departamento de Industrias, Universidad Técnica Federico Santa María, Av. España 1680, Casilla 110-V, Valparaíso, Chile
[b]Aix-Marseille Université, IUSTI/UMR CNRS 7343, 5 rue E. Fermi, 13453 Marseille Cedex 13, France
[c]Universidad de Chile, Departamento de Ingeniería Mecánica, Beauchef 850, Piso 5, Santiago, Chile

Abstract
The spontaneous ignition of a forest fuel layer by idealized firebrands was carried out experimentally in a bench scale apparatus designed to understand the relationship between the time to ignition and incident radiative heat flux on a ring-shaped forest fuel litter. Time to ignition, mass loss, radial temperatures and incident radiative heat flux were measured. The fuel samples were Radiata Pine needles, representative of Chilean forests and the influence of the physical characteristics of the fuel load were analyzed. The firebrand was idealized using a cylindrical electric heater capable of releasing heat flux up to 26.7 kW/m^2. For the fuel beds considered the inverse of ignition time was found to be linearly dependent on the incident radiative heat flux, typically observed for thermally thin solid fuels. Several tests were carried out in order to estimate the critical (minimum) heat flux for spontaneous ignition for two forest fuel loads. Additionally, a quasi-linear relationship between mass loss rate and incident radiative heat flux was experimentally determined.

Keywords: ignition time, wildland fuel, critical heat flux, firebrand, wildfire

1. Introduction

The wildland-urban interface (WUI) is the zone where housing structures meet or interact with wildland vegetation. WUI fires occur when wildland fires cannot be controlled, often due to extreme wind and fuel conditions, and spread into communities. These fires have been a large problem over the last years not only in Chile [1], but also all over the world. The most recent event took place during year 2017, a wildfire described as the worst in the modern Chilean history, with a peak of 142 simultaneous fires foci being probably generated by fire spotting processes, destroying over 5000 km^2 and 1000 buildings.

If a wildfire involves the production of flaming or glowing particles (firebrands) transported by the convective plume, which may cause new secondary fires ahead of the main front, the ignition mechanism is called spotting [2]. The spotting mechanism can be described in three main sub-processes: (i) the generation of firebrands from vegetation and structures, (ii) subsequent transport normally through the convective plume and by the wind [3] and (iii) the ignition of the forest fuel at landing position [4]. Nowadays a main challenge is understanding how these firebrands can ignite, create new fire foci over a forest fuel layer [2] and how it spreads**.** Many modelling attempts have been carried out in order to predict the fire spread including the mathematical complexity of the stochastic spotting process [5], however this issue has not been fully solved yet.

The transport of firebrands and associated models have been widely discussed in the literature [6-9]. Nevertheless, very few publications have addressed the issues of ignition due to firebrands and ignitability of fuel beds. Blackmarr [10] and Ferreira [11] carried out experiments with point-source ignitions using dropped lit matches. Manzello et al. [12, 13]