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Influence of different sample holders on the flammability of pine needles in the mass loss calorimeter

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Abstract

Forest fires in the last few years represent one of the main outcomes of the impact of climate change, and in this regard, a large number of researchers dedicated themselves to researching the combustion dynamics of forest vegetation. Unlike large-scale experiments, where due to limited resources in predicting forest fires, the development of fire models is a more cost-effective alternative. The required data for these models can be obtained in small-scale experiments, such as the mass loss calorimeter, which was used in this study. The concept of operation of a mass loss calorimeter consists in exposing the prepared sample in a sample holder to a certain thermal flux. By measuring the temperature of the combustion products, the heat release rate is determined, which is the most important parameter for characterizing the flammability of the materials.
The purpose of this paper is to determine the main flammability parameters that affect the combustion dynamics of forest fuel in a mass loss calorimeter. To understand the role of oxygen transport mechanisms in the combustion zone, three different configurations of sample holders were developed, which differ in dimensions and percentage of the opening of sample holder sides, to allow fresh oxygen concentration in the combustion zone. Therefore, the used types of sample holders are: two shapes of baskets with small holes in all sides (1-square shape, where the bottom is covered with aluminum foil; 2-round shape), and 3-flat square sample holder, whose surface is mostly open. The samples are exposed to a heat flux of 50 kW/m^2, the mass of the samples is fixed to 15 g, and the surface of the sample holder is evenly covered with fuel.
In this paper, the main focus is on determining the impact of different configurations of sample holders on the combustion dynamics of forest fuel. For the research, the design of the experiment was set up, which consists of 2 experimental factors, namely: types of sample holders and fuel moisture content (fresh and dried). The obtained results, such as the peak and mean value of the heat release rate, ignition time and burn duration, represent dependent variables, where the interdependence of experimental factors and statistical significance was determined using a two-way ANOVA. Among the obtained results, it was found that there is a significant difference in the combustion dynamics on different sample holders.

Keywords: pine needles, mass loss calorimeter, sample holder, flammability parameters

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