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# Evaluating the flammability of wood-based panels and gypsum particleboard using a cone calorimeter

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ABSTRACT

This study examined the combustion characteristics of wood-based panels and gypsum particle board (GPB) made from wood particles using a cone calorimeter according to the ISO 5660-1 specifications. The combustion characteristics of the wood-based panels and GPB were measured in terms of the time to ignition (TTI), heat release rate (HRR), smoke production rate (SPR) and CO yield under a fire condition. The results demonstrated variations in the burning characteristics between the wood-based panels and a significant influence of the surface materials and construction elements on the HRR and SPR. The HRR, SPR and the CO yield of GPB were significantly lower than those of the wood-based panels.

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## 1. Introduction

In recent years, the increasing demands on forestry resources for different applications have led to shortages of wood supply. Therefore, there is growing need to find alternative raw materials and increase the utilization rates of wood resources including wood-based panels, such as particle board (PB), medium density fiberboard (MDF), plywood, hardboards and wood flooring [1,2]. In particular, gypsum PB (GPB), which has superior properties, such as a lack of formaldehyde emission, fire-resistance and sound insulation compared to wood-based panels, has been used [3,4]. GPB consists mainly of natural gypsum with residual or recycled wood particles. In the manufacturing process for GPB, gypsum is added to water citric acid, pressed into stable and odorless panels, dried, and cut to the customary sizes. Moreover, the wood particles are not dried, and GPB is pressed under cold conditions, which reduces the thermal energy consumption. In addition, GPB employs industrially disposed gypsum, which is a by-product of many chemical processes [3,5]. GPB has attracted considerable research attention due to its widespread availability in nature, its ecological and technological properties, low energy consumption in manufacturing and many other positive properties [6]. Owing to these advantages, the largest use of gypsum is in the manufacture of GPB for use in partition walls, attachment shuttering, wall and ceiling paneling, and suspended ceilings.

The increasing demand for wood-based panels and GPB in building and interior materials has prompted concerns regarding their combustibility [7]. Wood-based panels ignite when exposed to fire, releasing heat, which can further promote the fire in some circumstances. For these reasons, stringent fire regulations govern the use of building and interior materials and other applications. These regulations require that the fire reaction properties meet specified levels. The reaction properties that are often used to define the fire hazard include the heat release rate (HRR), time to ignition (TTI) and flame spread rate, which are important because they affect the temperature and spread of a fire [8].

This study evaluated the fire safety performance of wood-based panels and GPB using a cone calorimeter. The cone calorimeter is a newly developed instrument for measuring the heat release and smoke emission behavior from a burning surface and analyzing the combustion products when a constant flow of air is provided to a confined space [9,10]. Of the many fire reaction properties, it is generally recognized that the HRR is the single most important factor in controlling fire hazards.

The aim of this study was to determine the combustion characteristics of wood-based panels and GPB according to the ISO 5660-1 using a cone calorimeter.

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## 2. Experimental

### 2.1. Materials

Wood-based panels, including 9 mm-thick PB, 12 mm-thick MDF, 8 mm-thick high density fiberboard (HDF), 8 mm-thick plywood and 8 mm-thick laminate flooring were obtained from Dongwha Enterprise Co. Ltd., South Korea. Laminate flooring consists of HDF as the core material with a deco paper bonded onto the face of the HDF using melamine–urea–formaldehyde resin [2]. Building gypsum was obtained from a gypsum manufacturer (Shan Xi Province, PR China). *Eucalyptus sp*. and *Pinus massoniana* wood particles were provided by Cang Song GPB manufacturer (Shan Dong Province, PR China) and Nanjing New Human Board Industry Co., Ltd. (Jiang Su Province, PR China), respectively. Screen analysis involves passing wood particles through screen meshes of various sizes. This was performed to determine


(a) *Eucalyptus sp*. (b) *Pinus massoniana*

**Fig. 1.** GPBs made with *Pinus massoniana* and *Eucalyptus sp*. wood particles [3].

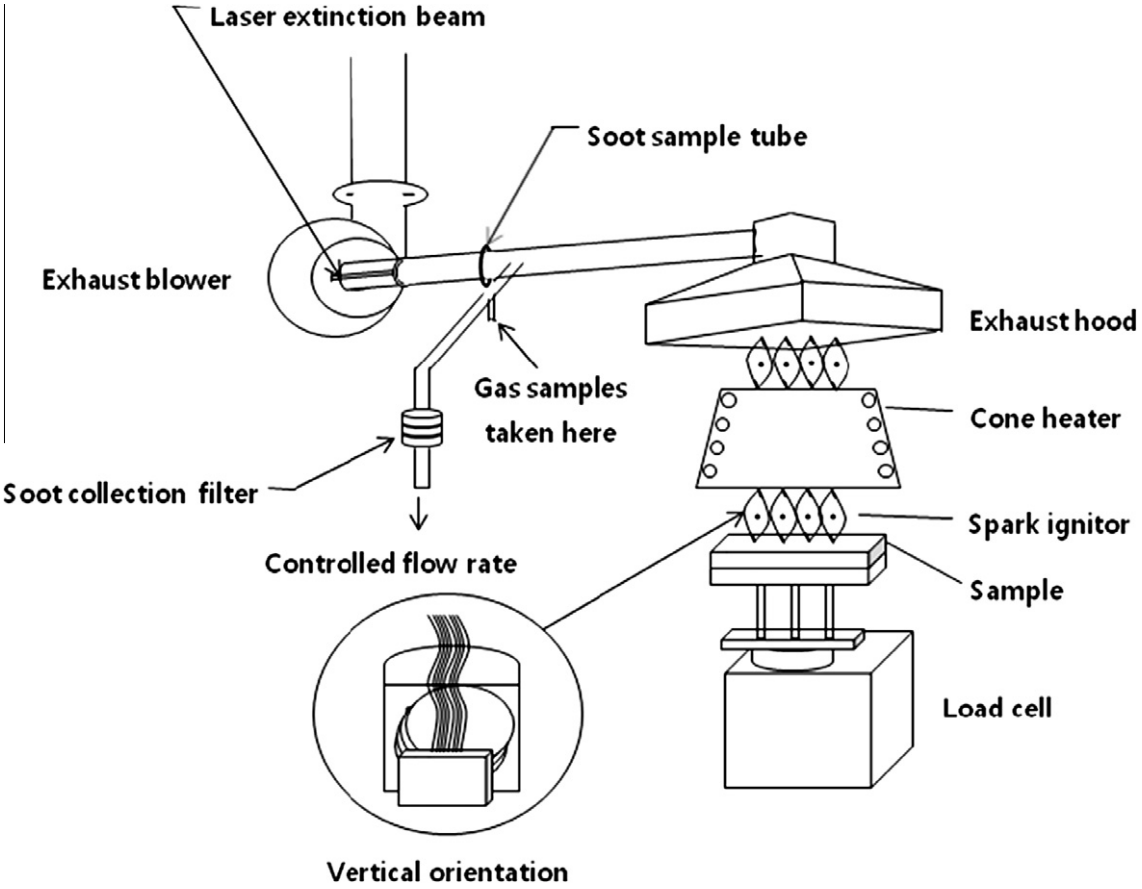


**Fig. 2.** Experimental set-up of the cone calorimeter.

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