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Thermal decomposition of wood: Kinetics and degradation mechanisms

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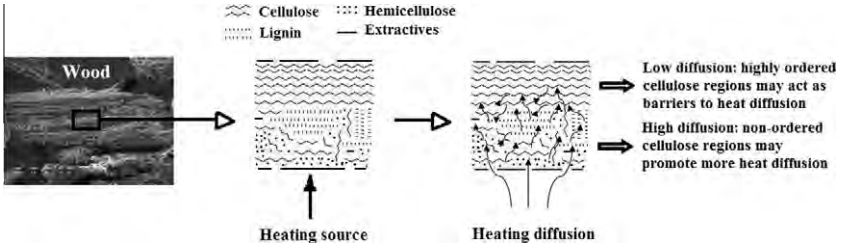
HIGHLIGHTS

- Higher extractives content accelerate the wood degradation process.
- Higher organized cellulose regions prevent wood thermal degradation.
- Wood degradation mechanism is mainly governed by diffusion process.

GRAPHICAL ABSTRACT



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ABSTRACT

The influence of wood components and cellulose crystallinity on the kinetic degradation of different wood species has been investigated using thermogravimetry. Four wood species were studied: *Pinus elliottii* (PIE), *Eucalyptus grandis* (EUG), *Mezilaurus itauba* (ITA) and *Dipteryx odorata* (DIP). Thermogravimetric results showed that higher extractive contents in the wood accelerate the degradation process and promote an increase in the conversion values at low temperatures. Alternatively, the results indicated that the cellulose crystallinity inhibits wood degradation; organized cellulose regions slow the degradation process because the well-packed cellulose chains impede heat diffusion, which improves the wood's thermal stability. The wood degradation mechanism occurs by diffusion processes when the conversion values are below 0.4. When the conversion values are above 0.5, the degradation is a result of random nucleation with one nucleus in each particle.

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1. Introduction

Sustainable heat and power generation from biomass are at the center of scientific and industrial interests, owing to the increasing awareness of the diminution of fossil fuels and the higher sensibility toward environmental preservation from pollutants generated by energetic systems (Di Blasi, 2008). Biomass is a source of short-cycle carbon, which is of utmost importance for future energy needs (Wongsiriamnuay and Tippayawong, 2010a). Wood is the main source of biomass (Di Blasi, 2008). Thus, wood remains one of the most important biomass materials for several applications because of its renewability, high-yield applications and appropriate characteristics (Wongsiriamnuay and Tippayawong, 2010a). Additionally, the growth of wood reduces the CO_2 in the atmosphere through photosynthesis (Wongsiriamnuay and Tippayawong, 2010a; Shuping et al., 2010).

From the chemical point of view, wood is a composite material comprised of cellulose, hemicellulose and lignin, along with smaller quantities of extractives and inorganic matter. From the physical point of view, wood is a complex structure with anisotropic properties (Di Blasi, 2008; Popescu et al., 2011). The chemical and physical properties of wood such as moisture content, chemical composition, density and crystallinity are factors that affect the characteristics of thermal decomposition and degradation kinetics (Di Blasi, 2008; Órfão et al., 1999; Popescu et al., 2011).

Pyrolysis can be described as the biomass conversion by heat in absence of oxygen in a relatively low range of temperatures (300–600 °C) which results in the production fuel gasses, charcoal and

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