

EXPERIMENTAL STUDY OF SELF-HEATING PHENOMENA DURING TORREFACTION OF SPHERICAL WOOD PARTICLES

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Abstract

Torrefaction is a thermal degradation process undertaken in the absence - or with a very low concentration - of oxygen. Generally, temperature is between 250 and 300°C and residence time from 10 to 60 minutes. It is seen as a promising pretreatment in the biomass energetic valorization scheme [1]. Meanwhile torrefaction technology is developed at industrial scale, the market is still in development [2]. Nevertheless, depending on process conditions, a subcritical self-heating might happen during biomass torrefaction due to the presence of exothermic reactions [3, 4]. Yet, this reactivity is not well understood but, as the temperature is a key parameter to control both quality and quantity of torrefied materials, this phenomenon is critical for industrial implementation and process reliability.

Torrefaction experiments are carried out with spherical beech wood particles of different diameters - 2, 3, 5 and 9 cm - and at three temperatures: 250, 275 and 300°C. Five thermocouples are set in the spheres at various depths and positions to consider wood anisotropy. The experiments are conducted in an electrically heated oven. Nitrogen is used as sweeping gas. The 30 L/min stream is pre-heated before being introduced in the reactor. After torrefaction, the particles are cut in the middle and Raman analysis is carried out along the radius. A subcritical self-heating is systematically observed for the biggest particles ($d \geq 5$ cm), whatever the torrefaction temperature. Raman analysis emphasizes a concentration gradient of oxygen, along fiber direction exclusively, when a self-heating has occurred. This finding supports the idea that oxygenated volatile matters react with the solid materials undergoing torrefaction. The crossing point method [5] is currently applied to determine the activation energy of the torrefaction reaction, which is a critical parameter for process modeling.

References

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