OPTIMIZATION OF MULTIPLE HEARTH FURNACE FOR BIOMASS TORREFACTION

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ABSTRACT Subject number 3 and subsection 3.2 Torrefaction of biomass

Gasification in entrained flow reactor and co-combustion of biomass in coal power plant are promising technologies of thermo-chemical conversion to produce electricity, heat, fuels and chemicals. Prior to injection in those reactors, biomass must be dried and ground to fine particles, until several hundreds of micrometers. These preliminary steps, especially grinding, consume large amounts of energy and represent obstacles that need to be overcome in order to expand the use of biomass in thermo-chemical processes.

Torrefaction is a mild pyrolysis process carried out at 200 – 300 °C under inert atmosphere. It is a technology which allows moisture and low weight organic volatile components of biomass to be removed, producing a hydrophobic solid residue with an increased energy density (on a mass basis) and greatly reduced grinding energy consumption compared to fresh biomass[1]. Electricity requirements for size reduction of torrefied wood are 50 to 85 % smaller in comparison with fresh wood[2]. Therefore torrefaction leads to a more suitable product for transportation, storage and feeding.

Currently, main applications for torrefied products are gasification and co-firing in coal power plant. Products can be used as a fuel either in pellet or powder after grinding.

A state of the art of the existing torrefaction technologies has been performed. On the outcome of this study it appears that CMI's torrefaction process is one of the most promising technologies. It's a multiple hearth furnace whom main advantages are to allow the biomass torrefaction over a large range of residence time, temperature and biomass feedstocks.

Within the framework of collaboration between French research centres CEA and CIRAD and the Belgium company CMI, the multiple hearth furnace developed by CMI has been adapted and optimized to torrefaction purpose. The main objectives were to reduce the production costs while improving significantly biomass properties.

To achieve the objectives, an extensive experimental program was conducted in the torrefaction pilot plant of CMI which has a 40 kg/h capacity. Sampling methods and instrumentations were developed to analyse solids and gas products. The optimized process has proved experimentally its capacity to obtain well-torrefied product and its flexibility towards operating conditions and feedstock, which can be either wood or agricultural resources.

Besides experimental work, a model of the torrefaction plant was built with Fluent®, CFD simulation software. This model has a supporting role in the extrapolation to industrial scale of the technology CMI.

Thanks to furnace technical improvements, residence time has been reduced and reactor capacity has been increased. According to previous works, the torrefied products were characterized by a higher carbon content and energy density. Products had also more homogeneous properties and were much more friable than raw material. These results valid the adaptation choices, and allow to be confident for the upscaling to an industrial plant.

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