Use of Life Cycle Assessment to determine the environmental impact of thermochemical conversion routes of lignocellulosic biomass: The gasification step

S. Gerbinet[1], H. Jeanmart[2], A. Léonard[1]

[1] Laboratory of Chemical Engineering – Processes and sustainable development - University of Liège, Belgium, B6, allée de la chimie 3, 4000 Liège, Saicha.Gerbinet.ulg.ac.be, Phone : +32 4366 3547

[2] Institute of Mechanics, Materials, and Civil Engineering, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium

Category: Renewable Energy & Feedstock

Abstract: Lignocellulosic biomass gasification is viewed as a promising way to substitute fossil fuels in several applications. This process converts the biomass into a combustible gas (mainly CO and H_2, together with CH_4, and impurities), called syngas, in the presence of a suitable oxidant. The syngas can be used directly to produce electricity and/or heat or can be converted into a large range of products, such as diesel, via a Fischer-Tropsch process, or methanol, used for producing dimethyl ether, both of which can serve as fuels in engines. Syngas can also be used to produce ethylene and propylene, two building blocks for the chemical industry.

The aim of this work is to determine the environmental impact of a gasification process converting lignocellulosic biomass. Indeed, this feedstock is interesting in that it implies small competition with food crops for land and water. Also, the whole plant can be processed. But the environmental impact has still to be accurately quantified.

The Life Cycle Assessment (LCA) methodology is used. LCA deals with the environmental aspects and potential impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use and disposal. In this type of environmental assessment the energy and material flows for the entire life-cycle are surveyed and analysed with special attention to possible environmental hazards or human health problems. A LCA consists of four interdependent steps defined by the ISO standards 14040 and 14044: goal and scope definition, inventory analysis, impact assessment and interpretation.

In a first step, wood gasification is studied. A downdraft, fixed-bed gasifier is considered. Moreover, it is based on the two-stage technology known to produce very low amounts of tar. The produced syngas is used for power generation or in a cogeneration (electricity and heat). This gasifier type is generally considered working close to the equilibrium state. So, real case data are compared with the results obtained by equilibrium calculations. Sensitivity studies are also conducted on the end of life of the ashes: Presently, in the Belgian legislation context, the ashes must be landfilled but, in the future, it may become possible to use them for field fertilization. The use of LCA allows to compare all these possibilities for

different impact categories. Moreover, electricity production from syngas will be compared with more traditional renewable electric generation systems (wind power, etc.) and non-renewable ones (Belgian grid mix, nuclear, etc.).