PROCESS INTENSIFICATION BY SUPERCRITICAL WATER TECHNOLOGIES

María José Cocero

High Pressure Research Group
Chemical Engineering and Environmental Technology Dept.
EII. Sede Mergelina, Valladolid University
SPAIN

Chemical technology must achieve a paradigm shift for the decentralized production necessary for biomass chemical industry. Compared with current centralized mass production processes, biomass processes cannot depend so much on scale merit concepts. This means that we will need to achieve factors such as reduction in equipment cost, environmental compatibility, safety and handling through compact apparatus and simplified conversion steps. Ultra-fast reactions are effective for reducing the size of the apparatus, since reducing the reaction time from 10 minutes to a few milliseconds allows reduction in the size of a reactor from 1 m^3 to 1 cm^3.

The supercritical fluids processes introduce pressure as a variable that can open the opportunity for new process with strong reduction in the operation time. Reactions in single phase avoid mass transfer limitations, high reaction rates and high solubility. At the same time, the pressure reduction allows fast fractionation of extraction o reaction process effluent. In this way, supercritical water (SCW) is a new reaction media to develop process for biomass transformation in energy or chemicals.

SCW oxidation is a well-known process, limited by the high process cost. Now the SCWO with hydrothermal flame allows total waste oxidation by reaction time lower than 1 second to produce high-pressurized steam. The complete solubility of cellulose in SCW allows biomass fractionation to get hemicelluloses, cellulose and lignin. Cellulose hydrolysis in SCW rents glucose, fructose and cellobiose (50%) or total mono-oligo saccharides (>96%) in a reaction time of 0.03 s, without degradation products as HMF. The SCW media avoid ionic degradation reaction and the control of the residence time limits the radical reactions.

The glucose hydrolysis, hydrogenation or oxidation reactions at high temperatures and at high pressures allow fast reactions and improve the selectivity by changes in the water density with pressure. This is a new promising way to obtain valuable chemicals from renewable materials.

*Corresponding author: mjcocero@iq.uva.es