A continuous reaction system for hydrothermal liquefaction of microalgae

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Among oleaginous crops for the production of biofuels, microalgae show to have big potentiality due to their high lipid content, high yields in terms of biomass per unit soil surface and time, as well as the possibility to be cultivated in industrial marginal soils [1]. Rather than dry processes, i.e. pyrolysis, torrefaction and gasification, hydrothermal treatments are preferable as the energy intensive drying of the feedstock can be avoided [2]. In the last few years research efforts were oriented to the use of the whole microalga as feedstock, instead of the conversion of the lipidic fraction previously extracted from the starting matrix. Alternatively, a combined process (first lipid extraction and transesterification, then hydrothermal treatment of the residue) has been proposed to maximize the exploitation of the matrix [3]. Due to the strong dependence of the composition of the microalgae on the considered species as well as on the growth conditions (light irradiation intensity, oxygen, CO_2 and nutrients concentration, temperature, possible contamination and so on), one technological challenge is to guarantee a conversion plant suitable to convert feedstocks with significant variation of the properties. This aspect is still more important if processes must be scaled-up to the industrial size, which is desirable for biofuels production in general. However, till now lab-scale batch systems have mostly been used for hydrothermal liquefaction (HTL) or supercritical water gasification (SCWG) of microalgae and there are only few examples of continuous pilot plants. In this work we developed a continuous layout for the hydrothermal conversion of microalgae at near and supercritical water conditions. To achieve the desired configuration several technological aspects were taken into account, such as the use of materials resistant to corrosion and to high pressure and temperature at the same time, the use of a preheating section for the treatment water and the mixing of this stream with that containing the biomass to be converted, the separation of the four outcoming product phases (gas mixture, aqueous and organic liquid, solid residue), the pumping of the biomass slurry. Before performing experiments with real biomass, the plant was tested at different temperatures and pressure by feeding glucose and glycerol as model compounds of the carbohydrates and the lipids of the microalgae respectively.
In the present work we will also show the results of preliminary experimental tests performed with *Nannocholoropsis gaditana* as feedstock. When microalgae have been used four different product phases were obtained and the effect of the investigated operative conditions on their relative amounts and on the composition of the produced gas mixture will be presented and discussed.

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