A THREE-STAGE THERMOCHEMICAL CONVERSION PROCESS FOR THE PRODUCTION OF BIOCHAR

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Within a French consortium of four companies and five laboratories from two scientific groups, Sea Marconi is one of the industrial partners of the LORVER project (www.lorver.org). The project aims at the sustainable redevelopment of brownfield deriving from the deindustrialization of the Lorraine region (France) by soil reconstruction, cultivation of different non-food biomasses and their final conversion into valuable outputs (biochar, bioenergy, natural fibers, metals).
Sea Marconi is responsible for the thermochemical conversion of biomass (poplar) specifically cultivated on brownfields for the production of biochar, with bioenergy as byproduct.
Based on a proprietary concept, design and engineering, a first 100 kg/h (nominal) pilot-scale plant was successfully delivered and is currently under testing at Sea Marconi premises in Lorraine (France) since 2013. This new solution represents the synthesis of the experience made after several years of work on pyrolysis plants, including an accurate analysis of drawbacks and advantages of Sea Marconi previous solutions (e.g. Haloclean®) and alternatives available on the market, with the aim of reaching the reliability required by industrial level applications and allowing a straightforward scale-up to higher throughputs.
The plant is designed as a three-stage gasification system, sometimes referred as *pyro-gasification*, where pyrolysis, (partial) oxidation and gasification occur in three different reaction zones properly interconnected. Partial oxidation of pyrolysis char supplies process energy to pyrolysis through the recirculation of heated steel spheres. The same spheres also enhance the pyrolysis process, providing mixing and milling of the organic matter being thermally treated. Gasification of tars and char occur into two separate reaction zones. Reforming of pyrolysis tars can be catalytic or not, preserving the same reactor.
The plant is designed in a way that process and product flexibility can be easily attained. Feed rate can be largely varied within nominal maximum throughput, process temperatures can be modified separately among the three reaction zones, and even product distribution can be modified according to applications: for instance, part of the char can be extracted before partial oxidation, if biochar production is favored. Finally, the plant is delivered in a containerized modular fashion that makes logistic and installation straightforward tasks, minimizing the required civil engineering activities before erection (Figure 1).

Figure 1 – Overall view of the thermochemical conversion plant

During the last year of testing the conventional “wet” downstream gas treatment subsystem was replaced by a revolutionary dry cooler developed by Sea Marconi, with the aim of cooling and cleaning the producer gas for downstream applications. Its main advantage is the possibility to recover most of the thermal energy from the producer gas as high-temperature air that can be used, in principle, within the process itself (e.g. for biomass drying or as oxidizing agent), with clear potential benefits for the overall energy balance.
At the present time Sea Marconi, together with some academic partners, is investigating the fate of metal trace elements, accumulated by the biomass cultivated on brownfields, among the different process outputs (i.e. biochar, ashes, syngas, fly ashes, quenching water, etc.). This task is fundamental to evaluate the feasible uses of process outputs, taking into account the local regulatory context.