University of Naples Federico II (UNINA)

The R&D activities on thermochemical conversion processes of biomass and waste at the Department of Chemical Engineering at the University of Napoli "Federico II" started about 23 years ago. Formulation and numerical solutions of detailed computer models, experimentation on chemical reactors and chemico-physical characterization of products are pursued, with a view of process design, development and optimization for energy and chemicals production.

The group is currently involved in the following research topics:

- Reaction mechanisms and products of biomass pyrolysis;
- Catalytic pyrolysis of biomass for chemicals and biofuels production;
- Char reactivity and kinetics;
- Development of transport models for particle pyrolysis (conventional and microwave induced heating) and pyrolyzers, particle combustion and gasification (coupled solid-phase and CFD gas-phase), updraft and downdraft fixed-bed gasifiers, fluidized-bed gasifiers and combustors (two-phase theory of fluidization coupled with the transport phenomena of the fluidized-bed reactor, including population balances).

Laboratory equipment includes:

- Home-made micro- and macro-TGA based on radiant heaters of high power and fast heating rate (measurements of weight loss characteristics, temperature profiles, product yields);
- Laboratory scale fluid-bed and fixed-bed pyrolysis reactors integrated by Soxthec extractor (biomass chemical composition), Karl Fischer titrator (water content), GC with FID and TCD detectors (gas and oil analysis), GC-MS (oil analysis), HPLC/GPC with IR and DAD detectors (oil analysis).

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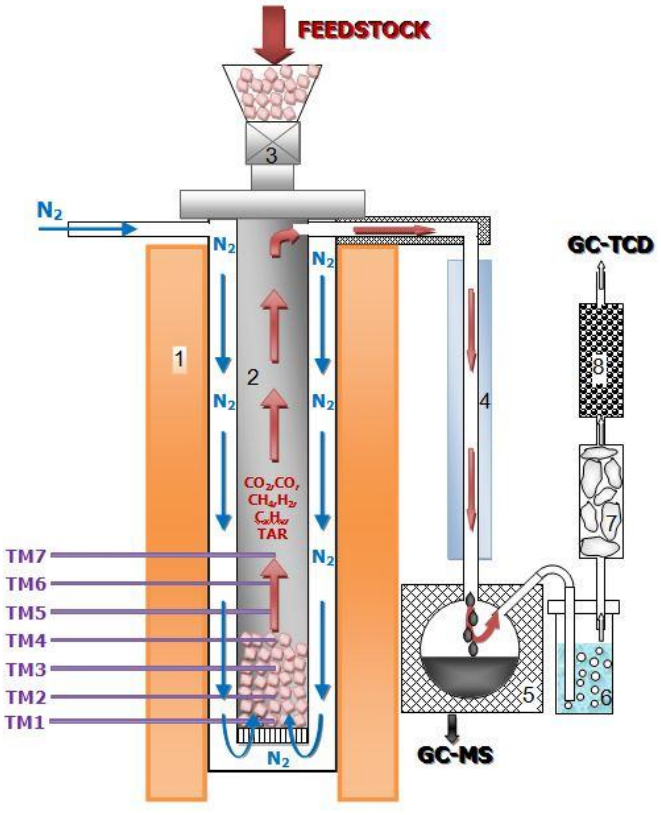

Figure 1: Schematic of the fixed-bed pyrolysis plant.

Figure 2: Isothermal packed-bed pyrolysis reactor.

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BRISK Activities

Experimental tests will be carried out using the isothermal packed-bed pyrolysis reactor for selected feedstocks and the tarry compounds, collected in the liquid phase, and also comprising the water generated from both drying and dehydration reactions of the pyrolysis process, will be characterized. In particular a HPLC method will be developed including the application of Gel Permeation Chromatography (GPC). After optimization HPLC and HPLC-GPC will be used in conjunction with CG-MS for the identification and quantification of tarry compounds on dependence of the pyrolysis conditions and the biomass type.

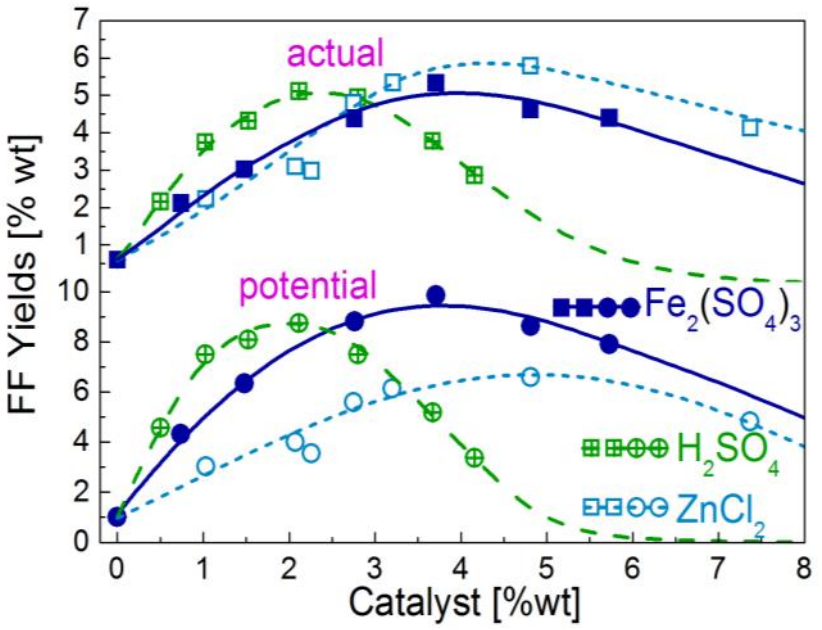

Figure 3: Actual and potential yields of furfural (FF), expressed as a percentage of the initial sample mass, from the catalytic pyrolysis of corncobs, carried out for a heating temperature of 800K, as functions of the impregnated catalyst concentrations.

Biomass pyrolysis takes place in a batch system where the core is a steel reactor. Nitrogen, fed through a jacket at the reactor top, is heated by an electrical furnace and distributed at the bottom by a perforated steel plate, which also supports the bed. Temperature profiles along the reactor axis are measured by seven thermocouples, with their tips exiting from a protective steel tube, at chosen distances from the flow distributor. The lower reactor zone, at steady conditions, is isothermal at a temperature determined by a proper set point of the furnace.

The temperature along the isothermal region (heating temperature) can be varied during the tests. After nitrogen flushing, when steady profiles are established and the desired heating temperature is achieved, the biomass sample is suddenly dropped inside the hot reactor. Nitrogen and volatile pyrolysis products pass through a condensation train consisting of two water/ice cooled condensers (with a catch pot, where the largest fraction of liquids is collected and chemically characterized), two wet scrubbers, three cotton wool traps and a silica gel bed (all connected in series). Gas sampling and analysis are made at selected times allowing the exit volumetric flow rate and mass of each gaseous species to be determined.

Contact

For further details about how to apply to utilise UNINA's facilities as part of the BRISK initiative contact:

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