Thermal treatment of waste and biomass

In order to renew our energy mix, we need to start considering household waste and agricultural and forestry residues as energy resources in their own right. In this context, three main activities took place in the period considered.

The first concerned the modeling of processes taking place within fluidized bed reactors used for waste incineration or gasification. This issue was first addressed in the laboratory in 1999, and continues to be studied now. The aim is to develop a complete model, including reactor hydrodynamics, coupled heat and matter transfers and homogeneous and heterogeneous chemical reactions. Future applications include the combustion and gasification of waste and biomass.

More recently, this activity was featured in a collaborative project whose objective was to integrate into the existing model a more detailed description of the chemical reactions associated with the presence of nitrogen in the sludge to be incinerated. Work has helped quantify the nitrogenous pollutants (NO, N_2O, NH_3, HCN) emitted by the incinerator and to validate the model through comparison with results from the industry.

The second activity is inherent to the development of a new process for producing electricity from a mixture of waste and biomass. This process combines several steps, including, in particular, gasification of the organic load and purification by thermal cracking of the gas produced. The gas can then be used in a recycling unit by combining a Rankine cycle and combustion of the syngas in internal combustion engines. Various studies served as a basis for the development of the industrial site CHO_Power (which has an expected electricity generation capacity of 12 MW with a yield of 40% http://www.cho-power.com/) and the KIWI research and development platform, both of which are located on the Europlasma site in Morcenx.

The third activity takes place further upstream and involves determining the kinetics of the primary pyrolysis of waste and biomass. Initially, this activity was kicked off as part of a project dedicated to biomass torrefaction. The main objective of this project was to study the torrefaction of local agricultural and forestry residues. An experimental pilot with a capacity of 2 kg/h was developed to study the influence of operating conditions on the quality of torrefaction.

In parallel, a high capacity thermobalance was developed, and this device has in fact produced the most interesting results to date. It has opened up new perspectives as regards the building of kinetic models describing the primary pyrolysis of waste and biomass. Indeed, the thermobalance can be used to monitor the evolution of the sample mass according to temperature and also the generation of the condensable and non-condensable co-products of the operation with a global material balance efficiency of 95 to 105% for the installation.

By performing coupled analyses of these co-products, we hope to be able to complete literature with information relating to the generation of these co-products, while respecting the material balance of the different atoms composing the initial biomass.