Inorganic and Slag Analysis

Slag Analysis

In thermal processes like combustion of biomass and secondary fuels solid materials is an important factor. Between fuel and slag or ash a multitude of products occur. Slagging in the combustion chamber and deposits on heat exchanger surfaces in the convective part of the boilers are among them.

In the framework of the programme oriented funding and third party funded projects the correlation between fuels and slagging in the combustion chamber as well as deposits on heat exchanger surfaces in the convective part of the boilers is investigated by mineralogical and chemical analysis with two primary aims: first the extension of the run times of plants between standstill times for cleaning by reduced slagging and second the optimisation of the energy efficiency of plants by reduced formation of deposits and an therefore optimised heat transfer on heat exchanger surfaces.

The second key aspect of the working group lies in the research of new utilisation potentials for residues deriving from thermal processes like bottom ashes, slags, and fly ashes. This research is done using the below described characterisation methods and in cooperation with other institute of KIT like the ISE and the AGW as well as with plant operators and manufacturers.

Inorganic Analysis

There are different analysis devices used in this working group to analyse the solid residues and leachates.
For sample preparation different homogenising devices, a jaw breaker, cutting and crushing mills are available. Solids are digested for the analyses of Fluorine, Chlorine, and Bromine by a calorimeter system ((IKA® AOD1.3).

The concentration of up to 75 elements starting with Boron and ending with Uranium can be analysed by a XFA system from BRUKER (S8 Tiger). Semi quantitative results can be achieved by a standard less approach (Semiquant). This is very useful for fast analysis of unknown samples. For larger sample series the XFA can be calibrated for the special matrix. Generally elements from Sodium to Lead are analysed.

The anions Fluoride, Chloride, Nitrite, Bromide, Nitrate, and Sulphate are analysed in liquids by Ionchromatography (DIONEX ICS-2000).
In homogeneous, very fine milled solids the elements Carbon, Hydrogen, Nitrogen, and Sulphur are measured after combustion via infrared spectroscopy (LECO TrueSpec with S-oven and LECO CHNS-932).

Environmental impact tests:
The characterisation of solid samples in view to their behaviour in the environment has a long tradition in the working group.
Here German and international standard leaching tests were used. The leaching properties depend on the conditions in the combustion chamber, the fuel parameters, the ash discharge system and the treatment methods of the ashes.
The methods used for these investigations are:

- DIN EN 12457
- DIN EN 14405

- Swiss TVA procedure
- NEN 7341 / 7343/ 7345
- TCLP Method 1311
- JIS K 0085-1 / 0085-2

The results of these tests are evaluated according to the national legal limits. Together with mineralogical investigations and mechanical tests they provide information about the potential use of residues e.g. as construction material.

The long-time-behaviour of harmful constituents in residues of thermal treatment plants are studied scientifically by pH-static tests, column tests (DIN 14405 and NEN 7343).With help of sequential extraction methods it can be examined how the heavy metals are fixed in the ashes.

Current projects:

- In the framework of a project financed by the fond for European Development (EFRE) the influence of the fuel specific properties of the biomass fuels on the mineralogical and chemical composition of slags and deposits in eight BMHP plants using different biomass fuels and equipped with different procedural techniques are investigated and correlated with results from laboratory tests and experiments in a pilot plant.
- An important aspect for the bioliq®-process is, that during the production of synthesized fuels no environmental harmful residues are produced which have to be disposed of. For this purpose the slags deriving from the entrained flow gasifier are characterised and potential utilisation paths determined. These is carried out amongst others in master theses.

Past projects:

- The experience of this workgroup on characterisation are used in the European project Lahtistreams „Advanced Integrated Waste Management and WtE Demonstration“, which started in 2006. In work package 3.2 one part is the characterisation of bottom ashes from a CFB-plant in Norrköping, Sweden and a grate furnace in Måbjerg, Denmark. Later ashes from the gasification plant in Lahti, Finland will be investigated for their environmental behaviour and chemical composition, too. (www.lahtistreams.com) (Finished in 2013).
- The research project “Enhancement of the energy efficiency in heat and power plants by an optimised heat utilisation in the boiler” deposits and fly ashes on superheater and economizer walls are investigated (www.dbu.de/projekt_26675/_db_799.html). The chemical analysis and sinter tests are carried out in this workgroup. (Finished in 2013).