A guide to the terminology of ashes and boilers for the user of Allaska

To describe an ash in the database Allaska, only three categories are used today: bottom ash, fly ash and APC residue (air pollution control residue).

Bottom ash is the ash extracted from the lowest part of the furnace while fly ash consists of the particles that, because of their small size or their low density, have been carried over by the combustion gases and fall out in various parts of the boiler and the flue gas cleaning system.

Ash is the mineral non-combustible part of a fuel, including impurities such as sand or gravel. In the flue gas cleaning system reagents are injected to remove pollutants. These reagents are e.g. lime for desulphurisation of the flue gases or active carbon to bind dioxins or mercury. The mixture of fly ash and residues from these reagents is called APC residue.

Limiting oneself to these three categories overly simplifies matters, but the information that is available is often not more detailed. Sometimes, it is necessary to be a little more detailed when describing from where the ash material has been extracted. This higher level of description may have been used in a project reporting data.

Some of the confusions that may arise in Swedish nomenclature do not necessarily occur in English.

Grate furnace or fluid bed furnace

The words boiler and furnace are often used interchangeably, but this is not the same piece of equipment: the furnace is that part of a “boiler” where the fuel is burned and the boiler is that part where the heat of combustion is delivered to a water/steam circuit. In Swedish, the word boiler is often used for the combination of both units.

In a grate furnace, the solid fuel is pushed onto a grate and combustion air is provided from below and through the grate. The fuel is dried, it is carbonised and then burns out on the grate. What is left of the fuel, ash, falls over the edge of the grate and is carried away as bottom ash. The gases produced during carbonisation are burned above the grate.

In a fluidised bed furnace the velocity of the air flow through the bed is high and the fuel hovers in the gas flow. All three processes (drying, carbonizing and burning-out) go on in the same volume. In order to keep the bed hovering at all stages of combustion, one usually uses an additional material, e.g. sand, to make the bed volume large enough. This may not be necessary if the ash content of the fuel is large.

One distinguishes between bubbling fluidised bed (BFB) and circulating fluidised bed (CFB). In a BFB the gas velocity is moderate and the bed stays in place in the furnace. In a CFB, the gas velocity is high enough to carry fuel and bed material out of the furnace. The bed material is separated from the combustion gases in a cyclone downstream and returned to the furnace.

Oversized material which cannot be suspended in the gas flow is extracted from the bottom of the BFB or CFB as bottom ash. One also bleeds out the bed in order to keep the chemistry of the bed material in the correct range. This ash is sometimes called bed ash. The Swedish word furnace sand or boiler sand refers to its particle size distribution, which is sand-like.

Ash from a grate furnace consists only of ash from the fuel and whatever impurities came with it. Ash from a fluidised bed furnace consists of both fuel ash and spent bed material.

Fly ash in the flue gas duct

Ash that is carried over by the combustion or flue gases will fall out on low points in the ducts or when there are obstacles. First to fall is the coarse fraction and last the finest fraction.

Very often, the heat exchanging surfaces of the boiler are not placed immediately above the furnace or the bed. The design illustrated in Figure 1 for municipal waste incinerators is rather common, also for furnaces burning biomass.

The duct from the combustor has been folded before the gas reaches the boiler proper in order to provide for a longer combustion time. Ash falls out at this 180^{o} turn. In Swedish it will be called “vändschaktsaska”, which sounds something like shaft turn ash in English. In English, it would probably be a “boiler ash”.

When the flue gases pass through the boiler, some ash will fall out: the boiler ash.

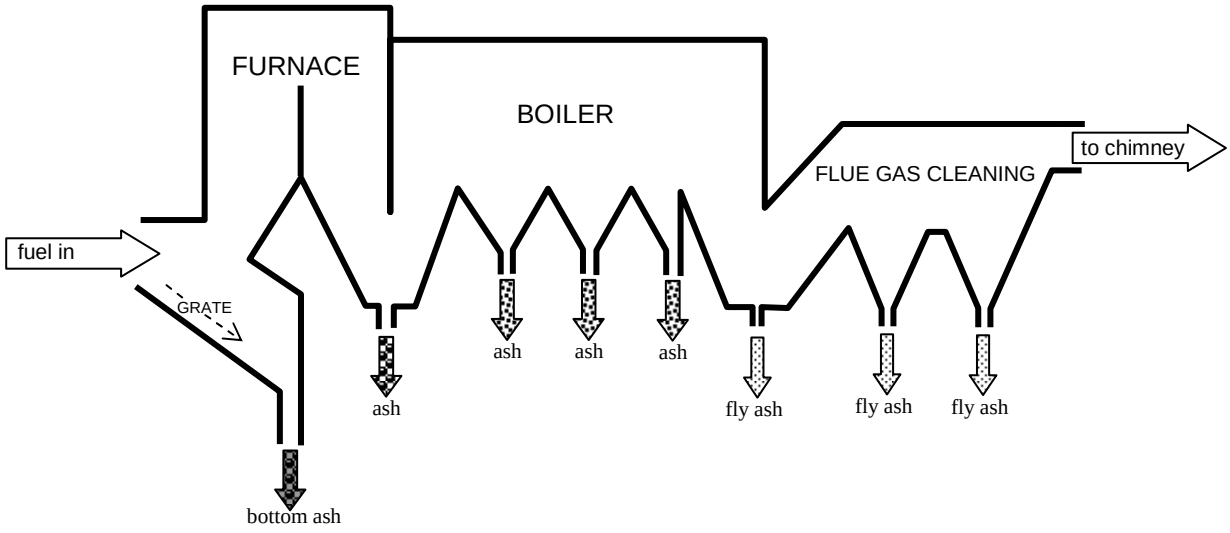

Figure 1 – A sketch of a municipal waste incinerator with grate furnace and dedusting system

After the boiler the flue gases are led to the flue gas cleaning system. De-dusting will take place in one of several types of equipment:

- Cyclones, often a battery of cyclones (multi-cyclones) removing particles above 10 μm
- ESP or electrostatic precipitator, where particles are charged in an electric field and captured by the electrodes, removing particles down to 0.1 μm and reduces dust content to 10-50 mg/Nm^3

- Baghouse filters, where dust is captured in textile filters or ceramic inserts, removing the fine particles and reducing the dust content to 3 – 5 mg/Nm^3

A material called fly ash may be called cyclone ash, ESP ash or filter ash if one wishes to keep apart the different types of equipment. All three types are seldom used together in one system. However, one type or two types in combination may be used: e.g. ESP only or cyclone and baghouse filter in succession.

Desulphurisation etc

One injects an absorbent in the flue gases in order to reduce the sulphur concentration. This may be lime (most often) or sodium hydrogen carbonate (more seldom). Some time is allowed for the finely divided absorbent and the sulphur dioxide in the gases to react before the spent absorbent is collected in a baghouse filter. This residue (APC residue) consists both of spent absorbent and fly ash.

Active carbon may be injected simultaneously in order to clean the gases from e.g. dioxins and mercury.

Please note that desulphurisation and active carbon are usually not used for clean fuels such as woody biomass.

If cleaning the flue gases needs to be pursued further, one can wash them in e.g. scrubbers. Solid ash is captured in the water at the same time as hydrogen chloride or sulphur dioxide. This ash is then extracted as sludge in the water treatment plant. For the time being, Allaska does not contain any data on this kind of sludge.

A vertical boiler

The combustion gas travel horizontally in the plant sketched in Figure 1, which design is the rule for municipal waste incineration. Boilers (furnaces) for other fuels are often built with a vertical gas flow. The boiler is then designed as a vertical shaft, the combustion gases entering the boiler from the top and exiting at the bottom as in Figure 2.

In such a design the combustion gases make a U-turn below the boiler. In Swedish this would be a “shaft turn ash”, but in English, this is a boiler ash. In Allaska, it is a fly ash.

The same black box is used in Figure 2 to represent a CFB and a BFB. Internal details in a CFB, e.g. the cyclone separating bed material that has been carried over, has been omitted from the sketch.

In Swedish, the bottom ash from a fluidised bed boiler is called “bed ash”.

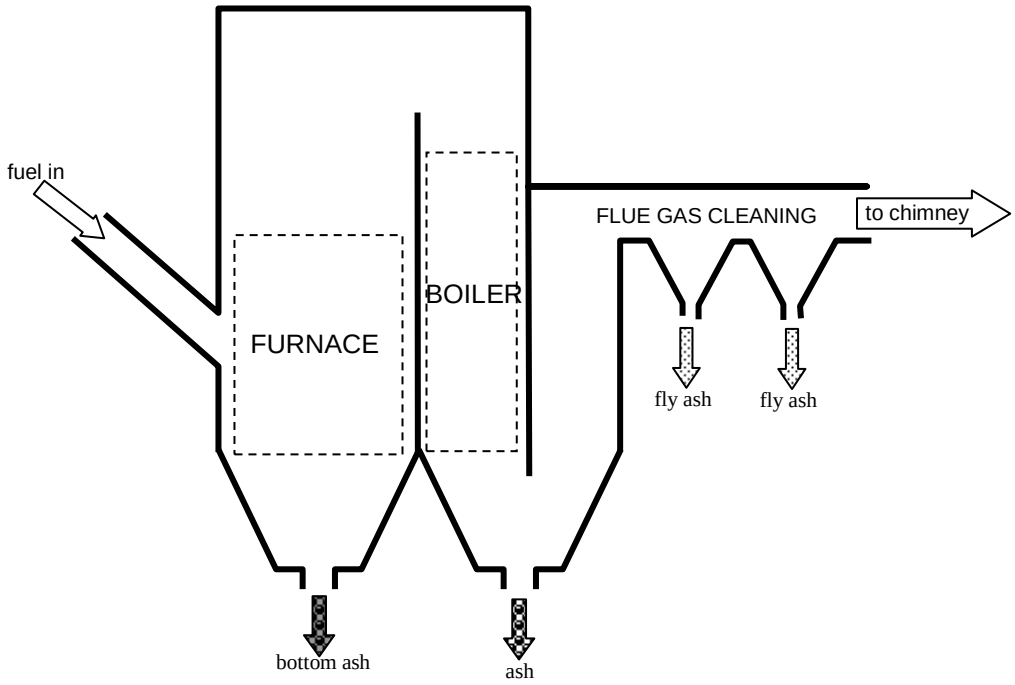

Figure 2 – A sketch of a furnace and boiler with a vertical flow of the combustion gases, a design typical for fluidized bed units

Mixed ashes

In practice, several flows of ash are collected together. I the boiler sketched in Figure 1, one can extract the U-turn ash and the boiler ash together with the bottom ash in order to save on equipment and handling. The bottom ash will then be a mixture of all three types of ash. Alternatively, the boiler ash may be extracted to the same container as the fly ash collected further downstream in the flue gas duct.

Analogously, one may convey the U-turn ash or boiler ash in Figure 2 to the container for the fly ash or to the container for the bottom ash.

It may be difficult to describe the ash more precisely than bottom ash, fly ash or APC residue if the exact arrangement of the ash extraction is not known.