8.5 Burner equipment

Burners have a series of equipment. They are needed for operation, e.g.

- ignition,
- power management (control of fuel and air)

and for safety, e.g.

- interrupt of fuel supply,
- flame monitoring,
- control and monitor of gas pressure with gaseous fuels,
- monitor of air fan operation,
- assure against leak gas,
- coordination of procedures in case of start, shut down and failure.

The equipment is below presented in principle. For detailed information it is referred to Cerbe 1992.

Ignition

For ignition

- pilot burners with premixed flame

are used at big burners and

- electric ignition devices, e.g. ignition transformer with electrode or arc

are used at small burners.

Control of burner power

At burners with small power, e.g. household burners or small steam generators, the burner power is controlled by turning on and off the burner (discontinuous control) or the changing between two power levels. At burners with high power and varying power demand the fuel is continuous controlled between an upper and lower level. The two limits are given by the flame stability.

For controlling the excess air number in addition to fuel supply the air flow has to be controlled. At gas burners it is done by a mechanical linkage of the air actuator with the fuel actuator. A servo motor driven cam disc adjusts the different actuator characteristics.

At technical firing, at changing calorific value and at high power burners, the air supply is changed independent of fuel supply. Therefor the oxygen concentration in the flue gas, or at hypostochiometric combustion the CO- or the CO₂-concentration, is measured. The dependency of this concentration from excess air number is described is chapter 2. The air fan is controlled in accordance to this dependency.
**Safety shut-off valves**

Burners have to be equipped with safety shut-off valves. They have to cut off the fuel supply in case of flame goes out, low gas, oil or air pressure, fault or burner shut-down. Magnetic valves or motor-driven valves are used as shut-off valves. According to requirements of the burner program sequence the valves are fast or slow shutting and single-stage, two-stage or continuous adjustable. The staged shut-off is used to prevent fluid hammer. The specifications of the valves are regulated by DIN 3394.

**Flame monitoring**

The burning of the flame has to be observed permanently, so that the fuel supply can be shut-off when flame goes out. Otherwise fuel enters the combustion chamber unburned with the risk of deflagration or explosion. Automatic ignition safeguards consists of a flame sensor and a control device, that signalise the fuel shut-off after a certain safe-time. This safe-time and the duration till re-ignition depends on burner power and burner type. Such times are regulated in DIN 4788. At burners with air fan reference values in operating mode are 1 s and in starting mode 3 s to 5 s.

For monitoring several properties of the flame can be used (Tab. 8-1).

At thermal flame monitoring a thermocouple given to the flame. The thermo-voltage is measured. This method is very slow. Therefore it is only applicable at burners without air fan up to a power of 350 kW.

The principle of an ionisation flame monitoring is, that gas molecules become electric charge carrier due to the high flame temperature. To use this effect for a safeguard the electric circuit is broken at the flame, so that the electric circuit is closed by the electric conductivity of the burning gas. A source of error is that a flame is simulated by a short circuit or a parallel to the ionisation way formed leakage current by moisture or tinder. To prevent this error the rectifier effect of the flame is used by supplying an alternating current to the different sized electrodes. A small current with direct current part flows. The high of this ionisation current is different at different flame areas. It increases with increasing flame temperature and increasing calorific value. The disadvantage of an ionisation flame monitoring is the abrasion of the electrodes due to the high temperature. The advantage is the short reaction time.

**Gas pressurestat**

At gas burners the gas pressure has to be lowered and kept constant before supplied to the burner to balance net fluctuations and keeping the gas flow constant. The types of gas pressurestats are regulated in DIN 3392.

**Gas pressure monitor**

Gas burners can be equipped with a gas pressure monitor. It shuts-off the burner if net pressure falls below a certain level.
**Function control device of a fan**

The function of a fan can be controlled by

- an air pressure monitor (e.g. DIN 3398),
- a flowmeter with signalisation,
- a flow monitor or
- a revolution monitor.

**Leak gas safeguard**

When burner power is higher than 350 kW leak gas safeguard is recommended (e.g. DIN 4788). It should permit flammable gases to enter the combustion chamber in shutdown periods or at burner reconnection due to leaky gate valves. At some firings the combustion chamber is rinsed before burner starting to discharge gas or oil vapour and thereby prevent deflagration at flame ignition.

**Excess air number control**

To control the excess air number the air flow is measured and controlled or the fan is controlled in accordance to the measured O₂, CO₂ or CO concentration in the flue gas.

At firings with several small burners, e.g. industrial furnaces, the air flow is measured and controlled at every burner to run the burner with optimum excess air number. The total air flow is controlled at a central fan.

At firings with one burner, e.g. steam generators, and firings with leak air caused by product openings, e.g. some industrial furnaces, the air fan is controlled in accordance to the measured concentrations. A measurement of the high air flow is very complex and involves high pressure loss. Furthermore, with leak air, it makes no sense to measure air flow at the fan. In hyperstoichiometric combustion the O₂- and CO₂-concentration of the flue gas is measured to control excess air number. In hypostoichiometric combustion the CO-concentration is measured. The kinds of measurement methods are already described in chapter 7.6.
Fig. 8.1-1: Principle of a radiation burner

Fig. 8.1-3: Photo of a radiation burner
Fig. 8.1-4: COSTAIR (Continuous staged air) burner

Fig. 8.1-7 a: Rotary oil burner
Fig. 8.1-7 b: Photo of an oil burner

Fig. 8.1-8: Vaporization oil burner
Fig. 8.1-9: FLOX (flameless oxidation) burner
Fig. 8.2-1: Swirl gas burners
Fig. 8.2-2: Flat flame burner

Fig. 8.2-3: High velocity burner

Fig. 8.2-4: Recuperator burner
Fig. 8.2-5: Burner with generative air preheating from flue gas
Fig. 8.2-6: Radiation tube burner
Fig. 8.2-7: Photo of a rotary kiln burner
Fig. 8.2-8: Gas flow of a rotary kiln burner
Fig. 8.4-1: High swirl combustion chamber
Coal containing dust

Air

Fig. 8.4-2: Rotary flow combustion chamber for dust fuels
Fig. 8.4-3: Lean gas combuster
Fig. 8.4-4: Photo of a lean gas combuster
Fig. 8.5: Example for Combustion Equipment

<table>
<thead>
<tr>
<th>Characteristic of Flames</th>
<th>thermal</th>
<th>electrical</th>
<th>optical</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Current generation in thermocouple</td>
<td>- Current generation in thermocouple</td>
<td>- Ionisation</td>
<td>- Current conduction inside a UV-probe</td>
</tr>
<tr>
<td>- Amplitude of a bimetal</td>
<td>- Amplitude of a bimetal</td>
<td>- Electrical conductivity of a flame</td>
<td>- Current rectifying of a flame</td>
</tr>
<tr>
<td>slow</td>
<td>slow</td>
<td>fast</td>
<td>fast</td>
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</tbody>
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Table 8-1: Characteristics from flames to their monitoring