MULTI FUEL CFB BOILER SIMULATOR

SYSTEM DESCRIPTION

FLUE GAS SYSTEM
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1 GENERAL

Following combustion of the fuel in the combustion chamber the flue gases first pass through the separators, where the coarser ash is separated and returned to the bed via the wall seal, and the finer fly ash is transported through the convection section of the boiler to the dust removal system (De-Sox plant) and out the units common stack.

The flue gases are drawn away by means of 2x 60 % centrifugal flow induced draft (ID) fans, after which they are discharged to the atmosphere via the stack.

Flue gas temperatures and pressure drops are measured throughout the system mainly to indicate the condition of the boiler and the need for sootblowing. Similarly flue gas is analyzed for O$_2$, CO, NO$_x$ and SO$_2$ to indicate the efficiency of combustion and also maintaining the emission under limits.

Part of the flue gases is possible fed back to the furnace for temperature control in furnace and to have better heat transfer in the convection part of the boiler by increasing the flue gas flow.

2 DESIGN DATA

Flue gas ducts are made of steel plate with a thickness of 4.0 mm:
- duct from the boiler to the De SOx
- duct from the De SOx to the I.D. fan
- duct from the I.D. fans to the stack
- from I.D fans of boilers to the stack

All the ducts are furnished with necessary equipment such as:
- bellows
- stiffeners
- supports

Air for combustion $\quad m^3 n/s \quad ____ \quad (Fuel H_2O = 54 \%)$
Gas from combustion $\quad m^3 n/s \quad ____ \quad (Fuel H_2O = 54 \%)$
3  

EQUIPMENT DATA

3.1 Furnace

Height of furnace  m  31.8  
Width of furnace  m  20.5  
Depth of furnace  m  6.7  

All water walls are membrane welded with an automatic welding machine for the walls to form a completely gastight structure.

Furnace is top supported from the steel construction. The heat expansion takes place downwards.

Hanger rods carry the weight of the furnace.

3.2 Induced Draft Fan (IDF)  

1 HNC41/42 AN201  

Design values at fan  

<table>
<thead>
<tr>
<th></th>
<th>107 %</th>
<th>87.8 % MCR</th>
</tr>
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<tbody>
<tr>
<td>Flow rate at NTP Nm³/s</td>
<td>106,1</td>
<td>88,3</td>
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<tr>
<td>Flow rate m³/s</td>
<td>162,5</td>
<td>130,7</td>
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<tr>
<td>Temp. °C</td>
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<td>100</td>
</tr>
<tr>
<td>dp kPa</td>
<td>10,983</td>
<td>7,992</td>
</tr>
<tr>
<td>Inlet statistic pressure kPa</td>
<td>-10.928</td>
<td>7.812</td>
</tr>
<tr>
<td>Motor power kW</td>
<td>2059</td>
<td>1529</td>
</tr>
<tr>
<td>Speed rpm</td>
<td>980</td>
<td>980</td>
</tr>
</tbody>
</table>

3.3 ID fan inlet damper  

1 HNC41/42 AN901  

Manufacturer Fläkt Woods Oy  
Actuator Automatic

3.4 Ducts

Flue gas ducts are made of 6 mm steel plate S235JRG2.

All ducts are furnished with necessary fittings such as:
- bellows
- stiffeners
- supports
3.5 Flue gas analyzers

Please, see the automation and instrumentation documentation.

3.6 De SOx-system

Please, see the “System description of DeSOx system”.

4 AUTOMATION

In this section automation is explained only basic level and more detailed descriptions can be found in Automation Descriptions.

4.1 Furnace pressure control

The furnace pressure is attempted to keep in given balance vacuum value by controlling of inlet vanes of the flue gas fans. Wanted vacuum at the combustion chamber constant value is controlled during the commissioning, and it is typically between –5…–2 mbar. The function of the control loop is important, because furnace pressure is one of the process quantities of boiler interlocking.

4.2 Oxygen control

Oxygen content is measured at three different locations in flue gas duct after superheaters.

Three measurements are conducted to find out the actual oxygen content, because the distribution of oxygen may not be homogenous throughout the flue gas duct. On the basis of these measurements a mean value will be calculated.

Excess oxygen in flue gas is regulated by controlling secondary air flow to lower and upper level nozzles. These air controllers’ (secondary air fan pressure control, lower and upper secondary air damper controllers and oxygen controller) must be on cascade mode (Auto Extern) in order the oxygen correction to work. For more about air controls, see "Secondary air system".
4.3 Flue gas temperature control

Flue gas has temperature control loop will maintain the temperature before De SOx-system high enough (above dew point). The control will provide the external set point to the control loops for steam valves of steam coil air heaters in primary and secondary air ducts.

4.4 Ammonium spraying control

Ammonium spraying is used to control flue gas NOx level. Amount of ammonia spraying is controlled by flow control valve in ammonia main line. Pressure in ammonia line is controlled by changing speed of the ammonium pump.
5 OPERATION

5.1 Closing of boiler mandoors

The furnace area mandoor design conditions are difficult, because there is hot (ca. 900 °C) circulation material behind. No steel without cooling stands these conditions. And the Gill Seal area mandoors are in most critical conditions, because there is continually “hydrostatic pressure” of returning material available.

The requirements are hard, because 900 °C circulation material, when discharging accidentally is dangerous to life, and in any case destroys devices on its way.

The mandoor itself is circular, light casted door, equipped with two hinge joints, sealing and two screw adjusted tightening hooks. The hinge joints are also screw adjustable, so the tightness of the door can be secured by four screws.

In the mandoor there is some (50 mm thick) fixed (by screws) refractory piece, covered by stainless steel plate. This is to insulate the metal door from the heat of the furnace.

There is also a separate thick (some 200 mm) refractory plug, the protection plug, just against the furnace. Practically this plug is like removable part of the refractory lining.

This separate plug is installed in the opening of the tube wall by hand (within the boiler start-up preparations) and the holes packed carefully by ceramic wool (brand is “Kaowool”). This tightening is done in order to prevent the circulating material accumulating between the protection plug and mandoor. This can finally push the plug in furnace or Gill Seal.

Between the protection plug and mandoor there is space, which is filled by ceramic wool (brand is “Kaowool”) within the packing of the mandoor. This is done in order to insulate the mandoor from the heat of protection plug (direct contact to furnace) and to prevent circulating material accumulating between the plug and the mandoor.

5.2 Start-up precheck

Before start-up of the boiler, assure that the system is ready for operation. If somebody has worked inside the boiler, check before closing the mandoors, that the inner parts are ready for operation and no one is inside the boiler.
5.2.1  Action by Control room operator and Auxiliary Operator

Verify that:
- All gas side manhole covers are in place
- All gas side access doors are closed
- Control system interlocks are checked and operative
- ID fans operational and properly lubricated
- Auxiliary steam for steam coil preheaters available
- Instrument air is available
- All heaters are set in operation 24 h prior

5.2.2  Action by Auxiliary Operator

Walk down the boiler to verify that:
- Boiler drum access doors are closed
- Combustion chamber doors are closed
- Drop leg doors are closed
- Separator doors are closed
- Cross over duct doors are closed.
- Convection pass doors are closed
- Superheater doors are closed
- Economizer doors are closed
- Air heater (primary and secondary) doors are closed
- Windbox doors are closed
- All fan access doors are closed
- Flexible joints in the duct connections allow movement in all directions
- There is no water or other liquid or waste things in fan casing
- Casing drains are open and clean

NOTE: For De SOx see manufacturer’s instruction

5.3  Start-up

- **Check** that the flue gas fan control (combustion chamber pressure) is in minimum position and flue gas duct is open all the way from the combustion chamber to the stack, although ID –fan inlet dampers are closed.
- **Check** that there are no valid protections for the ID –fans.

NOTE: When starting the fan it is recommended to have the output 0 %. This procedure must be used especially when the gas reaches its final design temp. slowly.
ID –fan(s) can be started manually or automatically from the air group/sequence function. It is recommended to use the air fan group start, because sequence makes all the necessary actions to start up the fan in question as well others' to wanted load.

(If started manually, switch on the ID –fan. Set the combustion chamber/furnace draft controller on automatic mode (Auto Intern and both fans themselves on Auto Extern). After starting the fan the inlet vane regulator must be opened at 30° (or to minimum required degree, which is will be set during the fan commissioning). Long term use with smaller angles may harm the regulator.)

Note: Fan can not be started, if it had already three starts in hour. This is a protection to the fan motor over loading, because electric motor takes more current during the start up. Fan does not either, when fan interlock is preventing the start (motor- or fan bearing temperature).

Verify, that ID –fan has started and that vibration level, bearing and motor winding temperatures are normal.

Verify the set value of the combustion chamber pressure control to –5.0 mbar and place the control in automatic (when ID –fan has been started manually).

When starting up the De SOx, follow the manufacturer's instructions.

5.4 Normal operation

- The operation, temperature and vibration of flue gas fan are observed.
- The operation of the combustion chamber draught control is observed.
- The oxygen and carbon monoxide amounts in the flue gas are observed.
- The rise of the final temperature of the flue gas is observed, and the soot blowers are operated when necessary.
- Follow the DeSOx system.

5.5 Shut down

- When no more steam is needed the burners are stopped.
- When the air fans has been switched off the flue gas fan can be stopped as well.
- The fan control is place in manual and the outlet is reduced to minimum in balance with other fans. This means, that primary- and secondary air fans load is reduced to minimum and stop at last in correct order, while ID –fan(s) is on automatic furnace pressure control.
- The flue gas fan(s) is stopped last.

When stopping the DeSOx, follow the manufacturer's instructions.
5.6 Operating Disturbances

5.6.1 High Flue Gas Temperatures

High temperatures are usually an indication of poor heat transfer. Often this is caused by too coarse a bed or too high moisture of solid fuel (high flue gas velocity). Attention should be paid to bed quality and operation of the bottom ash outlet or select solid fuel with low moisture content.

5.7 Power failure

Boiler, as well fans, will shut down.

6 CONNECTED SYSTEMS

Primary air system S1 HL___-MFB0001
Secondary air system S1 HL___-MFB0002
Solid fuel feeding system S1 HHH__-MFB0001/0002
Ammonium system S1 HSK__-MFB0001
Limestone system S1 EMB__-MFB0001
DeSOx-system S1 HT____-MFB3501/3502
Fly ash recirculation system S1 HT____-MFB3501
Pressurized air system S1 QFH__-MFB0001
Instrument air S1 QE____-MFB1001
Pre-treated water system S1 GHC___-MFB1002
Auxiliary steam system S1 LBG__-MFB1001
SCAH and condensate system S1 LCN__-MFB1001
Closed cooling system S1 PG____-MFB1001
Sand system S1 EMA__-MFB0001
Bottom ash removal system S1 HAD__-MFB0001
Fly ash S1 ET/ETG__-MFB0001
Duct burner system S1 HHA__-MFB0001
Start burner system S1 HJA__-MFB0001/0002
Lubrication system of fans’
7  APPENDICES

Control- and logic diagrams
Flue gas system  S1 HN__-MFB0001/0002
Flue gas fan(s)  S1 HN__-MFB0003