Automatic cleaning of steam boiler by high pressure water

Linear XZ positioner carrying nozzle for high pressure water.

Description

In the boiler furnace there are tubes to transfer heat from the burned fuel (coal) to the water circulated in the tubes. The tubes in the furnace are organized in several rows. Space between the tubes should be clean as much as possible. During the combustion there is a high tendency to fill that space by the solid unburned parts of fuel. This will cause worsen heat transfer from fire to the water and finally diminish the energetic efficiency of the boiler.

Space between the tubes has to be cleaned regularly. Usually maintenance personnel have to clean this space manually by the long metal bar. Equipment described in this document uses high pressure water (around 20 MPa) in a thin ray. Cleaning process can be automatic. Water feeds nozzle which is targeting space between tubes. Nozzle is attached by one end to the boiler wall. Free end of nozzle is used to change direction of water ray. Filling material (ash, slag) will be removed by consequent movement of the water ray over the tubes.

Movement of the nozzle free end is performed by the linear XZ positioner. Positioner is controlled by the programmable logic controller (PLC). Path is stored in the controller memory.

Benefits

- Energy savings
- Higher maximal power
- Extension of operating time between outage
- Boiler lifetime extension
- Automatic operation

Installed devices

- Linear XZ positioner
- Nozzle with tenon for positioner
- Ball joint holding nozzle in the boiler wall
- Steel enclosure with control electronics – circuit breakers, power sources, contact relays, galvanic isolation, control electronics for servomotors, PLC.

Mechanical implementation

Control electronics is installed in steel enclosure (dimensions: 600 x 600 x 210 mm). PLC is mounted on the front panel. Linear XZ positioner is mounted on the outer side of the boiler wall. Free end of nozzle with hose is attached to the slider of the positioner using Cardan's suspension.

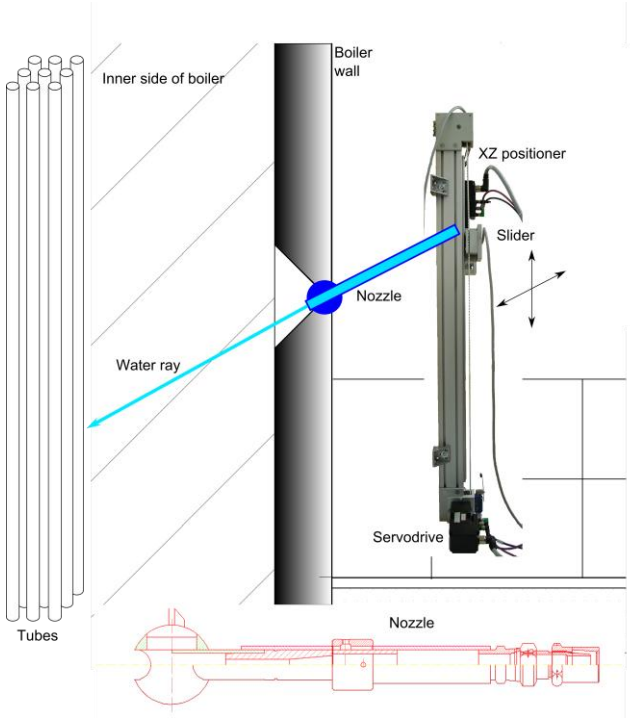

Figure 1: Nozzle

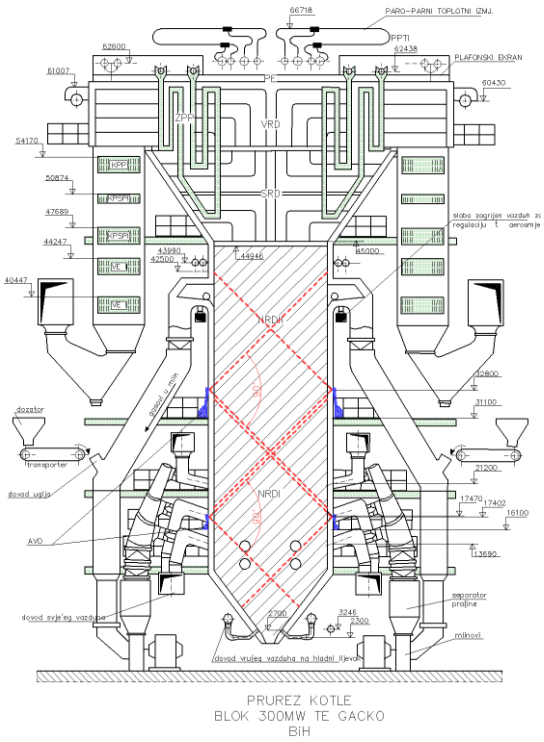

Figure 2: Boiler cross section – equipment displacement

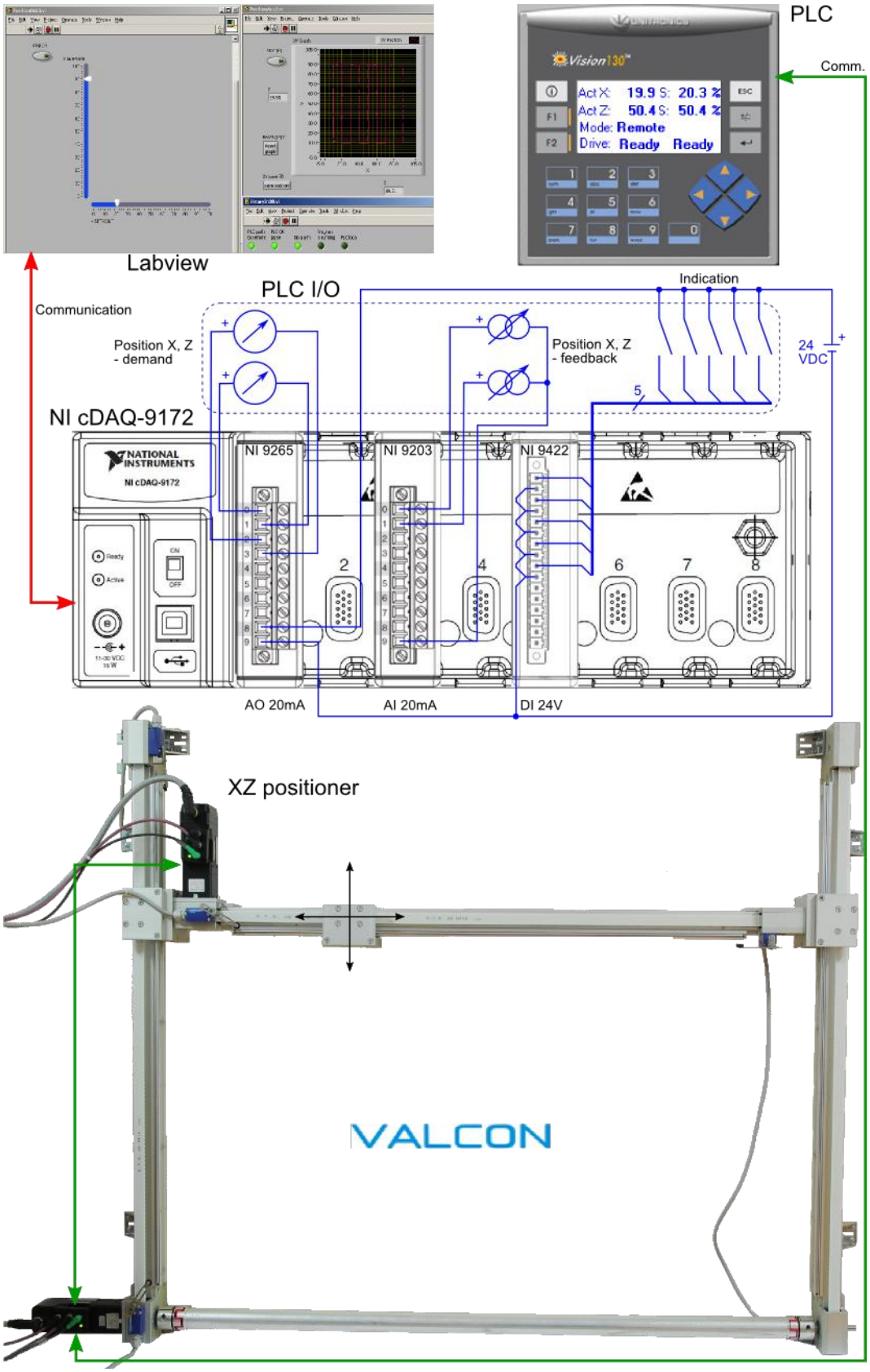

Figure 3: Connection for testing and tuning using NI data acquisition unit and SW Labview

Control

Positioner movement is controlled by PLC. Path is stored in the PLC memory. Maximal length for stored path is 500 points – coordinates [x_i, z_i]. In normal operation after tuning PLC is connected to the boiler control system (DCS).

Water to the nozzle is closed by the solenoid valve controlled from boiler control system. Before valve opening positioner goes to initial position [x_0, z_0] – on DCS command. Than DCS enables start of cleaning sequence. Current position [x, z] is available in DCS. Sequence can be paused or broken from DCS if necessary.

Position [x, z] can be set up from DCS manually or as a scheduled task. First, required position is set up than signal enables movement can be sent to PLC.

Path recording

Water ray path coordinates are stored in the PLC. It is created according geometric model of boiler. Before equipment is putted to normal operation after installation path has to be verified eventually tuned.

Path tuning can be done manually. Step by step moving through desired coordinates and saving them. This procedure can be done directly using the PLC or from the DCS:

1. PLC: Calibration mode has to be selected than set up required position using keyboard and save it.
2. DCS (here described tuning arrangement using NI compact data acquisition unit and LabView): Required position is set up from the superior system. When slider reaches this position it can be saved to the file. File has to be transformed to the defined format – MS Excel sheet – than it can be loaded to the PLC.

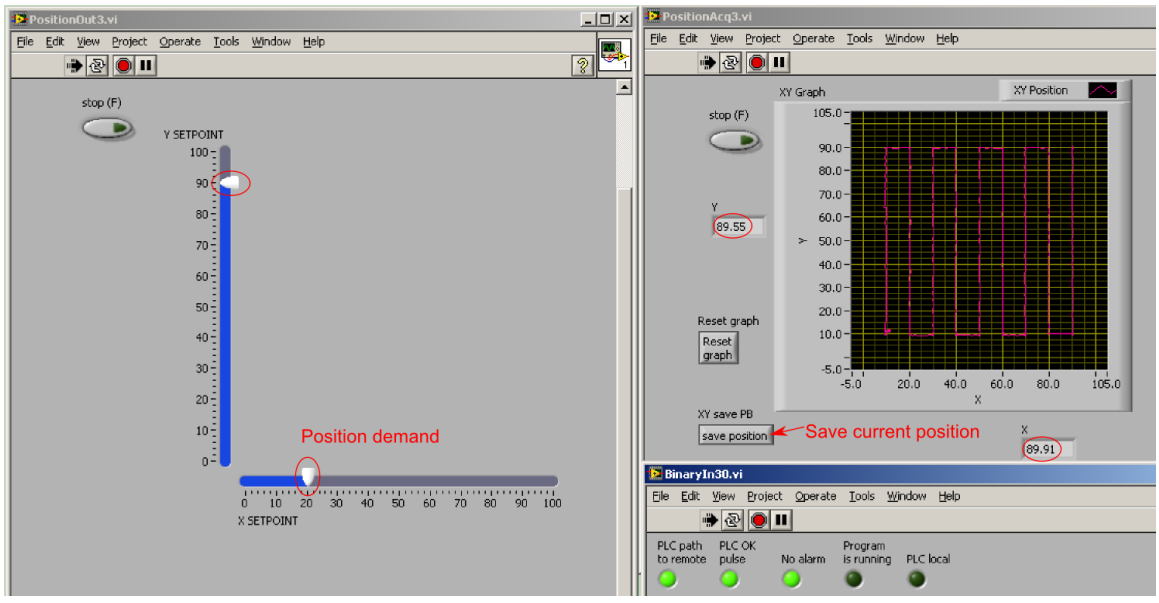

Figure 4: LabView applications panels