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Combined pyrometric system for diagnostics and control of flame in power plant

The Combined pyrometric system is a unique combination of hardware and software solutions enabling the use of "waste" energy in a thermal power plant. The waste energy means the losses due to the non-optimum position of the thermal focus and of the entire flame generally. This specific pyrometric system solves a special measurement and control problem in cola-fired power plants, and simultaneously brings about a considerable annual savings, that is, income from additional energy efficiency and thermal power plant boiler protection against frequent accidents.

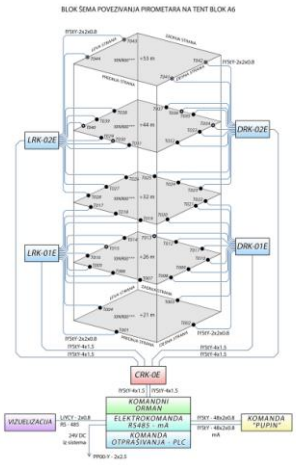


Fig 1.

KOTA +42,00m

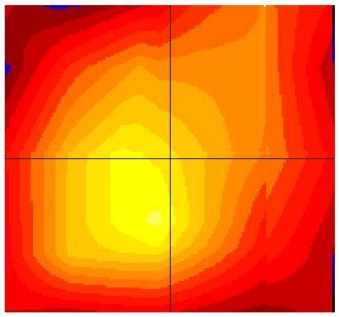
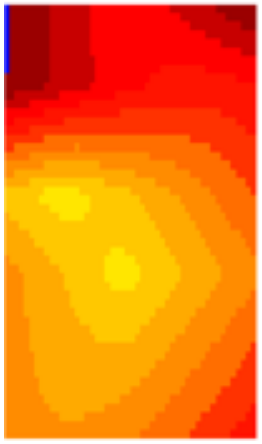


Fig 2.



+73,00m

+19,00m

Fig 3.

This completely unique measurement device is based on the principles of optical radiation pyrometry; whereas it receives individual pieces of information on the limit temperatures and the state of the the firebox walls slagging from contact temperature measurement devices. The system consists of specially designed two-color pyrometers arranged onto the boiler walls as in Fig. 1 (TENT A6). The full system consists of 44 two-color pyrometers and 88 thermocouples arranged in 5 levels in the boiler part where the main combustion process occurs. The arrangement and number of pyrometers and thermocouples may vary depending on the boiler shape and on the possibility of installation in a thermal power plant. As necessary, the pyrometers are with or without optical cable depending on the environment temperature at the measurement point. Each measurement point is provided with a specially designed pneumatic system for coal dust and ash removal, i.e., freeing of the optical path of coal dust and ashes, so that the system is full adapted to the difficult working conditions in the firebox environment. Individual measurement units (pyrometer, two thermocouples and the processor unit) are connected by a communication line (MODBUS on RS-485) to the central processor unit which compiles the data from all pyrometers and thermocouples. The data from the central unit go to the PC with special software for calculation and visualization of temperature distribution based on specific algorithm for underdetermined inverse problem solution. Solution is presented as horizontal cross section at any level of the boiler (fig 2.) as well as vertical cross section at any distance from the wall (fig 3). The combination and arrangement of pyrometers is such as to allow determination of the mean temperature on the optical path, as well as an effective coefficient of emissivity. Specially constructed two-color pyrometers have been designed to solve this measurement problem. The monochromatic pyrometers provide the effective mean temperature on the optical path, whereas the two-color ones provide the maximum temperature of the heated particles on the optical path. The combination of the two determines the effect of particle shadowing on the optical path, i.e., the effective coefficient of emissivity. The thermocouples provide information on the temperature near the wall. Hence, the distribution of temperature within the firebox may be determined based on all those data. The calculation within the software depends on the arrangement of pyrometers and it has to be adjusted for each and every boiler. Visualization of the temperature distribution determines the relative position of the flame in the firebox to the vaporizers placed by the firebox wall. This enables adjustment and optimization of combustion, through manipulation of the position of the thermal focus (the part of the flame with the maximum temperature). By adjusting the focus position (by means of the mill operation and by air control), it is possible to increase the efficiency of the coal loading and combustion processes, as well as to decrease the number of accidents related to slagging and excessive thermal overload of some surfaces due to flame asymmetry.

Compared to similar systems offered by competition (Siemens, Klyde Bergerman , Eutech itd) , with prices for 70% or 100% higher, our combined system possesses several advantages (innovations):

1. Instead in one level (8-12 measuring places for competitors systems), the combined system consists of 44-48 measuring units arranged in five or six levels of boiler combustion zone, enabling reliable 3D representation of temperature distribution as well as thermal focus position enabling the adjustment of the combustion in the boiler and increasing the efficiency of the process. Any other system doesn't have such abilities.

2. The combined system uses specially designed mono/two color pyrometers instead standard monochromatic pyrometers which effective temperatures (incoming radiation is perturbated by dust, coal particles and gases, so the measured temperature is lower then real). Mono-two color detector measures both effective (mono and two color) temperatures, enabling calculation of the effective emissivity as well as real temperature gradients in boilers.

3. Two thermocouples are included at every measuring place. The first measures the local temperature immediately near the system of pipes in combustion chamber and the second measures the temperature of the water steam. This innovation enables the determination of local conditions near the water pipes in the boiler as well as more accurate calculation of temperature distribution in boiler. The difference between temperatures measured by these two thermocouples gives the indication of slagging process, enabling the efficient control of a water guns for cleaning of the pipe system in the combustion chamber during the process of combustion (fig 4).

4. Competition systems require at least 80mm large opening in the wall at every measuring place and this requires expensive interventions on pipe wall system. The combined system requires opening <12mm and this is just small hole between pipes (fig 5).

5. The clean optic view is essential for the system functioning and it is continually perturbated by normal combustion process as well as by accidents in which for the short time boiler is overpressured. This is the reason why the system is supplied with specially constructed mechanical-pneumatical cleaning unit on every measuring place. This is enabled by original construction of the optics looking trough cleaning system. System controls sequential work of cleaning units enabling significant savings in instrumental air.

6. Every measuring unit is supplied by specially constructed viewfinder which for simple centering and checking the clarity of the view path, enabling easy system maintains in regular working regime.

7. Comparing to previously patented system, processing electronic of the measuring unit of the system is redesigned to accept 12 signals more enabling the incorporation of new sensors in a measuring place (additional thermocouples, NOx,CO_2 etc.). On this way the system is opened for further advancements with perspective to become universal measuring station incorporated in the system of automatic control of combustion.

8. The combined system is driven by new software with innovated algorithms which enables more accurate calculation and visualization of temperature distribution, based on use of combined mono/two color pyrometers and thermocouples.

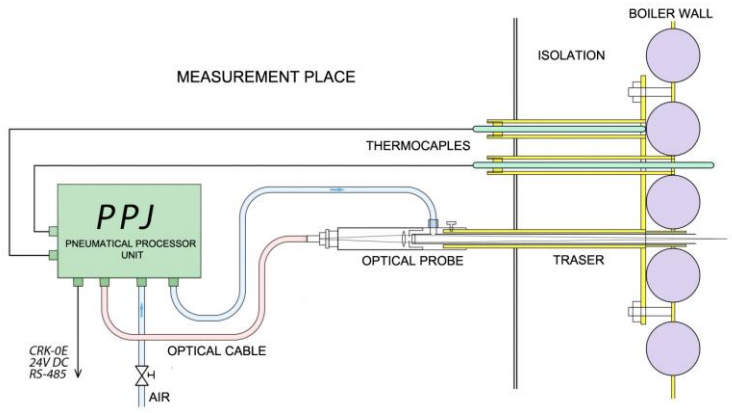


Fig 4.

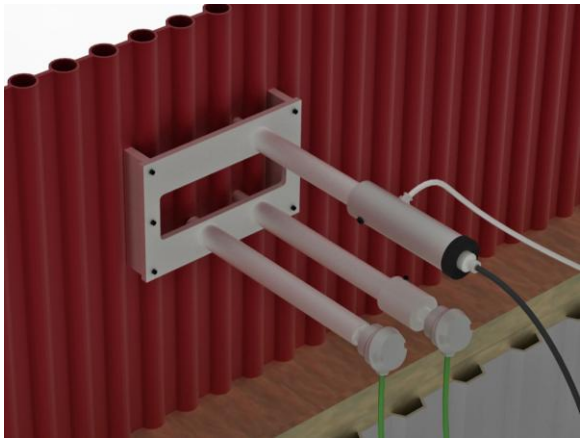


Fig 5.