ABSTRACT

The paper analyzes the impact of fuel quality on losses in electricity production and the failure rate of coal transport and slag collection devices in a power unit with a CFB 1300 supercritical fluidized bed boiler. The research mainly covered the years 2017-2020 and partly 2021 and recorded problems were related to the low transportability of the fuel. The delivered coal caused problems during unloading, it covered the wagons, made the standstill time of the wagons longer, and it was necessary to clean them and check them again on the scales. During transport with feeders, the coal was sticking to the feeding elements, making it difficult for the belt conveyors, scraper and screw feeders, it was sticking to the transfer nodes, which made the supply of fuel to the coal bunkers long-lasting, and the amount of transported material was variable over time.

Erosion of feeding elements was also diagnosed, generating downtime of coal feeders and slag collection feeders, and the need to periodically shut them down for the period of repair. These events caused a decrease in the availability of devices and the related limitations in electricity production.

The adopted research methodology was based on the obtained process data and allowed to describe two causes of operational problems related to the parameters of the supplied fuel. The first of them were losses in electricity production caused by excessive fragmentation of the fuel, the second reason were losses resulting from defects in the coal transport and slag collection systems. These losses were calculated from the potential maximum power of the unit, which would have been possible to achieve if there were no such losses. This value represented less production than expected, despite the existing demand in the power grid.

In connection with the above, the next step in the adopted methodology was the analysis of all directions of coal supply to the power plant in terms of commercial and physico-chemical parameters, including the granulation of the supplied fuel and the quality of the ash generated in the combustion process. It focused on the largest suppliers, who together account for almost 63% of all supplies delivered to the power plant. These data were compared with the design parameters of the tested generating unit and compared with the register of block power losses and emergency events.

These analyzes showed low transportability of coal, caused by a higher share of the finest fraction than specified in the project. As the results show, all coals from major suppliers exceed the amount of this fraction (from 44.6% to 117.7%). In addition, physical and chemical parameters, including the composition of oxides contained in the ash and fuel, affect the failure rate of the installation and contribute to the observed operational problems. In particular, the content of oxides with high hardness in the 10-degree Mohs scale, i.e. aluminum, iron and silicon oxides, causes that the erosive effect of coal and ash has a significant impact on the wear of structural elements of the coal and slag transport system.

In addition, the supplied coal has a low or medium tendency to slagging, while the tendency to foul the walls of the combustion chamber does not affect the operation due to the type of boiler (CFB). In accordance with the adopted methodology, it was recommended to prepare fuel mixtures from mines, for which coal exhibits such characteristics as no or low tendency to slagging, the smallest share of the finest fraction (from 44.6% to 59.9%), which improves transportability and the lack of exceeded content of the hardest of the oxides, i.e. aluminum oxide (hardness 9 on the Mohs scale). Other coals should be an addition in the recommended mixtures.

In addition, in order to reduce the finest fraction, it is recommended to install a granulator in the fuel transport installation behind coal sifters and to modernize the fuel and slag transport installation in order to improve their availability.

These proposals concern:

• wall coal feeder - elimination of the casing connection element (bypass) and construction of the casing as a single whole without a secondary air bypass. The modernization will shorten the repair time of the feeder and reduce the number of repairs for erosion leaks in this part of the installation.

• vertical secondary air compensator - redesign of the pipeline system with the compensator installed in a horizontal position to eliminate dust deposition in the expansion compensation space. This solution will reduce the risk of system failure.

• housing of the wall coal feeder - making the indicated area of the housing from a material more resistant to abrasion. Additionally, it is suggested to have the air pipeline inlet directed in the direction of flow (and not at a right angle). Thanks to this solution, faults related to erosive casing leaks will be limited.

• coal chute pipe - design and installation of 3 pieces of fire extinguishing steam stub pipes at the height of the pipe with shut-off valves at each stub pipe. This will facilitate the removal of coal overhangs and thus improve the smoothness of the feed.

• coal dispensers - design and installation of additional extinguishing steam connections on the housings. This solution will increase the operational safety of the installation.

• pin gate valves under coal silos - use of a hydraulic knife gate valve. Thanks to this solution, the time needed to disconnect the coal container from the feeder will be shortened and work safety will be improved.

• bottom ash cooler - construction of a shaft with the application of a protective layer (e.g. surfacing) in the indicated area or use of protective coatings applied by thermal spraying.