MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(709) - OPTIMIZATION OF OVERFIRE AIR FOR IMPROVED PERFORMANCE AND NOX REDUCTION IN A COMMERCIAL WALL-FIRING COAL BOILER

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Air staging with the use of overfire air (OFA) is a well-established technology for reduced NOx emission in commercial coal-fired power plants. However, its performance can vary by the detailed design of OFA including the number of ports, location, and air flow distribution. This study evaluated the performance of the existing OFA in a 595 MWe wall-firing coal boiler and optimized its design using computational fluid dynamics (CFD) incorporating advanced coal combustion submodels. For the reference case with the existing OFA design, the CFD results showed a reasonable agreement with the design data in terms of heat distribution and NOx emission. Analyzing the detailed flow and reaction characteristics of the reference case, a few issues were identified on the existing design. The OFA jets from the front and rear walls in a single level concentrated the gas flow to the center while the mixing between gases was not efficient. This led to a high-speed, high-temperature gas stream entering the heat exchangers, which may cause severe erosion and slagging by ash particles. At the same time, the location of OFA allowed a limited retention time between the uppermost burners and OFA preventing further reduction reactions of NOx.

To improve the OFA design, various modifications were evaluated including i) the installation of additional OFA ports on the upper level and on the side wall, ii) various arrangements of active ports, and iii) different air flow distribution. The best boiler performance was found when the OFA was split into two levels and the ports were arranged in a staggered manner between them so that the number of ports (i.e., average jet velocity) were identical to the existing design. Also, the air flow rate on the upper level was doubled in the best case. This lowered the peak gas temperature entering the heat exchanger zone by as much as 51 °C, while the NOx emission was reduced from 134 ppm to 126 ppm (6% O_2). In addition, heat transfer characteristics were favorable in the best case because the heat absorption on the furnace wall (evaporator) was increased by approximately 10 MW_{th} and the distribution of heat flux between the platen superheat panels became more uniform.

Palavras-chave : boiler, coal, overfire air, wall-firing, NOx