MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(704) - NUMERICAL STUDIES ON BOILER PERFORMANCE AND INFLUENCE OF BURNER TILT DURING UNEVEN SECONDARY AIR SUPPLY IN A TANGENTIAL-FIRING COAL BOILER

Hyunbin Jo (Korea, Republic of)[1]; Jongkeun Park (Korea, Republic of)[1]; Woosuk Kang (Korea, Republic of)[1]; Jun Seok Hong (Korea, Republic of)[2]; Sung Min Yoon (Korea, Republic of)[3]; Ho Won Ra (Korea, Republic of)[3]; Changkook Ryu (Korea, Republic of)[1]

1 - School of Mechanical Engineering, Sungkyunkwan University; 2 - R&D Center, Korea Western Power Co., Ltd.; 3 - Korea Institute of Energy Research (KIER)

Draft Paper

Tangential-firing (TF) boilers develop a large swirling fireball by coal and air injected from the corners of the burner zone, which has many advantages including intensive mixing, long particle residence time, and uniform heat absorption between walls. However, actual systems may suffer from troubles that break the axisymmetry of the fireball. This study investigated the impact of uneven secondary air (SA) distribution between the corners in a 500 MWe TF boiler caused by contamination of air preheaters. A total of six cases were selected from actual operation data in which the SA flow ratio between corners ranged from 1.0 (normal operation) to 1.91 at different burner tilt angles. The computational fluid dynamics (CFD) simulations adopting advanced coal combustion models were performed for these cases to validate the modeling approach. Then, a total of 16 new cases were established for parametric studies varying the SA ratio (1.0 − 1.9) and burner tilt angle (−15° − +26°) while fixing other operation variables constant, such as coal properties, excess air ratio, and boiler load.

The results showed that the uneven SA supply between corners led to large variations in the flow, temperature, and reaction stoichiometry. The deformation of fireball concentrated the heat flux on particular areas of the walls (evaporator), with up to 19% larger heat absorption on two walls compared to the other two. The total wall heat absorption was also larger than the normal operation cases. The peak temperature entering convective tube bundles increased by 20 °C or larger compared to the respective normal operation cases with the identical burner tilt, which can significantly increase the propensity of ash slagging. NOx emission increased by 6.7% on average, which was associated with the non-uniformity of O2 concentration. In contrast, the total carbon conversion was not noticeably influenced by the uneven SA supply. The trends at different burner tilt angles were similar to those with uniform SA supply, but a burner tilt of +15° exhibited the worst results in the overall performance. Downward burner tilt alleviated the non-uniformity of flow and heat transfer to some degree by a larger exchange of momentum between air jets.

Palavras-chave : Burner tilt, Computational fluid dynamics (CFD), Tangential firing, Uneven secondary air supply, NOx emission