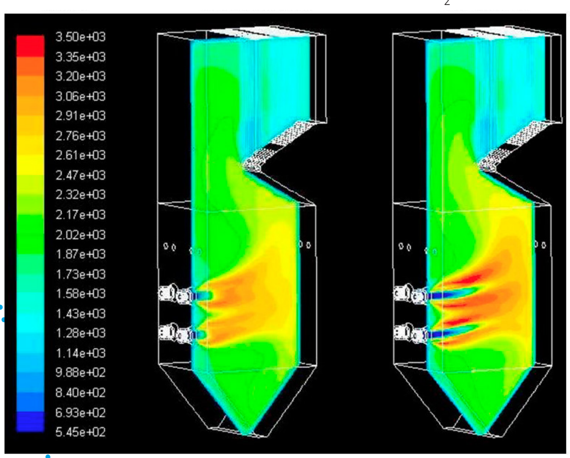
Oxygen enrichment in pulverized coal boilers

A powerful tool to increase biomass utilization and combustion efficiency

With large numbers of pulverized coal (PC) boiler operators actively pursuing blending of biomass with coal, the challenges associated with biomass/coal cofiring are becoming more clearly identified. Beyond the limitations in biomass feeding through coal pulverizers, there are combustion limitations that must be addressed and overcome in order to maximize renewable energy utilization. For example, the lower heating value of biomass relative to coal leads to lower burner flame temperature, which in turn yields less heat transfer via radiation to waterwalls (proportional to T_4), thereby resulting in costly unit derates. Another major issue is the potential increase in carbon-in-ash caused by the inherently larger biomass particle size relative to pulverized coal. Apart from the resultant lowering in boiler efficiency, this can also lead to significant carbon deposition on convective pass tubes, which has the potential to increase tube surface temperature and corrosion, and ultimately to reduce tube life and increase unit downtime.

CFD comparison of air-biomass combustion to oxygen-enriched air-biomass combustion



We look forward to sharing with you our customized approach to solving your biomass cofiring needs!

In order to address these issues and develop innovative, cost-effective and practical solutions, Air Products undertook and recently completed extensive analysis of oxygen-enriched combustion of biomass in a 22 MWe US utility wall-fired pulverized coal (PC) boiler. The analysis was executed with a computational fluid dynamics (CFD) code that was experimentally validated in the same boiler firing coal. The analysis included both waterwall and convective pass effects. By increasing flame temperature (see inset) and enhancing fuel/oxidizer mixing, results showed that strategic oxygen injection equivalent to only a few percent increase in O_2 concentration of the combustion air is capable of essentially eliminating boiler derate and carbon carryover, even where 100% of the coal is replaced by biomass. The biomass in this case was a mixed agricultural waste having an as-received heating value of nominally 7000 Btu/lb, and the coal was of a sub-bituminous rank having an as-received heating value of 10,500 Btu/lb. Depending upon the burner design, oxygen enrichment can be accomplished solely via existing PC burners or in tandem with Air Products' proprietary cofire injector technology. Beyond the results highlighted by the CFD analysis, decades of successful commercial oxygen enrichment practice in varied industrial combustors has proven that oxygen is a powerful tool in stabilizing combustion performance and seamlessly adapting the process to changing fuel supplies and is certainly a key to overcoming uncertainties in long-term biomass sourcing.

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