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Conversion of coal-N to NOx under fluidized-bed combustion conditions

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Abstract

The objective of this project was to assess the conversion of coal-N to nitrogen oxides during combustion in a fluidized bed. Nitrogen oxides are harmful environmental pollutants generated in coal-fired power plants when fossil fuels are burned which contribute to acid rain and photochemical smog. Fluidized-bed combustion technology, with its reduced SO_2 and NO_x emissions, is an attractive option compared to conventional pulverized coal (PC) boilers mainly due to the low operating temperatures employed, usually between (800–900°C).

Four coals namely Secunda, Kuthala, Delmas and New Vaal were characterized using proximate, ultimate, calorific value (CV), ash and petrographic analyses. All tested coals are inertinite rich with Delmas coal having relatively high vitrinite content. All coals were classified as bituminous, with three coal samples falling in the medium rank C (Kuthala, Delmas and Secunda) and one in the medium rank D range (New Vaal).

The effects of coal characteristics on the conversion of coal-N to NO_x for different South African coals tested in BFBR is also examined. The analysis of experimental data on the combustion in FB reactors revealed different trends in the conversion of coal-N to nitrogen oxides. The conversion of coal-N to NO decreased with nitrogen for coals tested. The relationship between the conversion of coal-N and CH/N using a correlation developed by Vermeulen, revealed an almost linear correlation between the two parameters for the tested coals, although the trends were in opposite direction. An even better linear correlation was found between conversion of coal-N and fuel ratio and again two sets of tested coals show excellent linear trends but in opposite direction. The correlation proposed by Vermeulen is therefore not applicable in the case of South African coals as it over predicts the conversion of coal-N to NO. New correlations developed for coals tested at Eskom by Moodley and Papo in the form of the Vermeulen's correlation but with different values of fixed coefficients are: $y = 6.5973x + 0.4649$, $R^2 = 0.9987$ and $y = 4.7911x + 15.297$, $R^2 = 0.9999$ respectively. New correlations for the coal samples tested in this study could not be obtained as NO values could not be measured.