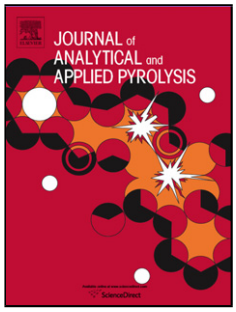

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Coal particle and bed physical transformational behaviour after thermochemical conversion in a fixed bed

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Highlights

- Packed bed combustion and gasification of a range of particle sizes
- Transient start-up behaviour of packed coal beds
- Post experiment dissection of the bed contents
- Physical characterisation of bed contents
- Fixed bed voidage determination during chemical transformation

Abstract

This paper examines the physical transformational behaviour that coal particles and the bed structure undergo in a fixed bed reactor. The transient overfeed configuration is used with feed gas entering from the bottom of the 1.2m reactor with an inner diameter of 104mm. The fuel bed loading, of 3.3kg on average, consisted of non-devolatilized seam two coal of 4, 6 and 8mm particles from the Highveld region in South Africa and was inertinite-rich. Transient exit gas composition and temperature profile inside the fixed bed of particles, is presented along with a full chemical and physical characterisation of the feed coal and the partially converted bed contents consisting of coal, char and ash particles. The bed dissection method implemented was designed to limit mechanical fragmentation by minimizing particle handling and bed structural disturbance during sampling. Particle size distribution and the particle size distribution width showed a significant variation in the oxidation zone and the ash bed which was not previously quantified on industrial scale experiments. The bulk, true as well as the apparent (measured by hydrostatically weighing in mercury) densities are reported for the different reaction zones of pyrolysis, reduction, oxidation and the ash bed, and showed significant variation in each zone. The particles and the fixed bed structural change was established by the measured particle porosity and the fixed bed voidage. The extensive role of particle agglomeration in the lower sections of the fixed bed was demonstrated in the bed voidage data and is evidently tracked as the reaction front moves up through the fixed bed of particles. The mode of operation simulated the transient start-up procedure and subsequent particle and bed transformational behaviour during industrial fixed bed combustion and gasification.

Keywords: *Coal, Thermochemical conversion, Density, Bed Voidage, Particle Porosity.*