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High-Pressure Entrained Flow Gasification of Biomass and Victorian Brown Coal

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In Australia, Victorian brown coals (VBC) represent a significant, low cost energy resource with large proven reserves. However, their utilisation is limited almost exclusively to mine-mouth power generation with relatively low efficiencies and high greenhouse gas emissions. Gasification is an alternative technology that can convert coal to cleaner power, as well as precursor feedstocks for the production of chemicals, hydrogen, and transportation fuels.

Previous work on VBC gasification was mainly conducted using fluidized bed gasification, with low carbon conversion and low calorific value fuel gas. More recently, atmospheric pressure entrained flow gasification trials were conducted on these coals in the temperature range of 700-1400ºC. This current work focuses on enhancing the previous entrained flow gasification experience by conducting pressurized gasification experiments on the fuels at pressures of up to 2MPa due inherent advantages of high pressure such as the increase in fuel throughput and a reduction in the pollutant emission.

Biomass, on the other hand, is an attractive low cost, renewable substitute for the fossil fuels that has received tremendous impetus over the past few decades. In Australia, a bio-energy roadmap targets that by 2020, the bio-energy contribution to the total electricity generation to be 3.7% from the 0.9% in 2008. Furthermore, within the diverse biomass feedstocks, wood related wastes such as Bark hold enormous potential 5,060GWh by 2050 in contributing to the energy mix. This creates the interest for the exploring the gasification of biomass either as a stand-alone fuel or to incorporate through co-gasification with VBC.

This paper presents the data from the pressurized entrained flow gasification trials (carbon conversion, gas composition and pollutant emission) for both the VBC and biomass conducted at various pressures under 2.0MPa and at temperatures up to 1200ºC under 50%CO_2 in N_2. Further, the residual chars were characterized for their reactivity, particle size distribution and morphology. The carbon conversion as expected increased with pressure and the gas compositions reflected the same. The high-pressure gasification experiments were reconciled with the high-pressure pyrolysis and atmospheric pressure gasification data and char-reactivity measurements.