Direct Conversion of Chemically De-Ashed Coal in Fuel Cells

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We report chemical, physical and electrochemical properties of various charred, chemically de-ashed bituminous coal relevant to its use in a laboratory-scale direct carbon conversion fuel cell. Certain grades of pulverized non-agglomerating bituminous coal have been converted into a low-ash by caustic leaching of alumino-silicate and other solid inclusions. The chemistry is similar to that of the Bayer process for refining of alumina from Bauxite. Carbon particulates have been produced commercially as a non-abrasive turbine fuel having ash content of 0.17% at a published cost of $3/GJ ($100/ton). Initial tests show steady state carbon/air cell voltages of 0.8 V at 1 kA/m^2 (80% efficiency) using fuel that was charred for 45 minutes in molten carbonate electrolyte at 750 °C. The non-agglomerating properties of the particulates suggest a means of distribution of the fuel to the cells by pneumatic entrainment in a non-reacting carrier gas. For fuel cell stacks costing $400-1000/kW, this and similar fuels may define a route to distributed utility or industrial DC generators that is cost-competitive with existing and advanced coal-based technologies.

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