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Dry Coal Beneficiation Method-Effective Key to Reduce Health, Environmental and Technical Coal Firing Issues

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Coal plays significant role in energy acquisition for today's world. According to International Energy Agency world energy demand in the next 30 years will grow approximately 60%. Direct burning of coal for energy could be a major source of emission of hazardous elements and particulate matters if nonchalance comes to pass in any of the stages involved in the solid fuel to energy conversion process. In fact moisture and substantial amounts of ash forming minerals are integrated parts of ROM (Run-Of-Mine) coal. Increases in long wall output in the last 10 years to more than 6 Mt/y significantly elevated the amount of moisture and mineral content of ROM coals. These two elements of ROM coal directly affect efficiency of coal – fired electricity generation plants and emissions of particulate materials, oxides of sulfur (SOx) and trace elements such as mercury and arsenic. Most of the environmental issues encountered today could be solved or mitigated by employing efficient coal beneficiation methods (which are not widely practiced by power industry yet). This could results in smaller carbon footprint.

Two main schemes of wet and dry methods for coal beneficiation (prior to consumption) could be considered if involvement of water in process is taken into consideration. Currently, dry coal beneficiation methods are not as attractive as wet methods (such as froth flotation, jigging, spiral separators or heavy media), generally because of their lower separation efficiency, but due to higher unit costs ($/t), inadequate water resources and subsequent recycling expenses, high clay content of the low rank coals, sliming of wastes, high operating costs of coal and waste slurry treatment, lower thermal efficiencies due to high moisture and other issues in cold countries, dry methods are gaining more and more recognition, accordingly, than wet coal methods. Clean coals are not only more efficient in terms of combustion, but also more uniform in size, composition, calorific value and moisture content. The benefits of efficient beneficiation processes to the downstream industry and environment include more reliable and uniform operation, lower SOx emission (and consequently less flue gas desulfurization requirement), less maintenance and lower overall operating costs as well as reduction in coal transportation costs ($/t).

Air dense medium fluidized bed (ADMFB) coal separation as a dry beneficiation method is gaining more recognition compared to other dry separation methods such as: air jigs, magnetic separators, electrostatic separators and pneumatic oscillating tables, for dealing with ash minerals due to simplicity of process, lower air volumes and pressure requirements, lower capital and operational costs and possibility of integration of beneficiation and drying in a single unit. Studies showed that, comparable separation performance is achievable if the functionalities of involved parameters are understood well.

Extensive studies are going on particularly in countries with high coal consumption to investigate key parameters effect on separation and drying performance of ADMFB. The results of the recent research conducted at the University of Alberta on application of continuous ADMFB separator revealed that, it is possible to eliminate 65% of ash minerals in a single stage treatment. Used fine silica sand as fluidized media, the ash content of ROM coal has been reduced from 29 to 10% with organic material recovery and solid yield of 89 and 70%, respectively. Any decrease in ash content could directly affect product quality in terms of hazardous elements and clean coal burn out behaviour. Concentration of any elements/component would increase if they were associated with organic phase (lighter phase) while their concentration would decrease if there were a positive affinity between such components and ash minerals. In fact the mode of occurrence determines elimination or increase of components. Changes in concentration of some trace elements due to ADMFB coal beneficiation of four samples (LA: low ash, HA: high ash) are presented below as an example (Figure 1).

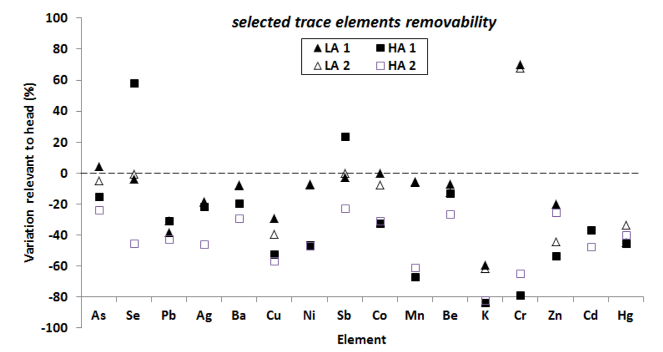

Figure 1: Selected trace elements removability

Increase in heating value of clean coals, as side effect of coal upgrading, could benefit coal firing power plants. As a simple example; considering gross energy of ROM coal and its beneficiated product 17.8 and 24.1 MJ/Kg, respectively, it is possible to acquire the same amount of energy by firing 73.7 Kg of clean coal instead of firing 100 Kg (for instance) of ROM coal. At the same time 22.65 kg of fly ash will be avoided. Now under such circumstances, the existing power generation plant could be reorganized between two scenarios; first, lower furnace feeding rate while recovering the same amount of energy from it and producing 72% less fly ash. Second, to continue with previous nominal plant feeding rate (as designed for ROM) while using clean coal product, and producing 36% more energy due to burning 44.9% extra solid (consider solid yield differences), but still, with lower fly ash generation (62% less compared to ROM feed design).

The moisture content of coal in addition to decreasing its heat value, and consequently the efficiency of the coal fired power plants, increases its handling and hauling costs significantly. Therefore taking advantage of waste heat of coal-fired power plants for simultaneous or sequential coal drying prior to feeding into furnaces could be considered as a strong advantage for ADMFB coal beneficiation. Kinetic studies showed that it is possible to remove considerable amount of surface and open porous moisture (over 50%) in a short time once low temperature hot air was used as fluidization gas.