# Utilization of Biomass for Homeostasis Engineering

(Binding and Desulfurization Characteristics of Pulp Black Liquor in Biocoalbriquettes)

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**Abstract**

Many South Asia people use high sulfur containing coal as the major fuel. The combustion of these coals lead to serious environmental pollution and health problems. There is a lot of biomass in these areas. The $SO_2$ emissions from the combustion of coal can be captured by adding lime based desulfurizing agents (DSA) to the coal briquettes and combustion characteristic can be improved by combining biomass and coal. The physical and combustion characteristics of some Indian (Bihar, Assam) and Nepali (Dang, Abidhara, Lignite) coal have been studied. The process of desulfurization of these coals was investigated using calcium hydroxide and calcium carbonate as DSA. Calcium carbonate is more efficient in char combustion than volatile combustion, where as Calcium hydroxide and Sodium hydroxides are efficient as DSA in both char and volatile combustion. For most of the coals the Desulfurization efficiencies are over 80% in case of $Ca(OH)_2$ and NaOH for molar ratios of DSA to sulfur (Ca/S) of 2 and 3. For the same Ca/S ratios the desulfurization efficiency is about 75% when calcium carbonate is used. Use of Calcium carbonate and Calcium hydroxide as DSA in coal briquettes could be an efficient and economical way to control the pollution from the use of high sulfur containing coals used in brick industries in Nepal and South Asia.

**Key word:** biocoalbriquette, biomass, coal, desulfurization, combustion, desulfurizing agents

## 1. Introduction and Objects Related with COE

Large amounts of coal are used in many South Asia countries as the major fuel in industries and for power generation. Industrial boilers, furnaces and kilns in South Asia, including Nepal also use coal as the major fuel along with fuel wood, rice husk and saw dust, etc. Particularly the brick kilns in Nepal use a wide variety of fuels such as wood, coal, lignite, agro-residue and even automobile tires. Most of the brick industries operate with old Clamp kiln and Bull trench kiln technologies, which are inefficient and polluting. The operating temperature of these kilns is between 700 to 800°C. The main cause of pollution is the burning of coal which has high sulfur content. Lime based products (calcium carbonate and calcium hydroxide) are mixed and used in combustors and boilers to control the $SO_2$ and $NO_x$ emissions during the combustion of raw coal. One simple and cheap method to control these emissions is the introduction of lime based products as desulfurizing agent (DSA) into the coal during briquetting to produce coal briquettes. Such briquettes are found to have good self desulfurization effect during combustion.

In this research work, bio-coal briquettes were developed and the physical and combustion characteristics of different raw coals and biomasses were studied by conducting proximate analysis, ultimate analysis. Figure 1 shows the schematic manufacturing process of bio-coal briquette. Here, Calcium hydroxide, Sodium hydroxide and Calcium carbonate at different Ca/S molar ratios were used as the desulfurizing agents during briquetting of coal.

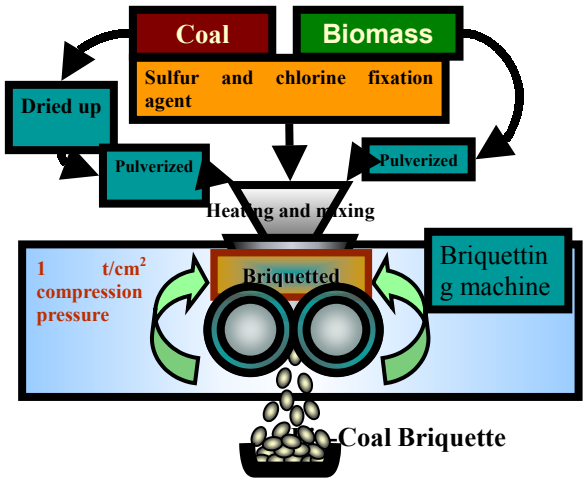


Fig.1 Schematic Manufacturing Process of Bio-coal briquette

## 2. Results

Bio-coal briquettes were developed with Nepali Coal and Indian Coal. The physical and combustion characteristics were studied by conducting proximate analysis, ultimate analysis. Also, Desulfurization characteristics were studied.

### 2. 1 Combustion characteristics

The loss of mass during combustion as a function of time for the same coals and biomasses is shown in Figure 2. For coal A the loss of mass in the volatile combustion stage is more rapid than for coal D, which is characteristic of release of organic sulfur in volatile emissions. Volatile matter is main component in biomass. However, char is main in coal. The solid fuel combined coal and biomass has good flammability and durability.

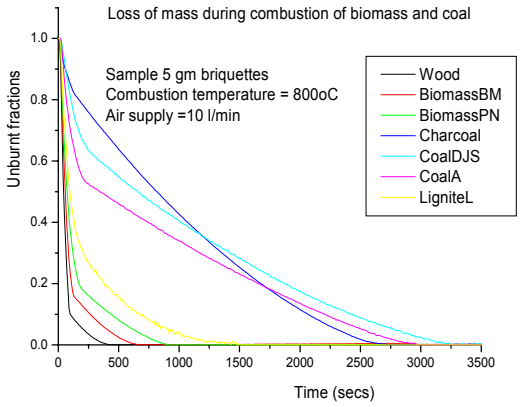


Figure 2. Combustion profiles of biomass and coal

### 2. 2 Desulfurization

The desulfurising efficiencies of different coals using DSA (Calcium carbonate, calcium hydroxide, sodium hydroxide, $MgCO_3$) for Ca/S molar ratios=3 are given in Figure 3. Calcium hydroxide is the best DSA in all the cases with desulfurisation efficiencies reaching over 80%. $CaCO_3$ is also a suitable DSA for coals (D and Ab) having lower values of volatile matter. The desulfurization efficiencies related Ca are above 80%. $MgCO_3$ was also used for but do not show promising results with desulfurisation efficiencies below 50 % for most of the coals.

Calcium hydroxide is best DSA. The reason is followings;1) Calcium hydroxide was decomposed at 350℃, and simultaneously, $H_2S$ is released from Volatile matter. 2) Reactions were occurred.

$$Ca(OH)_2 \text{ ------>} CaO + H_2O$$

$$CaO + H_2S \text{ -----> } CaS + H_2O$$

$$Ca(OH)_2 + SO_2 \text{ ------>} CaSO_3 \cdot 1/2H_2O + 1/2H_2O$$

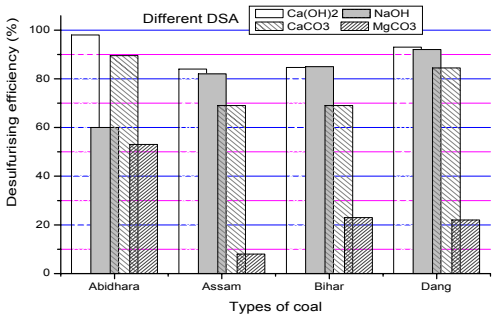


Figure3 Desulfurisation using different DSAs.

### 3. The Contribution to the COE Program.

In this study, the combustion and desulfurization experiment of the coals and biomasses desulfurization were done. These experimental results show that the flammability and durability were increased, when the biocoalbriquette was synthesized with coal and biomass. The desulfurization efficiencies related Ca are above 80%. $MgCO_3$ was also used for but do not show promising results with desulfurisation efficiencies below 50 % for most of the coals. These results suggest that biocallbriquette is effective fuel in Nepal.

### 4. References


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