## Energy Revolution Through Biomass Gasifiers: A Case Study From India

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India, being an agrarian country, is rich in biomass resources and millions of tons of biomass is being generated in the form of dry wastes like agro residues, fuelwood, twigs etc and wet wastes like cattle dung, organic effluents night soil, sugarcane bagasse, banana stem, rice husk etc in rural areas where poor people live and where other sources of energy have not yet reached. On a conservative estimate, about 30 million tones of solid waste and 4400 $m^3$ of liquid of liquid waste are generated every year in urban as well as in rural areas from household and other commercial activities. Therefore, biomass holds considerable promise as an eco-friendly source for generation of power for decentralized applications. Nearly 46% of the total energy consumption in India is now estimated to be met from various biomass resources such as agricultural residues, animal dung, forest waste and firewood. To tap this large potential a National Program on Biomass Power / Cogeneration has been launched by the Government of India, envisaging bio-mass based power generation, biomass / bagasse-based cogeneration, biomass resource assessment, through a number of projects including the installation of gasifiers. Greater focus has been laid on the promotion of village electrification projects, as well as on industrial applications. The producer gas is burnt directly for thermal applications (it can even be used for replacing diesel oil engines for mechanical and electrical applications for water pumping). So far, India has installed nearly 1700 gasifiers systems in more than dozen States with an aggregate capacity of around 35 MW. The biomass gasifiers are boon to the Indian rural population where country's developmental activities could not reach for the want of energy resources. Such energy development is particularly important in minimizing drudgery of Indian rural women, who otherwise spend a lot of time and energy in collecting fuel wood. In fact, it can be said that a quiet energy revolution is being brought about, particularly in villages un-reached and unreachable by conventional electricity through the grid. What is of significance is that locally available biomass material like pruning and residues from energy plantations in the area, weeds, paddy husk etc are used as fuels in the gasifiers.

## The Design and Analysis of Activated Biochar Material for Control of Elemental Mercury Emissions from Industrial Facilities into the Global Atmospheric Pool

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Mercury in the environment has been one of planet earth's largest environmental issues over the past decade. The emental mercury is emitted from various industrial sources of the planet into the atmospheric environment's global pool. Once in the atmospheric environment, the elemental mercury mixes globally within the atmosphere's pool. Then deposits uniformly to the planet's surface. it is the aquatic systems of planet earth that are the most sensitive to the elemental mercury deposition. The mercury deposition essentially methylates the various water systems of planet earth. The Saskatchewan Research Council with the University of Saskatchewan' s Chemical Engineering Department and SaskPower have been working for many years with programs on the activation of biochar aerosol material for in-stack elemental mercury capture and removal prior to emission of the flue gas into the atmospheric environment.

Preliminary programs have been conducted with various coal burning Power Plants within the province of Saskatchewan Canada to use several biochar companies material to design an injected biochar aerosol that will effectively capture and remove elemental mercury within an operational industrial flue gas stream setting. We used the Emission Control Research Facility (ECRF) of SaskPower to conduct these programs. At the ECRF with an input Powdered Activated Carbon (PAC) feed rate of 1.0 lbs/M/Macf the elemental mercury removal rate for the same flow rate of activated biochar aerosols was 90% from the flue gas stream compared to a corresponding 75% elemental mercury removal rate for the same flow rate for a coal carbon based activated carbon based aerosol particle. We also conducted research on varying the levels of activation for a specific type of biochar aerosol injected into a similar flue gas stream for effective elemental mercury capture efficiencies. Specifically with the same biochar precursor source material we compared a reference level of activation with an optimum level of activation for its elemental mercury capture characteristics within a flue gas stream. The results showed that for the same biochar precursor material it was the optimum level of microporosity with a BETA surface area of 538 $m^2/g$ on the injected aerosol surface that effectively removed 92% of the elemental mercury in the flue gas stream vs. the reference level of microporosity with a BETA surface area of 482 $m^2/g$ on the aerosol surface that removed 78% of the input elemental mercury.

We have shown that biochar material if prepared in an appropriate manner can be an effective capture agent for industrial in-stack elemental mercury atoms. Indeed, biochar produced aerosols for elemental mercury sequestration are quite superior to coal carbon aerosols specifically designed for flue gas stream mercury removal. The full details of this project results and it implications for global atmospheric emissions of elemental mercury to the environment will be presented.