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# Optimization of Integrated Clean Production of Pyrogas, Biogas, Methanol, Bioelectricity, Fertilizer and Feed from Agro Wastes with Reduced Emission

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## Abstract

Brazil is the leader known for its ethanol biofuel development, but also for biomass charcoal, yet lacks in clean rural biofuel and bioenergy production. This paper deals with the system design based on zero emission for sustainable projects developments based on the the alternative bioenergy production from biomass wastes using innovative process equipments design and the process optimization. The main objective is towards development of sustainable small scale not only clean energy production as well as with co-production of hot and cold thermal energies from bio wastes. Agro industrial wastes pose a major concern today due to the increase of production with time and thus needs ecological solution. For this problem, an integrated industrial ecological system using the clean Small Bioenergy-Systems (SBS) based on the Zero waste concept was studied by the three basic principles. The first principle is to use all components of the biological organic materials of the wastes. The second principle is to obtain more co-products from the wastes. The third principle is to close the loop via reuse, recycle and renewal of the material and nutrient flows. The SBS approach has many benefits and potentials. The system design is meant for small-scale energy production using hybrid bio-fuel and internal combustion (IC) engine from wastes: It was developed using process analysis (synthesis, modeling, and design) of two stage anaerobic bio process and its integration. SuperPro Designer Process simulation software was used to make synthesis and evaluate these options and performs mass material balance.

Case study was made with the anaerobic process in several stages and recycle of reactor output are found to be very use full and increases the biomass load and also the productivity when used with staged baffled and up flow reactor to produce biofertilizer, bio-hydrogen, bio-methane ,charcoal, ethanol and bio electrical energy with recycle of water ,$CO_2$ and microbial biomass, which are integrated to internal Combustion engine for combined heat and power (CHP). Existing biogas technologies has potential for practical application combined with hydro pyrolysis to make methanol via low temperature methanol production, but if biohydrogen systems are to become competitive, they need more detailed integrated two stage biohydrogen and methane bio reactor to enhance the efficacy of biofuel utilization for energy needs. The results obtained from several preliminary project developments of clean SBS are reported for integrated system developments for fuel and food using process and cost simulation models. These models render

the process development and optimization problem with ecological economic potential objectives to be resolved very rapidly and make it possible make successful project design with the reduction of $CO_2$ emission , water consumption and solid residues, sustainable bioelectric CHP with value added co-products.

***Keywords:*** *Clean technology, Carbon Reduction, Biomass, Syngas, Biogas, Biohydrogen, Biomethanol.*