

**Abstract:**

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Bio-Coal Production Using Novel Two Stage Rotary Roaster

Biomass is a versatile energy resource that could be used as a sustainable energy resource in solid, liquid and gaseous form of energy sources. Biomass though a carbon neutral renewable fuel is associated with several shortcomings like heterogeneity, hygroscopic behavior, fibrous nature, low energy density, and low bulk density. These shortcomings create difficulties in storage, transportation, and processing of biomass. Torrefaction, a mild roasting process in inert atmosphere, is an emerging thermochemical pretreatment process that can eliminate many of the above shortcomings of raw biomass. Removal of volatiles through different decomposition reactions is the basic principle behind the torrefaction process. Torrefaction process upgrades the quality of biomass such as combustion behavior that increases the blending ratio of biomass in the co-firing power plant. Several types of technologies for torrefying biomass like rotating drum type, moving bed, fluidized bed, microwave, and pressurized reactors are in developing process.

However, the supply of inert gas and heat in large industrial units is the main issues regarding both cost and operational issues. Though some commercial units so far have been using flue gas as a heat carrier and working media, presence of free oxygen in the flue gas often requires a very sophisticated control system. Sometime the spontaneous combustion of fine particles affects both operation as well as the product quality of torrefaction. In order to avoid such issues, an indirectly heated system though it has poor heat transfer compared with that of directly heated system is often used. In addition to this, use of volatiles produced during torrefaction is one of the methods to increase thermal efficiency of torrefaction. But, the presence of moisture may decrease the quality of volatiles. So, it is desirable to develop a system that can separate and collect the moisture and volatiles separately. Rotary drum reactor is one of the reactors that can easily separate the volatiles and moisture by dividing the torrefaction process into two stages: (i) drying and (ii) devolatilizing. Staging helps to collect the moisture free volatiles from devolatilization reactions whereas the volatiles itself can be considered to be working media for torrefaction.

The overall objective of this research is to develop an indirectly heated two-stage rotary reactor based torrefaction process and to establish the design methodology for the same. It will

explore the solid transportation, heat transfer phenomenon, analysis of solid product at different operating conditions, and heat and mass transfer modeling of torrefier. In this paper, results of solid transportation in rotary reactor and quality of torrefied products will be discussed.