ABSTRACT

Lignite bioliquefaction is a recently developed non-conventional mode of processing that is hailed as a promising technology to combat the alarmingly rising environmental, economical and technological issues of concern. This novel technique employs microbes and their metabolic counterparts in a prudently designed scientific process for production of fuel and non-fuel utilities from the abundantly available fossil reserves. Development of this nascent technology may also find applications in other coal benefaction processes for production of novel value added products and in the treatment of coal derived wastes. The present work is a comprehensive representation of aerobic and anaerobic bioliquefaction of Vastaan lignite (an Indian variety) carried out at a laboratory scale.

A hyperactive *Pleurotus* sp. that was previously isolated at IIT Kharagpur has been employed for the aerobic liquefaction of Vastaan lignite. Elaborate investigational studies during the process, led to certain interesting findings. Humic acid was obtained as the major product along with certain aromatic compounds, long chain fatty acids, etc. as other intermediate degradatory products. A coherent understanding of the raw, residual, mediator and intermediate analysis directs that the liquefaction process was a combination of solubilization and depolymerization with the latter being distinct. Laccase was found to be the predominant mediator for the process. Media design by prudent selection of components at appropriate concentrations was conducted by selection of statistical and optimization techniques. At optimal conditions 22-35% humic acid yield was obtained. Humic acid obtained by *Pleurotus* mediated liquefaction was recovered, thoroughly characterised and tested for agricultural applications.

Anaerobic liquefaction of lignite was carried using an indigenously concocted consortium of microbes isolated from varied sources. It could successfully convert lignite to biomethane. Inocula performance was assessed in the presence of certain additives and conditions. Process conditions for biomethane production from lignite were optimized using empirical modeling techniques. Simulation and modeling was further extended based on a hypothesis proposed for the sequential steps of the process. A Kinetic model was finally developed which demonstrated appropriate predictability and thus holds promise for greater applicability in the processes when extended to large scales. Finally aerobic anaerobic processes were coupled where the *Pleurotus* mediated aerobic liquefaction proved effective as a pretreatment technique for lignite biomethanation.

Keywords: Lignite, bioliquefaction, humic acid, biomethane, modeling, *Pleurotus* sp.