



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Sutapa Das
Roll Number : 166107009
Programme of Study : Ph.D.
Thesis Title: VALORIZATION OF RICE-HUSK FOR OPTIMAL PRODUCTION OF BIO-OIL, BIO-CHAR, AND SILICA NANOPARTICLES
Name of Thesis Supervisor(s) : Prof. Vaibhav V. Goud
Thesis Submitted to the Department/ Center : Department Chemical Engineering
Date of completion of Thesis Viva-Voce Exam : 07th November 2022
Key words for description of Thesis Work : Pyrolysis, Bio-Oil, Bio-Char, Silica Nanoparticles, Bio-Adsorbent, Super hydrophobic membrane, Oil-water Separation, Response Surface Methodology

SHORT ABSTRACT

Rice husk is an agricultural waste-product whose management has yet not been standardized on a commercial-scale following sustainable norms. Ineffective waste management of this abundant biomass often leads to large amounts of rice husk being decomposed via means such as open-pit incineration. This severely impacts the environment and is one of the leading causes of air pollution, notable mostly in the region of North India. Over the decades, different processes have been adapted to tackle this issue. One of the thermochemical techniques, pyrolysis, offers immense potential towards converting this biomass to several value-added products. This thesis employs the usage of slow pyrolysis to achieve the conversion of rice husk to bio-oil, bio-char and silica nanoparticles. In order to optimize the overall process towards maximizing the product yield, an optimization scheme, namely, Response Surface Methodology (RSM) has been employed which helps determine the ranges for the different process variables - temperature, gas holding time and gas flow rate. Extensive characterization of the process and the products have been carried out. Slow pyrolysis has been performed under inert (N₂) and reactive environments (CO₂) to understand the effect of ambient conditions of the product profile. For instance, bio-char, displayed adsorbent features such as high porosity, surface area, and hydrophilicity when generated under CO₂ environment, while under N₂ environment, it possessed a high carbon content, thus highlighting its usage as a soil conditioner for improving soil fertility. Bio-oil, on the other hand, was also obtained and its physico-chemical characterization revealed potential for usage as a fuel. It was subjected to different upgradation techniques such as solvent-exchange and catalytic-upgradation in presence of bio-char. Thus, the latter technique also presented itself as another route towards utilization of organic modifiers for improving bio-oil properties. Silica nanoparticles (SI NP), were also generated using the rice husk as a feedstock. These particles were obtained as a result of calcination process involving bio-char. SI NP could themselves be modified and applied as a membrane, using natural cotton substrate, for effectively separating oil from an oil-water mixture. Thus, in a nutshell, this thesis aims to highlight the effectiveness of the slow pyrolysis process by utilizing the abundant biomass for obtaining the diverse collection of valuable products.