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High Pressure Delignification Process for Nanocrystalline Cellulose Production from Agro-Waste Biomass

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Abstract : Nanocrystalline cellulose (NCC) has been widely used for miscellaneous applications due to its superior properties over other nanomaterials. However, the major problems associated with the production of NCC are long reaction time, low production rate and inefficient process. The mass production of NCC within a short period of time is still a great challenge. The main objective of this study is to produce NCC from rice husk agro waste biomass from a high pressure delignification process (HPDP), followed by bleaching and hydrolysis processes. The HPDP has not been explored for NCC production from rice husk biomass (RHB) until now. In order to produce NCC, powder rice husk (PRH) was placed into a stainless steel reactor at 80 ˚C under 5 bars. Aqueous solution of NaOH (4M) was used for the dissolution of lignin and other amorphous impurities from PRH. After certain experimental times (1h, 3.5h and 6h), bleaching and hydrolysis were carried out on delignified samples. NaOCl (20%) and H2SO4 (4M) solutions were used for bleaching and hydrolysis processes, respectively. The NCC suspension from hydrolysis was sonicated and neutralized by buffer solution for various characterisations. Finally NCC suspension was dried and analyzed by FTIR, XRD, SEM, AFM and TEM. The chemical composition of NCC and PRH was estimated by TAPPI (Technical Association of Pulp and Paper Industry) standard methods to observe the product purity. It was found that, the 6h of the HPDP was more efficient to produce good quality NCC than that at 1h and 3.5h due to low separation of non-cellulosic components from RHB. The analyses indicated the crystallinity of NCC to be 71 %, particle size of 20-50 nm (diameter) and 100-200 nm in length.

Keywords : nanocrystalline cellulose, NCC, high pressure delignification, bleaching, hydrolysis, agro-waste biomass
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