



Prospects of rice straw as a raw material for paper making



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ABSTRACT

Pulp and paper mills are indispensable for any nation as far as the growth of the nation is concerned. Due to fast growth in population, urbanization and industrialization, the demand and consumption of paper has increased tremendously. These put high load on our natural resources and force the industry to look for alternative raw material. Rice straw is a lignocellulosic material abundantly available in wood short countries like China, India, Bangladesh, etc. and can be used as raw material for this industry. Open burning of rice straw releases noxious green house gases to the air and poses serious threats to global air chemistry and human health. So, it is a dual benefit option (for farmers and industries) to use rice straw as a raw material in pulp and paper industry. Organosolv pulping using acids are the prominent choices of researchers to convert this residue into valuable pulp but in developed countries only. Developing world favours the soda and soda-AQ processes as these are economical. As a virtue of less lignin content in comparison to wood, rice straw requires less harsh conditions for cooking and can be easily pulped. Bleaching is a crucial step of paper making but also responsible for causing water pollution. Many studies revealed that during the process more than 500 chlorinated compounds are released that are highly toxic, bioaccumulative and carcinogenic in nature. Most of the industries over the globe switch on to the elemental chlorine free short sequence bleaching methods using chlorine dioxide, hypochlorite and hydrogen peroxide. This paper presented the effective need of ecofriendly, economically reliable pulping and bleaching sequences in case of rice straw to eliminate the problems of chlorinated compounds in wastewater of paper mills. Such approach of using waste as a raw material with its environmentally safe processing for making paper can prove to be valuable towards sustainable growth.

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1. Introduction

Pulp and paper manufacturing has become an intrinsic section of industrial production over the globe. With increase in population, the demand and consumption of paper has increased tremendously. The demand for pulp, paper and paperboard is about 402 million tonnes per annum over the globe and this demand projection has occurred within 2 years only (Kulkarni, 2013). The demand for paper may projected at 521 million tonnes per annum by 2021 (Pulppapernews, 2015). During the years 1999–2005, consumption of paper increased from 316 to 351 million tonnes and was expected to increase up to 500 million tonnes (Mt) in year 2025 that means a growth of 1.6% in a year (Gracia et al., 2008; Parkash, 2012; FFI, 2013).

1.1. Need for agro residues in paper industry

Pulp and paper industry is highly based on woody raw material. Due to facilitation in the demand and consumption of paper, the protended demand for woody raw materials may exceed their production and supply (Akbari and Resalati, 2012). In India, the annual current pulp and paper production gap is 0.7 million tonnes and expected to become 1.5 times more by 2015 (Parkash, 2012). This ultimately leads to the destruction of our natural forest cover. Confined production of forest based raw materials, in companion with the increased demand for pulp and paper production and awareness among environmental protection has forced the industries to work on alternate raw material (Sharma and Kumar, 1999; Ali and Sreekrishnan, 2000). This has opened a way for agro residues to be used as raw material in pulp and paper industry for cleaner production (Jiménez et al., 2005; Haung et al., 2008).

1.2. Sustainable approach to use agro residues

For quality reasons, agro based raw materials like bagasse, rice straw, wheat straw, kenaf, jute, hemp have replaced the traditional woody raw materials (Sridach, 2010). Agro based raw materials have easy pulping capabilities, good bleaching capacity and excellent fibre content to make good quality paper (Atchison, 1995; El-Sakhawy et al., 1995; Jiménez et al., 2008). It is a high time to increase economic status with minimum harm to environmental components and to save, utilize and recycle the expensive chemicals and raw material for sustainable growth. Agro residues are the prominent choice of wood scarce countries like China, India, Egypt, Pakistan, etc. (Hosseinpour et al., 2014; Maddern, 2003; Anapanurak and Pisuthpichet, 1997). Though, agro residues are

highly compatible for pulp and paper industry but account only 6–12% of the total global paper production (Bhardwaj et al., 2005; El-Sakhawy et al., 1996; Atchison, 1974). Several kinds of nonwood lignocellulosic agricultural remains have been investigated of which wheat, rice, bagasse and barley straw are most prominent (Xu et al., 2013; El-Taraboulsi and Hurter, 1985).

1.3. Rice straw: social and industrial aspects

Rice straw is an abundant and easily available non wood raw material in developing countries mainly India (Rodríguez et al., 2010). These countries produce a large amount of rice straw which poses serious problems for farmers. The outsized amount of paddy is produced annually over the globe (~755 million metric tonnes) and during the production equal amount of straw is also produced (FAO, 2013). So, converting this waste to valuable raw material in production of paper is an ecofriendly approach for waste management. It may prove to be a promising option to conserve our natural resources. Farmers get rid of burning the residue which reduces the environmental pollution load. It also reduces the severity of health problems associated with air pollution originated during straw burning. Rice straw mainly consists of cellulose, hemicelluloses, lignin and silica and this chemical composition provides it considerable attention in pulp and paper industry to obtain more added values from agricultural remnants.

Rice straw is used for paper making in the countries of Southern and Eastern Asia (i.e. China, India, and Sri Lanka) and in Egypt. Many pulp and paper mills are using rice straw in blend with other agro based raw materials in various proportions to make paper for various uses like writing, printing, low grade wrapping papers and greaseproof papers, etc. As, the world is facing the challenge of conserving the non renewable fossil fuels, a global attention is required on production of renewable second generation fuels. The lignocellulosic biomass specially the agro residues may be utilized for the same. Jahan et al. (2015) proposed that the hemicelluloses extracted from pulping liquor can be utilized for biofuel production. Separated lignin and other organic components from the pulping liquors can be utilized as soil amendments in the field which can prove to be beneficial for both soil quality and serve as a potential disposal alternative (Xiao et al., 2007).

1.4. Problems associated with rice straw pulping and bleaching

High silica content in rice straw poses problems for both industry and environment. Many researchers have put their efforts to find reliable ways but most are only industry oriented. Bleaching

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