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Potential of Solar Energy Utilization for Process Heating in Paper Industry in India: A Preliminary Assessment

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Abstract

This paper presents the results of a preliminary assessment towards the potential estimation of solar process heating in paper industry in India. To begin with, data for (i) classification of paper mills on the basis of size and feedstock used (ii) extent of cogeneration in paper mills (iii) annual paper production (feed stock wise) (iv) specific thermal energy requirement for process heating etc. have been collected. Annual process heating requirement for paper production (based on feed stock used) in paper mills in India has been estimated. Availability of adequate solar resource in different states of the country was assessed for potential estimation. Some commercially available solar collectors that can supply heat at required temperature of paper industry (50-250⁰C) have been selected and an assessment of their performance has been made. Majority of paper mills in India those are using agro residues and recycled fibers as raw feedstock are located in the states with adequate DNI availability (1900kWh/m²). Annual process heating potential for the paper industry in India has been estimated at 43 PJ.

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1. Introduction

Paper industry in India accounts for about 2.6% of the world's production of paper. Although, per capita consumption of paper in India is around 9.5 kg, which is significantly lower than world average of around 58 kg (even the average consumption in Asia is 21kg) [1]. However, an increasing trend of paper consumption has been observed in the recent past. Paper Industry in India ranks 6th in term of gross energy consumption while three types of raw materials namely wood (31%), agro-residues (22%) and recycled fiber (47%) are used in the paper mills in India. Past trend of paper production and per capita consumption in India is presented in Table 1 [1].

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Table 1. Time trend of annual production and per capita consumption of paper in India

Year	Paper production (million tons)	Per capita paper consumption (kg)
1950	0.11	0.9
1970	0.75	1.9
1990	2.43	3.6
2000	4.87	5.5
2006	6.8	6.7
2007	8.3	8.3
2010	10.11	9.3

At present fuel mix in paper industry in India comprises mainly of coal, petroleum fuels, biomass and electricity with the first two providing more than 68% of the total final energy consumption [2]. It is desirable to reduce fossil fuel consumption while meeting the increasing energy demand of paper industry. This may have the twin benefits of reduced consumption of fossil fuels and lowering of greenhouse gas emissions. A reduction in the consumption of fossil fuels in the paper industry in India can be achieved by (i) improving the efficiency of fuel utilization and (ii) substitution of fossil fuel by harnessing renewable sources of energy area in suitable processes and end use. While energy efficiency improvements are necessary and would provide substantial benefits in the short run, harnessing of renewable energy sources to meet the energy demand of paper industry can provide multiple benefits for the Indian economy for the long term.

Paper industry primarily consumes energy in two forms-electrical and thermal. A major fraction (75%) of energy used in paper production is essentially for process heating at low and intermediate temperatures (50-250⁰C) [3]. In a typical paper mill, processes such as pulping, drying, bleaching and washing (using hot water), boiler feed water heating etc. require most of the process heat. This heat is transferred through a heat transfer medium that could be water, steam, air or thermic oil based on specific process requirements. Typical paper manufacturing processes with corresponding required temperature and medium are presented in Table 2. With the use of state of the art technologies, solar energy can be efficiently harnessed to provide heat at required temperatures (below 250⁰C) with or without integration with conventional fossil fuel based process heating systems.

Table 2. Processes with corresponding temperatures and media required in a paper industry

Typical process(es)	Required temperatures (⁰ C)	Medium
Bleaching	120 – 150	Water
De-linking	60 - 90	Steam
Paper drying	90-200	Air, Steam
Pulp preparation	120 - 170	Pressurized hot water

Several Studies have been reported in the literature that deal with the potential of SIPH in paper industry. [4-6]. In the context of India, a study carried out by GIZ estimated a potential of 1.88 PJ per annum [6]. However, the study was limited to low temperature process heat applications such as hot water generation and boiler feed water heating only and did not consider use of solar energy to meet process heating demand (through steam generation) at higher temperatures. Also the solar resource

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