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REDUCING GHG EMISSIONS FROM PAPER INDUSTRY USING ENERGY EFFICIENT TECHNIQUES

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Abstract:

The increasing levels of greenhouse gas (GHG) emissions are becoming a matter of concern as the threat of climate change escalate, highlighting the significance of research on GHG emissions to better understand their sources. The pulp and paper industry is a significant contributor to greenhouse gas (GHG) emissions and it is crucial that steps are taken to reduce these emissions. Between 1973 to 1990, the pulp and paper industry successfully cut its emissions by a significant 85% and over the last two decades, the industry's energy consumption has only increased by 1%. Given the persistent environmental threat and the expansion of the industry, the pulp and paper sector must continue paving the way within the manufacturing industry by incorporating innovative technologies into existing mills or creating cutting-edge solutions to improve energy efficiency across all stages of paper production. Even older paper mills can benefit from energy-saving techniques like Best Energy Practices without undergoing costly upgrades. As the world becomes more conscious of the manufacturing industry's impact, the pulp and paper industry must continuously evolve and adopt new technologies to meet their goal of reducing emissions by the mid-century.

Keywords: Greenhouse gas, Emissions, Technology, Energy consumption, Drying.

Introduction:

The increasing levels of greenhouse gas (GHG) emissions are becoming a matter of concern as the threat of climate change escalate, highlighting the significance of research on GHG emissions to better understand their sources. The atmospheric concentration of greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, has risen since the start of the industrial age, contributing to global warming and climate change. The pulp and paper industry is a significant contributor to greenhouse gas (GHG) emissions and it is crucial that steps are taken to reduce these emissions. The pulp and paper industry contributes to GHG emissions through various sources such as energy consumption, chemical processes, and transportation. The past several decades has seen a dramatic change in the pulp and paper industry as it adopted to the changing demands and pressures of the world. The rise in consumption of paper, the movement for environmental consciousness, and instability of the world economy led to the development of technological innovations with improved energy efficiency. Given the persistent environmental threat and the expansion of the industry, the pulp and paper sector must act to decrease greenhouse gas emissions. This can be achieved by incorporating new technologies into existing mills or creating cutting-edge solutions to improve energy efficiency across all stages of paper production.

Current Efforts to Reduce Emissio

The International Energy Agency reports that global energy consumption increased at an alarming rate in 2018, outpacing

the average growth rate since 2010. The boost in energy usage was a result of a robust global economy and the increased need for heating and cooling in certain regions. As a result of the higher energy consumption, carbon dioxide emissions rose by 1.7% in 2017, reaching a new high.1 Pulp and paper is the world's fourth-largest energy-consuming industry, accounting for about 5% of the world's energy consumption, and its carbon emissions account for about 2%.1 The production process of the pulp and paper industry is energy-intensive, significantly due to chemical pulping, black liquor evaporation, and the drying process which all require enormous amounts of energy.2 Most of the on-site energy used in the forestry-pulp and paper industry is generated through combined heating and power (CHP) generation units, while some energy is obtained from other power generation sources such as combustible energy or renewable resources.3 The high energy consumption and emission of pollutants during the product conversion process contribute to the negative impact of the pulp and paper industry on the environment.3

Despite these negative effects, the pulp and paper industry has shown remarkable progress in reducing its carbon footprint. Between 1973 to 1990, it successfully cut its emissions by a significant 85%. Despite a 23% growth in paper and paperboard production over the last two decades, the industry's energy consumption has only increased by 1%.4 Many pulp and paper agencies have pledged to help the industry further reduce emissions in the next few decades. The European Union (EU) has established a set of ambitious targets to limit the increase in average global temperature.5 These include reducing GHG emissions by 40% before 2030 and by 80-95% before 2050.5 The Technical Association of the Pulp and Paper Industry (TAPPI) is promoting the use of advanced technologies and materials such as biomass energy and nanotechnology in pulp and paper to reduce overall energy consumption and carbon emissions.6 Furthermore, the Confederation of European Paper Industries (CEPI) has already begun working on a 2050 roadmap to transition to a competitive low-carbon economy. By 2050, CEPI aims to reduce CO2 emissions by 80% (compared to 1990 levels) and lower energy requirements by 20% in the wood fiber industry, while increasing product value by 50% (Fig 1).6

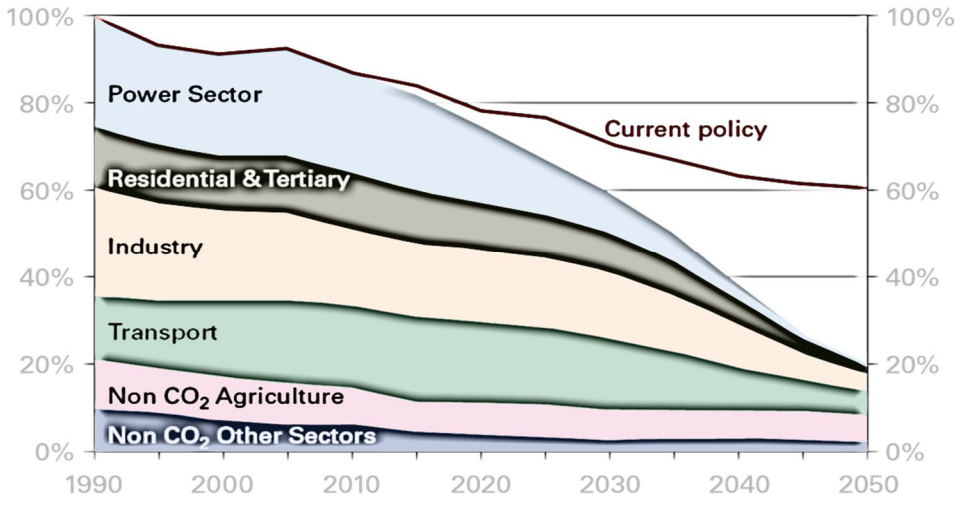

Fig. 1. CEPI breakdown of the roadmap to 2050

The pulp and paper industry is also responsible for emitting significant amounts of air pollutants such as particulate matter, volatile organic compounds (VOCs), and nitrogen oxides (NOx). To produce secondary thermoelectric energy, substances such as coal, natural gas, bark/wood residual, black liquor, and auxiliary fuels (heavy oils) are burned in boilers thereby releasing large amounts of CO2 and nitrous oxide.6 These air pollutants can have significant impacts on human health, such as respiratory problems and decreased air quality, and can also harm the environment through acid rain and ozone depletion. To mitigate the impacts of air pollutants, the pulp and paper industry can adopt best available technology (BAT) and best environmental practices (BEP) to reduce air emissions. BAT and BEP refer to the use of the most advanced and effective technology and processes to reduce air emissions. For example, the use of scrubbers in industrial processes can significantly reduce emissions of particulate matter, VOCs, and NOx. Additionally, the use of more energy-efficient processes, such as using low-emission boilers, can also reduce air emissions from the industry.

Current Energy Efficient Innovations

The pulp and paper market has advanced dramatically in the past decade with developments of several cutting-edge technologies aimed to increase energy efficiency within the currently operational paper mills. One of the newer innovations that can be implemented with relative ease is using a closed hood system instead of an open or semi-open hood system over the paper machine (Fig 2). Use of the closed hood reduces energy consumption and CO2 emissions, with estimated energy savings up to 45% upon implementation. Microwave drying is another innovation that can be used to reduce the energy consumption related to the paper drying process. Microwave drying allows for higher drying rates while preserving the quality of paper. Microwave technology can be an add-on accessory for existing paper machines within various sections of the machine. In the press section, microwave technology can be used to preheat the web and reduce

the water load before the dryer section.7 In the dryer section, microwave technology can be applied to supplement existing cylinders that operate by conduction heating. Microwave drying technology is shown to increase paper machine speeds by 30% while reducing paper drying energy consumption by 20%.7 Despite its benefits, microwave technology is not widely implemented due to its higher energy consumption rates. Therefore, this serves as another area for possible developments related to the modernization of the existing pulp and paper mills.

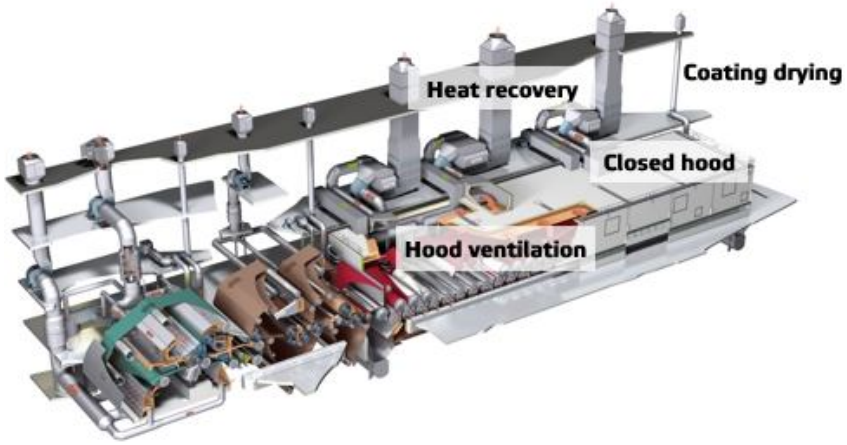

Fig. 2. Picture of a typical closed hood system. Closed hood systems lead to lower energy consumption by capturing more steam to be reused and leading to less steam consumption.

Another innovative drying method that can be utilized is the Condebelt Drying. Instead of using the conventional steam-heated cylinders, this process dries paper web in a drying chamber between two steel belts. The upper belt is heated by steam with temperatures ranging from 110 to 160 degrees Celsius, while the lower belt is cooled by circulating water to approximately 80 degrees Celsius (Fig 3). Studies have demonstrated that Condebelt drying delivers fast drying rates, reaching over 145 kilograms per square meter per hour.6 Additionally, it enhances the strength, smoothness, and resistance to humidity of the final product. Currently, Condebelt drying is most suitable for drying paperboard. This technology has the potential to save up to 15% in steam consumption while also decreasing electricity usage6.

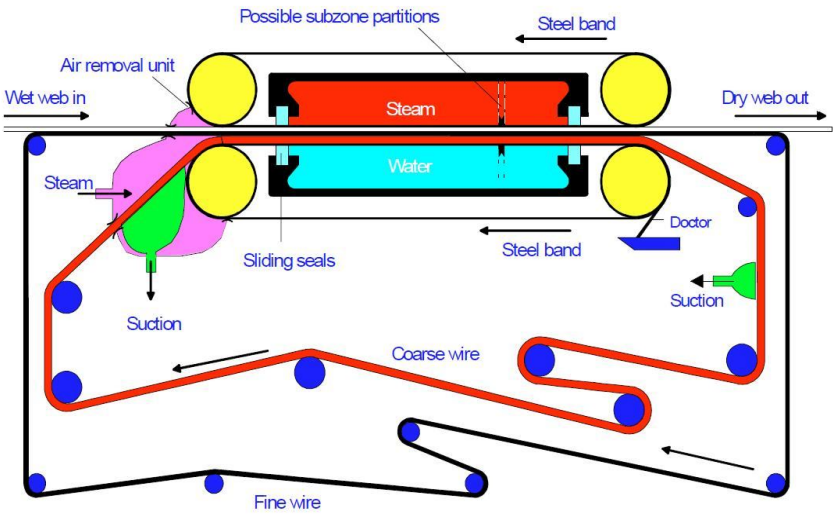

Fig. 3. Condebelt drying process, the upper belt is heated by steam while the bottom belt is cooled by circulating water, leading to faster drying rates. Both belts are steel bands which have smaller shell thickness which leads to higher heat transfer.

Future Innovations for Pulp and Paper Mills

In recent years, several studies are examining the potential for reducing energy consumption and the options that are available for cutting GHG emissions within existing mills and future developments. The Joint Research Centre (JRC) predicts an increase in the European Pulp and Paper sector's energy consumption and CO2 emissions by 1.1% and 4.8%, by 2050, respectively.8 Their analysis shows that application of the best available technologies in papermaking could lead to a 14.4% decrease in energy consumption throughout Europe, resulting in a 62.2% reduction in CO2 emissions.8 Most of the improvements in energy savings will come from integration of state-of-the-art technologies into new equipment for heat recovery, black liquor gasification, and highly efficient appliances. Additionally, technological advancements within the paper drying process will further reduce overall energy consumption of paper mills. Upgradation of older, existing paper mills can serve as another avenue for reducing energy consumption and GHG emissions within the pulp and paper industry. Key strategies identified in reducing GHG emissions and energy consumption within existing paper mills include improvements with relation to more energy efficient technologies. This includes converting from fossil fuels to locally produced biofuels (bark and black liquor), enhancing the energy management system, maximizing the operation of wastepaper and paper recycling, and incorporating innovative technologies.8

Within the current structure of paper mills, each step of the paper making process provides the potential for energy savings and emission reduction. At the start of the pulping process, energy savings can be accomplished by pretreating the raw material (wood chips) leading to improvements in pulping efficiency. Majority of the energy and chemicals utilized during the wood chip chemical process are used to break the covalent bonds between the fibers. By using microwave pre-treatment technology, the cellular microstructures of the wood are altered, allowing for easier passage of pulping chemicals to the center of the chips. This leads to an overall reduction in the total amount of energy and chemicals required for the pulping process.9 Furthermore, the

microwave pre-treatment technology not only lowers the H-factor of the wood chips but also potentially reduces fuel consumption in the lime kiln. Through incorporation of the microwave pre-treatment technology, existing pulp mills can benefit via increases in pulp yield and energy efficiency while minimizing chemical usage.9 There are several pre-treatment techniques currently in the market such as chemical pre-treatment with oxalic acid and biological pre-treatment, all of which result in less energy use.

Another aspect of the current mills that can be converted to improve energy efficiency is the Recovery Boiler. Dual-pressure recovery boilers enable pulp mills to harness the power generation potential of a high-pressure reheat cycle in the recovery boiler.9 Dual-pressure recovery boilers are a combination of a classic recovery boiler and a subcritical utility boiler and consist of two parts: a lower furnace and an upper furnace. They can be paired with various condensing, non-condensing, or a combination of condensing and non-condensing turbine cycles, resulting in significant improvements in power generation efficiency.9 The new recovery technology could generate up to five times more electrical power (by 30-130%) for pulp mills that are using low solids and direct contact evaporators.9

Moving through the papermaking process, the area with the highest potential for efficiency improvements is the drying process, which currently accounts for about 70% of total energy used for pulp and papermaking. The energy consumption required during drying could be reduced by using new technology, such as dry sheet forming, a process that eliminates the addition of water in the production of paper. The dry sheet forming process utilizes air laying techniques to distribute and suspend wood fibers in the air before molding them into paper. In this method, resins are applied to the sheet and polymerized to help strengthen the web.9 Dry forming technology eliminates the need for wastewater treatment and effluent which are common in traditional paper mills. Because no water is used in this technology, it helps avoid the wastewater effluent and treatment that are part of the conventional paper mill operations. Additionally, it is estimated that the air-laid dry sheet forming technology could result in a 50% reduction in total drying energy with only minimal increases in energy consumption (from 150 to 250 kWh/t paper).9 Further research for developments to the dry sheet forming technology for specialty applications is ongoing.

JMC Paper Tech Pvt Ltd's Contribution Towards Green Manufacturing

JMC Paper Tech Pvt Ltd is striving to lead the charge in reducing energy consumption and ultimately, lowering GHG emissions. JMC's workshop has already established green environmental processes, such as installation of solar panels on the roof, resulting in significant increase in energy savings. JMC is also dedicated to manufacturing products that current and future paper mills can use to achieve greater energy efficiency. One such product is the steel dryer, which boasts a reduced shell thickness that promotes higher heat transfer. This, in turn, lowers the steam pressure needed for drying, resulting in significant energy savings. The grooving inside the shell also increases the overall heating area, resulting in better conductivity. In several countries, including India, the burning of Bagasse and Agro waste is contributing to alarming levels of air pollution. JMC offers a solution to this problem through its continuous digester systems, which are used to pulp raw Agro waste chemically. The resulting unbleached pulp is obtained without burning of waste. The steel dryer and continuous digester system are just a few products from JMC's manufacturing lineup that serve as a testament of JMC's commitment to helping paper mills reduce energy consumption and combat GHG emissions.

CONCLUSIONS:

Throughout the world, concern about the health of the planet's ecosystem is growing, especially related to global warming and the emissions of greenhouse gases. The pulp and paper sector has consistently been a pioneer in sustainability, boasting a history of resource renewability and energy efficiency. However, it's crucial that they continue to strive for improvement, particularly in reducing their carbon footprint and driving technological advancements. As stated above, Pulp and Paper industry is the fourth largest energy-consuming industry, accounting for about 5% of global energy consumption and 2% of global carbon emissions. There are numerous innovative technologies available to lower energy costs and GHG emissions throughout the production process, from wood chips to final drying. As the world becomes more conscious of the manufacturing industry's impact, the pulp and paper industry must continuously evolve and adopt new technologies to meet their goal of reducing emissions by the mid-century. Even older paper mills can benefit from energy-saving techniques like Best Energy Practices without undergoing costly upgrades. The time to act is now, and the pulp and paper industry must do their part in mitigating the effects of greenhouse gas emissions.

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