FILLERS AND THE CARBON FOOTPRINT OF PAPERMAKING

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Carbon footprint reduction is a global concern. For the papermaking industry, strategically effective measures of carbon footprint reduction can include many aspects such as energy efficiency improvement, use of renewable carbon-neutral energy, practicing of sustainable forestry, and development of an integrated forest products biorefinery. Filler addition in papermaking can save substantial amounts of pulp fibers, and reduce energy consumption, which can surely contribute to reduction in paper's carbon footprint. However, the negative effect of filler addition on paper recycling, and the energy consumption associated with the production, processing, and treatment of fillers, will contribute to the carbon footprint. On balance, it can be considered that filler addition in reasonable amounts is likely to lower the paper's carbon footprint. Certain research work is still needed to better understand the relationship between filler addition and the carbon footprint of papermaking.

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Carbon Footprint and Papermaking

Global warming, which has generally and widely been considered to be predominately caused by greenhouse gases as a result of human activities, has been one of the most critical and strategic environmental challenges. Carbon footprint is a term commonly used to describe the total amount of carbon dioxide and other greenhouse gas emissions. For the papermaking industry, the carbon footprint of paper is the amount of greenhouse gases released into the environment during the full life cycle of papermaking. The major contributor to this carbon footprint is carbon dioxide emissions from fossil fuels used to generate heat and power, including purchased electricity. Carbon dioxide emissions from transportation of raw materials and paper, as well as methane emissions from landfill sites can sometimes also be important contributors. Globally, the calculation/evaluation and reduction of carbon footprint of the papermaking industry is an urgent and strategic task. In order to achieve a substantially or absolutely sustainable and environmentally friendly future for the papermaking industry, strategically effective measures (such as energy efficiency improvement of the manufacturing processes, energy self-sufficiency, use of non-fossil/carbon-neutral fuel energy and bio-based and

biodegradable papermaking chemicals, practicing of sustainable forestry, development of integrated forest products biorefinery technology, efficient use of wood and non-wood fibers, more local sourcing of fiber resources, and rational and efficient paper recycling) can be implemented to reduce its carbon footprint. It goes without saying that ensuring a carbon-neutral economy of papermaking is one of the ultimate goals of green and sustainable development. With its renewable fiber resources, ecologically adapted forest management techniques, continuously improved manufacturing and environmental processes, and ever-accelerated updating of recyclable products, the papermaking industry has the potential to be recognized a key player in ongoing effects to protect our climate, environment, and the whole planet.

Filler's Contribution to Reduction of Carbon Footprint

The use of inorganic or mineral fillers in papermaking has been practiced since the eighth century, and their primary contributions, which are widely known to papermakers, can generally include cost and energy savings, improved optical properties and dimensional stability of paper products, and increased furnish drainage rate. Also, it is worth noting that filler addition can contribute to the reduction of carbon footprint as illustrated by the following three aspects:

- Substantial amounts of pulp fibers derived from natural resources including wood and non-wood materials can be saved, which can possibly enhance the carbon sequestering capacity of natural environment and reduce carbon footprint.
- The use of energy (especially the energy for paper drying) in papermaking can possibly be significantly reduced, and the dependence of papermaking industry on fossil fuels can therefore be alleviated, resulting in reduced carbon footprint.
- Fillers' high light scattering ability can make it possible to achieve paper opacity specifications at a lower basis weight, using less material per unit area.
- The saving of pulp fibers can possibly result in lowered carbon footprint originating from pulp production.

The saving of fiber resources is always one of the main motivations of papermakers when considering the use of fillers to meet their needs. Also, the role of filler addition in energy saving is more and more clear now. For example, researchers at IPST (Institute of Paper Science and Technology at Georgia Institute of Technology) have recently shown that adding starch-coated clay to linerboards can save drying energy by at least 10%. Usually, pulp savings and the reduction in energy consumption can simultaneously contribute to cost reduction in addition to carbon footprint reduction.

Carbon Footprint Originating from Filler Addition

Actually, the use of fillers in papermaking has its own carbon footprint. This can manifest itself in two important ways:

- The use of fillers, especially at high levels, can discourage the industrial practice of paper recycling, which can possibly increase carbon footprint.
- The intensive energy consumption associated with production, processing, and treatment of fillers can possibly increase the carbon footprint of papermaking.

Paper recycling is an important aspect of efficient use of lignocellulosic materials. The presence of fillers in paper can cause certain difficulties in paper recycling, which is possibly associated with increased energy consumption during the recycling processes. In addition to recycling, one of the most common fates of paper is landfilling, though incineration, composting, as well as other treatments may also be used. In specific applications, the filled paper that is more difficult to recycle might be more likely to end up in landfills, which are a potential source of methane, a much more potent greenhouse gas than carbon dioxide. Also, the production, processing, and treatment of fillers are generally energy-consuming, which can surely contribute to the carbon footprint.

On Balance, Filler Addition in Reasonable Amounts Can Be Expected to Lower Paper's Carbon Footprint

Based on the above discussions, for the commonly used fillers in papermaking, it can be considered that filler addition at very high levels might possibly be unfavorable to carbon footprint reduction. Nevertheless, on balance, the use of fillers in reasonable amounts is very likely to lower paper's carbon footprint, due to pulp and energy savings. Novel technologies capable of extending the use of fillers in conventionally unfilled paper grades, such as acid-stabilization of calcium carbonate fillers, and improvement in bonding capacities of fillers, have the potential to reduce paper's carbon footprint. The development of filler technologies for enabling the use of fillers in reasonable amounts while maintaining or even upgrading product qualities, is surely of strategic significance.

For better understanding of the relationship between fillers and the carbon footprint of papermaking, certain research work including establishing reasonable and feasible methodology for data collection, identifying the effects of various fillers, statistical study, modeling, and industrial demonstration and analysis, is still necessary.

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