Let's Contribute to Protecting our Planet by Reducing the Brightness of Paper: Less is More

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Sustaining life on the Earth with its ever-growing population is forcing changes in people's way of life, industrial and agricultural production, exploitation of energy resources, and approaches to ecology. We face continual growth in the world's population, and the demand for materials is growing even more rapidly. Every manufacturing and consumer sector is looking for ways to save energy and materials, attempting to minimize their negative impacts on the environment. In the pulp and paper industry, one of the segments in which progress can be made and help protect the planet is to reduce the brightness of paper. Such a reduction would lead to a lowering in the energy and material costs associated with paper production.

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According to the Food and Agriculture Organization of the United Nations (FAO 2019), the production capacity of paper and board mills exceeds 278 million tons per year, of which more than 64 million tons consists of printing and writing paper (excluding newsprint). Of the several characteristics of the paper (brightness, whiteness, opacity, *etc.*), consumers focus mainly on its brightness. From the used definitions of brightness, we have adopted the definition of ISO: brightness can be defined as the percentage of blue light (457 nm wavelength) that is diffusely reflected from the paper's surface (Couch 2005). In contrast to brightness, whiteness measures the relative balance of light reflected over the entire visible spectral range (approximately 380 to 720 nm) (McLaughlin 2019). The most important stage in paper production, in which there seem to be the greatest opportunities for saving, is its bleaching to achieve the required level of brightness.

Pulp and paper producers are continually striving to increase the brightness level of both uncoated and coated paper grades to make their products competitive in the domestic or foreign markets. The brightness of standard papers for office printing ranges from 82 to 95 ISO. Brightness levels ≥ 90 ISO are associated with high-quality papers. In terms of brightness, two opposing aspects act against each other. On the one hand, customers demand paper with maximum brightness. On the other hand, compliance with such requirements leads to growing consumption of primary wood, chemicals used to increase brightness, and energy demands of the papermaking process.

The process of increasing the brightness consists in a more thorough removal of lignin and other substances that contribute to the colour of paper. The result is a growth in the cost of the bleaching process and the amount of chemicals used, which leads to a

negative environmental impact not only at the place of production but also on a global scale. On the one hand, the advantage of bleaching process refinement is that additional impurities are removed from the paper and the printability of the paper made of pulp may be improved. On the other hand, however, this advantage is suppressed, and in some cases even overcome by increased bleaching costs, reduced pulp yield, and higher energy consumption. This trend in the production of high-quality papers continues, and so far, there have been no apparent efforts of leading representatives of the pulp and paper industry to set lower brightness standards.

When a member of our industry is asked whether such high brightness is needed, often the answer is "the customer demands it." Let's demonstrate the issue for the case of office papers. National governments, agencies, and other institutions buy office paper, and its use is trivial. Print the information, scroll it on, and then save or shred it after a while. The question is, does the paper really have to be so white for such use? Covid's time led to the relocation of several professionals to the household, which resulted in higher paper consumption in households as well, and in turn, the paper only served as a helper for better work and orientation with information. If we look at the choice of office papers from a household perspective, in most cases one does not really need to buy the most expensive paper, and many customers do not even look for the brightness of the paper.

All of this fits the idea of producing lower-brightness paper in the beginning at least in some segments of marketable papers. The savings achieved by reducing brightness can be exemplified by a few data. According to Couch (Couch 2005), removing the bleaching step could reduce paper costs by $ 34 per ton. A pulp mill processing 1,000 tons per day would save more than $ 11 million a year. As today's cost costs rise rapidly (energy, chemicals, wood), these savings should be much higher. Reducing the brightness would shorten the production process, a reduction in energy consumption by about 1/3 and consumption of hazardous chemicals (including hydrogen peroxide, chlorine dioxide, and alkalis). Just for illustration, the global market for ClO_2 was valued at $857.8 million in 2019. It is expected to reach $1,265.5 million by 2027, with a compound annual growth rate (CAGR) of 5%. There is a tendency to produce papers made from pulp without chlorine or its compounds (such paper is referred to as Totally Chlorine Free). In this process, peroxides and oxygen in an alkaline environment are used. The global market for H_2O_2 rose to US$ 3.1 billion in 2021 and it is expected to reach US$ 4.06 billion by 2027, which implies a CAGR of 4.2% during 2022 to 2027 (IMARC 2021). According to the FAO (2019) survey, the paper production capacity in 2023 would approach 64,319,000 metric tons/year (types: coated printing and writing paper, coated woodfree printing and writing paper, uncoated printing and writing paper, uncoated wood containing printing and writing paper, uncoated woodfree printing and writing paper). If we were to save $ 34 per ton by lowering the brightness, the savings for these segments amount to $ 2.19 billion.

An increase in pulp yield caused by the above-mentioned savings should reach up to 1%, which, in turn, reduces the necessity for tree felling (Couch 2005). However, it is necessary to be aware that due to the political (especially war in Ukraine), trade (sanctions and embargoes imposed on trade with Russia), and health (caused by Covid 19) turbulences in the world, it is currently not possible to more accurately predict and quantify the material and energy cost trends related to pulp and paper production. The need to meet ecological criteria should help move the papermaking process in the direction of zero-waste technologies, and at the same time bring about a change in people's thinking. It is commonly heard that fibre and paper production hurts the environmental. From another

perspective, the industry strives to be eco-technology. Environmentally minded young people, in particular, can be expected to be the driving force behind technological change and a reduction in the demand for high-brightness, high-gloss paper. In addition, many consumers have realized that not all paper applications require high brightness, which in some cases may even create glare (Bin *et al.* 2011, Li *et al.* 2012) and impair readability. Some researchers have disputed the idea that higher contrast between the colour of the character and the pad (paper), the better the readability and recognizability of the printed text (Kazikova *et al.* 2008; Szitas *et al.* 2008). On the contrary, the papers should not have such a high brightness, as the recognizability of the text is deteriorating (Kazikova *et al.* 2008; Szitas *et al.* 2008). This aspect of the uselessness of high brightness can be confirmed by stating that most paper is used (printed) just once and stored or shredded after reading.

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