



Water is of central importance for the production of paper: no water, no paper

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Water in the Paper Industry

Current situation and future options

Paper is a commodity product and it is still hard to imagine a world without it. Water is one of the key components of papermaking. Without water, the production of paper is unthinkable. Being one of the most important industrial water consumers, paper producers were challenged to reduce their impact on water resources in the past decades. Competent decision making by top managers and well trained and motivated staff delivered substantial progress in reducing the water consumption in paper mills. Due to its high competence in closing water circuits the paper industry nowadays counts among the most advanced industrial sectors regarding water efficiency. In the following sections the current situation and future options will be illustrated.

Current water consumption levels

In the early stages of industrial papermaking, paper was produced with high specific water consumption. The paper industry has improved its processes in the last few decades for economic and ecological reasons and, as a result, has been able to reduce its water consumption significantly. This was only possible because of the increasing closure of in-mill water circuits and consistent reuse of clarified process water by former fresh water consumers.

A survey conducted by Papiertechnische Stiftung (PTS) and the German Pulp and Paper Association (VDP) showed that the average specific effluent volume of Germany's pulp and paper industry decreased from

46 to 9 l/kg of product produced between the 1970's and today (Fig. 1). Nevertheless, the paper industry remains one of the biggest consumers of industrial water.

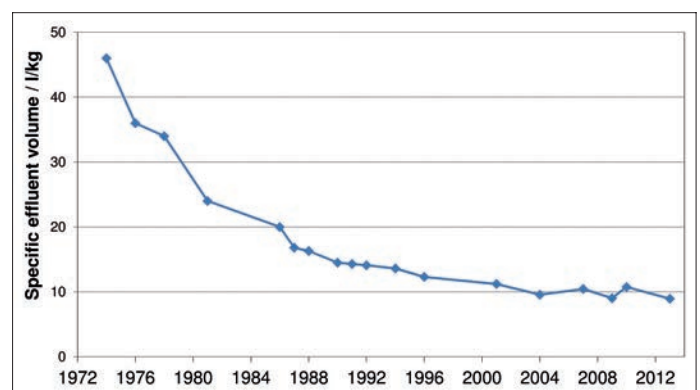


Fig. 1: Averaged specific effluent volume in the German paper industry¹

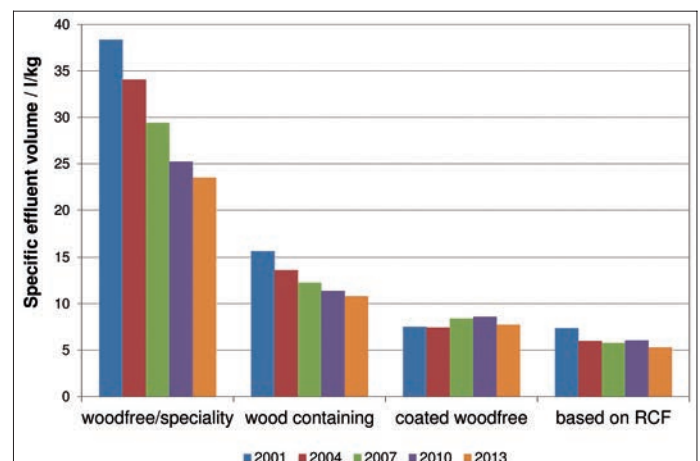


Fig. 2: Grade specific effluent volume in the German paper industry¹

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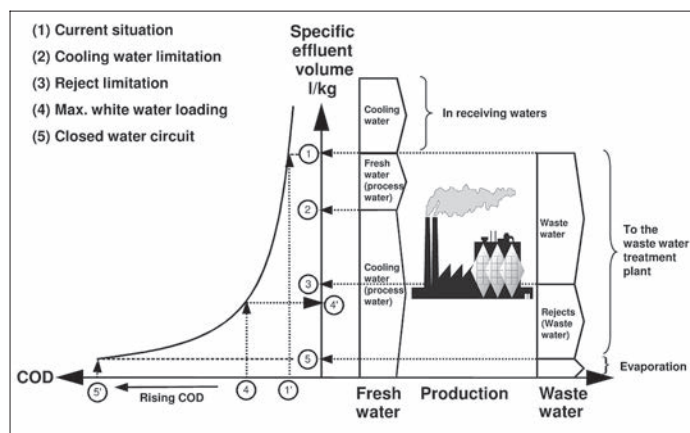


Fig. 3: Limits in reducing the specific effluent volume ²

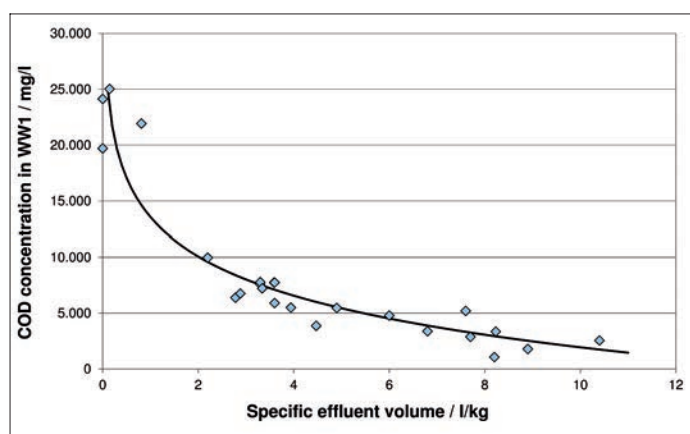


Fig. 4: Chemical oxygen demand (COD) concentration in white water 1 of European paper mills producing corrugated base paper as a function of the specific effluent volume ²

The consumption levels can vary from mill to mill because of both general and process-related reasons such as raw materials used, paper grades produced, and plant structure. Furthermore, local boundary conditions, such as requirements on waste water discharge, have an impact on the consumption level. High specific effluent volumes occur particularly in the production of specialty paper grades (Fig. 2). These mills are often faced with structural handicaps that cause increased specific effluent volumes: small paper machines, low production rates, frequent grade changes, and often very high quality requirements on the final product. The lowest water requirements can be found in mills that produce packaging papers, such as corrugated base paper or board. Some of these mills have already managed to close their water circuits completely, resulting in a zero effluent production.

Fresh water use

Depending on the availability and local conditions, either surface water or ground water is used as fresh water for the process. Drinking water is normally only used for certain purposes, such as trim squirts. In the German paper industry, roughly 70 % of the fresh water is taken from surface waters ¹. In state-of-the-art mills, there are only few fresh water consumers. In view of the limited fresh water volume available, it must be used efficiently. Hence, fresh water used for cooling purposes should be collected and reused as warm water in the process. Typically, the highest share (approx. 40–50 %) of the entire fresh water volume is used for high and low pressure showers in the wire and press section. Other fresh water consumers are for example sealing water for liquid-ring vacuum pumps and packing glands, and the make-up of additives. Process water should be used for all other purposes, such as stock dilution, consistency control, or cleaning.

Limits of water saving

When reducing the specific effluent volume some typical limits have to be considered (Fig. 3): the fresh water volume that is used for cooling prior to its final use (2), the water volume that is discharged with the rejects (3) and the maximum COD value that the product can tolerate in the white water (4).

In a selected circuit, this value also corresponds to a minimum effluent volume for the system concerned. The above-mentioned limits differ in every individual system. The factors that influence these limits include the existing plant technology, raw materials used, and paper grades produced.

Low specific effluent volumes result in growing system loads in process waters in terms of dissolved and colloidal materials (Fig. 4) that can cause severe losses in quality and productivity. This situation is aggravated by the use of paper for recycling as raw material.

If the specific effluent volume is to be reduced successfully, the impact of such measures on the papermaking process must also be taken into consideration. Loop separation and counter current arrangement enable the paper mills to reduce the transfer of detrimental substances coming from highly loaded loops (e.g. stock preparation) into subsequent process steps, thus relieving the paper machine loop.

Although, the increasing closure of water loops involves many problems, it is bound to be part of the paper industry's future development. Only if the goal of preventing effluent production and the goal of reliable production and satisfactory product quality are reconciled can the narrowing and ultimate closure of water circuits become reality.

Milestones in water reuse

Several paper mills producing packaging grades from paper for recycling run their processes in a closed water circuit. However, a further reduction in effluent volume is often prevented by the above mentioned enrichment of detrimental substances and its consequences. To further decrease the water demand in the paper industry it is necessary to overcome the current obstacles (e.g. scaling and fouling) to the implementation of advanced water treatment technologies enabling the mills to reduce the amount of dissolved substances in the process water.

Smurfit Kappa Zülpich Papier GmbH, Zülpich/Germany, has pioneered the biological treatment of process water in a closed water circuit. Forced by increasing amounts of odorous compounds in its water loops, the company decided to install an integrated biological treatment plant consisting of an anaerobic and an aerobic stage in the 1990's. Several other installations followed. This example shows also how much effort it takes to achieve circuit closure.

But there are also more recent examples of a successful further reduction in effluent volume. Membrane treatment is evolving into a key technology as it is enabling the mills to reduce also the inorganic load. The world's first installation of a membrane bioreactor with subsequent reverse osmosis in a paper mill can be found at Koehler Pappen, a cardboard mill in Germany.

Holmen Paper uses a combination of membrane technology and UV disinfection at its mill in Madrid for the final treatment of municipal waste water which is replacing the complete fresh water volume used in the papermaking process. Besides these examples there are several further uses of membrane technology in the paper industry opening up a huge field of applications.

Waste water treatment

Most mills are unable to produce in a closed water circuit. Normally, the arising wastewater is nowadays treated fully biologically in on-site or municipal waste water treatment plants. In Germany more than 90% of the paper is produced in mills treating their waste water in a biological waste water treatment plant (Fig. 5).

The paper industry uses a variety of effluent treatment systems. The preferred process combination for each individual case depends on the grade-specific quality of the effluent that is to be treated. Experience shows that multistage processes based on aerobic–aerobic or anaerobic–aerobic principles enable a significantly more reliable operation of the plant.

Future challenges

The pressure on the paper industry to further narrow its water circuits has increased significantly during the past decades, although approx. 90% of the mill's water intake is returned to its source. Growing attention to water scarcity and pollution results in new legislative directives, forcing industries to reduce their water use and pollution, and motivating them to implement innovations and carefully observe the impact of measures.

Since the technologies of the past can no longer meet the requirements of the future, saving fresh water or lowering the organic loads of effluents requires the increasing use of innovative internal and/or external treatment technologies and concepts (Fig. 6).

Initiated by the Confederation of European Paper Industries (CEPI) the goal of an 80% reduction in CO₂ emissions has been set within the so-called "Roadmap 2050". Water management and waste water treatment have to contribute to achieving this goal. Hence, the paper industry is faced with great challenges and has to perform the balancing act of safeguarding the day-to-day business whilst making a big step forward.

Outlook – future options

Why is waste water treatment always associated with costs? Waste water is more than water. It contains an appreciable amount of energy – chemically bound and thermal. Heat recovery and anaerobic treatment are first steps towards an energetically self-sufficient waste water treatment. Exploiting the potential energy – caused by differences in vertical height – for power production can furthermore be an option for some mills.

However, that is not enough: low-energy processes like the use of algae are in development and waiting for implementation, respectively. One future option could be the power production from waste water by means of microbial fuel cells.

Reclaiming valuable materials from effluents is a further challenge to ensure the future of the paper industry. Besides for water treatment, membrane processes can also be used for reclaiming valuable materials from effluents. Several different processes are currently under development. But most of their technological and economic benefits have yet to be studied.

Important developments are needed to improve the reliability of the treatment technologies and their adaptation to the mill's specific process conditions; first attempts have already been made.

Further resource saving options might be tapped by using industrial symbiosis, by integrating of the urban surroundings and by establishing biorefinery pathways. On the way to integrated paper production sites, obstacles like communication problems have to be overcome, and paradigm changes and substantial R&D work must be performed. But the

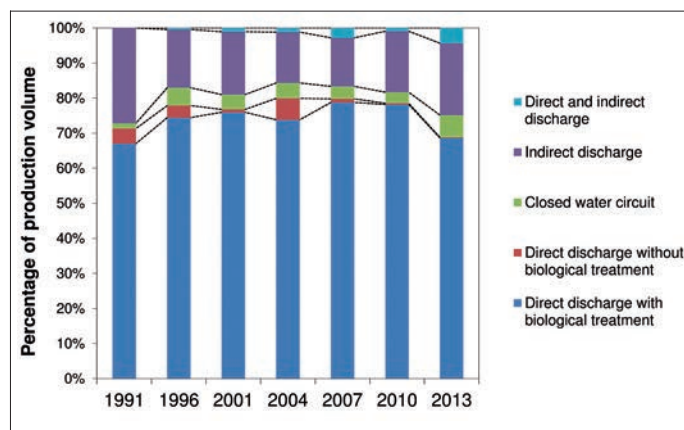


Fig. 5: Waste water discharge in the German paper industry in relation to production volume ¹

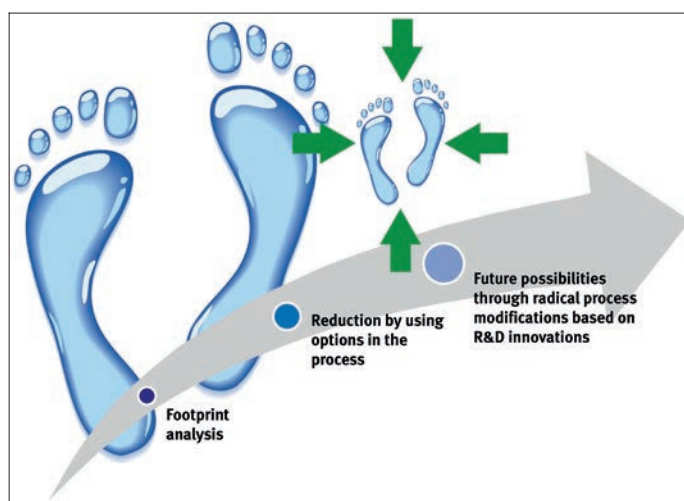


Fig. 6: The road towards resource efficient and sustainable processes in the paper industry

opportunities are striking: industrial symbiosis and biorefinery concepts can save a great deal of costs and open up new markets. Pulp and paper mills are perfectly qualified to play a key role in this bio-based economy. A vision for the future of waste water treatment is a process integrated biological reactor which produces energy and valuable by-products whilst cleaning the waste water and is therefore a big step forward towards achieving the CEPI roadmap goals.

Partner on the way to sustainable water management

The shortage of resources results in high costs. In addition, there is great societal pressure to act in a sustainable manner. Stewardship of available water enables paper mills to increase their production. As an internationally linked research center, PTS (Papiertechnische Stiftung – Paper Technology Foundation), Munich/Germany, is the ideal partner for companies wishing to achieve sustainable water management. Its research objectives are tuned to the needs of industry who take an active role in planning and conducting the projects.

Together with its customers, PTS develops environmentally-friendly, sustainable products and processes. PTS assists its customers with operative tasks of their daily business – neutrally and confidentially. This includes the fast and reliable identification of problem causes as well as the development of effective countermeasures.

References

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