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WATER AND SEWAGE MANAGEMENT
IN THE PAPER INDUSTRYGOSPODARKA WODNO-ŚCIEKOWA
W PRZEMYŚLE PAPIERNICZYM

Abstract

The paper industry products are materials formed as a result of a complex series of consecutive processes, which makes this industry branch a very specific and professional. In order to reduce the consumption of excessive amounts of water in papermaking processes, closed circuit water systems are used. An example of a vibrant paper mill is a Paper and Cardboard Factory BESKIDY. The paper factory is supplied with tap and well water, which covers the largest part of water demand. Excess water called as post-production circulation water, is directed to the Factory Sewage Treatment Plant. The process of purification of industrial sewage in Factory of Paper and Cardboard BESKIDY meets the requirements of the Polish Regulation of the Minister of Construction (Journal of Laws of the Republic of Poland of 2006 No.136 item 964), which means waste water – sewage management is properly carried out.

Keywords: pulp and paper industry, Sewage Treatment Plant, hydropulper device

Streszczenie

Produkty przemysłu papierniczego są uzyskiwane jako rezultat kompleksowej serii następujących po sobie kolejno procesów, co czyni z tej gałęzi przemysłu bardzo wąską i specyficzną branżę. W odpowiedzi na potrzebę zmniejszenia zapotrzebowania na wodę w procesie produkcji papieru, wykorzystuje się zamknięty obieg wody. Przykładem zakładu papierniczego jest Fabryka Papieru i Tektury BESKIDY. Obiekt jest zasilany wodą wodociągową oraz wodą studzienną, które pokrywają największą część zapotrzebowania na wodę. Nadwyżka poprodukcyjna wody obiegowanej jest przekierowywana do zakładowej oczyszczalni ścieków. Proces oczyszczania wody spełnia wymagania Rozporządzenia Ministra Budownictwa (Dz. U. 2006.Nr 136, poz. 964), co wskazuje na poprawnie przeprowadzony proces oczyszczania ścieków.

Słowa kluczowe: papier i przemysł papierniczy, oczyszczalnia ścieków, hydropulper

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1. The technological process of paper production

The paper products are materials used every day. Hardly anyone thinks about how great their amounts are consumed in the world, or even in Poland. Those products arise as a result of a complex series of consecutive processes, which makes the industry very specific and professional.

The basic technological processes used in the manufacture of paper products are as follows [1]:

- preparation and grinding of fiber mass,
- preparation of paper pulp,
- forming a paper web,
- compression of paper web,
- drying the paper web,
- finish paper web.

The *processes of preparation and grinding* of the pulp have to process the fiber into a water formed of predetermined concentration. Grinding serves to confer a suitable length and fiber flexibility.

Paper pulp preparation procedure provides for an adequate fiber mass in conjunction with chemicals that after the “mixing, dilution, sorting, cleaning and venting” [1] is directed to the paper making machine.

Forming a paper web of the pulp processing is assumed to form a paper web having certain structural characteristics and dryness.

Compression of paper web leads to partial drying of the paper web and obtaining its smoothness.

Drying the paper web is the post-drying elimination of the aqueous residue from earlier process, and hardening the paper.

The last process, which provides to finish the paper web production includes cooling, optimum moisture, smoothing, followed by winding the paper on a drum, and in a later stage cutting the paper web into the appropriate sizes and packing.

A very important “raw material” in the paper industry is water. It acts as both a basic component of the pulp and is used in technological and operational processes on a paper machine. The problem of water consumption in paper making processes has become an important aspect both environmentally and financial. In order to reduce the consumption of excessive amounts of water, it is used in closed circuit systems. According to Stępień [2], it allows to save up to 80% of the raw water. However, this requires pretreatment of the water in the system. The aim is to recover the raw material supplied in the form of fibers and water for reuse. The most commonly used device that the purification process is carried out within a short time is: flotation, pressure filters, centrifuges and clarifiers.

Similar solutions are offered by K. Imhoff and K.R. Imhoff [3], closing the process of water cycle in paper production system, which limited the consumption of fresh water. Imhoff [3], closing the process water system, limited the consumption of fresh water. Closed circuit also helps in the recovery of cellulose fibers, which can be reused for the production of paper products. K. Imhoff and K.R. Imhoff also propose to neutralize the colloidal suspension by adding e.g. ferrous sulfate.

Closed circuit may also affect the production cycle negatively. As noted by K. Olejnik and K. Kosińska [6] in the initial stage negative effects of the use of the same water again are

not observed. Only after reaching the limit of water consumption per unit of production in the long term, it may result as impaired recycling production processes.

We must remember that outside the water within the circulation as well as water discharges to the sewage treatment plant, technological circuits provide the loss of large amounts of water to evaporation. Despite the developed techniques, the recovery at the present time is not viable [8].

2. Water circulation in the Factory of Paper and Paperboard BESKIDY

An example of an industrial plant specializing in the production of paper products is Factory of Paper and Cardboard BESKIDY. It is the leading European manufacturer of recycled paper towel, ZZ type towel, cardboard fiber textile and cardboard protection floor. Due to the range of offered products, as well as various requirements of process water, the water system in the Factory BESKIDY is supplied in two ways. The basic unit of water supply are water wells.

In addition, in the event of loss of well capacity the water demand is covered with municipal water. Most of the water is recovered, in a closed circuit system technology.

Closed circuit is very beneficial for economic and environmental reasons. The plant significantly reduces water consumption. About 75% of post technological water is recycled, while the remaining 25% of the demand is supplied from external sources.

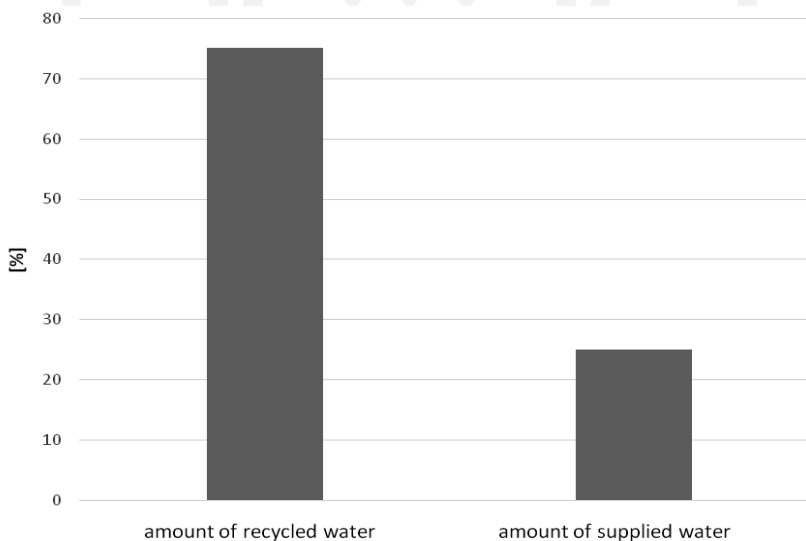


Fig. 1. Scheme amount of water used in the manufacture of paper towel

The technological process of Factory BESKIDY can be divided into two smaller ones. One is responsible for the series production of tissue paper (Fig. 1), while the second is a series of cardboard (Fig. 2).

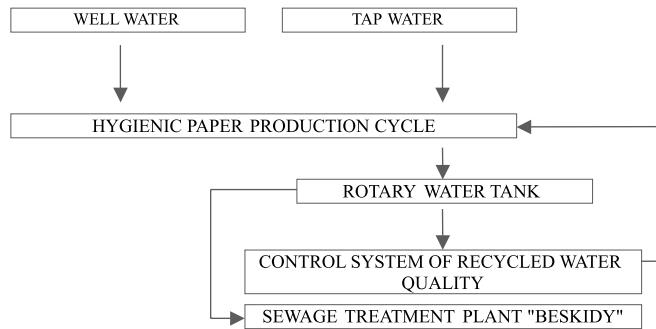


Fig. 2. Technological scheme of the water used in the manufacture of paper towel

Process water used in the production of paper towel is derived from two sources. The first one is Wadowice Water Supply System, while the second is a factory's deep well. Tap water is used rarely, usually during maintenance and pump failure in a deep well. Well water is added to the paper, which after passing through the device that separates impurities (e.g. sand traps, sorters pressure), directs to the infusion of the paper machine, where the pulp is separated from water using a sieve. This is the first water circuit, in which, after a cleaning cycle in a battery of hydrocyclones and flotation units, water goes back to the production cycle. Well water is also used for maintenance process of a machine (rinsing screen, needle nozzle and fan). Excess water is discharged to Sewage Treatment Plant of BESKIDY Factory.

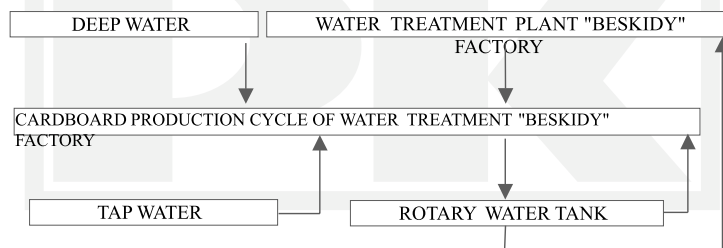


Fig. 3. Technological scheme of water used to produce cardboard

Process water used for the manufacture of cardboard (Fig. 2) is the water coming from the well as along with water pretreated in the Sewage Treatment Plant belonging to the factory.

In the little part of the process, water is used from the Water Supply System. The dominant part of the water used in the production of cardboard comes from industrial wastewater. It is directed to the hydropulper where the raw material is mixed to form a homogeneous steady mass. It is purified on the Rawk's then goes to a screen, where water is separated from the mass. Water drained in a screen is transported to the water tank rotator, where is directed to the hydropulper, and the surplus to the treatment of the factory.

3. Quality of recycled water from pretreated wastewater

“Waste product” is an excess of water from manufacturing processes in paper industry. Its various characteristics require a suitable cleaning process. The results of analysis are presented in Table 1.

Table 1

Qualitative characteristics of the effluents in the Paper and Cardboard Factory BESKIDY with values of Polish Regulation of the Minister of Construction (Journal of Laws of the Republic of Poland of 2006 No. 136 item 964), Source: Paper and Cardboard Factory BESKIDY

Factor	Unit	The value of the factor PCF BESKIDY	J.L. 2006, No. 136, it. 964
pH	[-]	7.3	6.5–9.5
BOT5	[mg O ₂ ·dm ⁻³]	180	700
COD (Cr)	[mg·dm ⁻³ O ₂]	772	1000
ammonium	[mg·dm ⁻³ N]	0.093	200
nitrite nitrogen	[mg N·dm ⁻³]	<0.006	10
suspended o.	[mg·dm ⁻³]	260	500
volatile phenols	[mg·dm ⁻³]	0.012	15
chrome	[mg·dm ⁻³]	0.037	1
chrome (VI)	[mg·dm ⁻³]	0.03	0.2
zinc	[mg·dm ⁻³]	0.14	5
cobalt	[mg·dm ⁻³]	0.0076	1
copper	[mg·dm ⁻³]	0.013	1
lead	[mg·dm ⁻³]	0.0097	1
trichloromethane	[μg·dm ⁻³]	<0.4	1
tetrachloromethane	[μg·dm ⁻³]	<0.4	1.5
index of mineral oil	[μg·dm ⁻³]	0.4	15

The values of qualitative characteristics of waste water obtained from analysis were compared with the guidance of the Polish Regulation of the Minister of Construction (Journal of Laws of the Republic of Poland of 2006 No.136, item 964). The results comply requirements of law regulation therefore were considered as correct.

4. Wastewater treatment plant in Paper and Cardboard Factory BESKIDY

Excess post-technological water of the production of paper and cardboard is directed to internal Wastewater Treatment Plant. At first the industrial “waste water” goes to the lattice. Continuing with the pump P1 it passes through the screen arc, and then is directed to the trap. It is discharged into the reservoir by P2 pumping station and then to the bioreactors. Waste water pretreated in bioreactors is stored in a buffer tank. Next, wastewater is supported by a series of technological processes. At the end of waste water treatment process, excess of post technological water is discharged to the municipal treatment plant.

5. Water consumption in the Factory of Paper and Paperboard BESKIDY

Table 2

Water demand in the Paper and Paperboard Factory BESKIDY Source: PCF BESKIDY

Month	WATER DEMAND FOR THE PRODUCTION in the year 2012			
	Well water		Municipal water	
	m ³			
	cardboard	toilet paper	cardboard	toilet paper
I	5357	6264	122	1786
II	2692	9843	53	645
III	7794	5423	239	732
IV	9175	8505	146	2
V	10975	7282	58	117
VI	22	7770	31	136
VII	4748	6813	53	176
VIII	5926	7872	75	108
IX	8424	6800	42	50
X	150	8251	38	315
XI	7257	6826	50	276
XII	3673	8505	47	25
Total	66193	90154	954	4368

From the data presented in Table 2 it is clear that higher water demand in annual summary is a characteristics of a technological cycle for paper towel. Production of cardboard: in

most cases the annual total has a lower consumption, both for well water and water from the municipal system. Apparent is the dominance of well water in the water management of factory.

6. Conclusions

Sewage water mills management require recirculation of water. Closed circuit and the repeated use of the same volume of water, significantly affect the ecological aspect of water treatment process. Well water sources militate in favor of economic considerations that provides strategic solutions for the production cycle of Paper and Cardboard Factory BESKIDY. The process of purification of industrial sewage in CPF BESKIDY conform the needs of Polish Regulation of the Minister of Construction (Journal of Laws of the Republic of Poland of 2006 No.136, item 964), which indicates a properly conducted waste water – sewage management.

Reference

- [1] Przybysz P., *Outline of the paper-making process*, Publisher Progress, Łódź 2011.
- [2] Stępień J. (ed.), *The chemical industry*, [in:] *Water and wastewater management in industrial plants*, Arkady Publishing, Warsaw 1973.
- [3] Imhoff K.&K.R., *Kanalizacja i oczyszczanie ścieków*, Wydawnictwo Arkady, Warszawa 1982 (City sewer and wastewater treatment, Arkady Publishing, Warsaw 1982).
- [4] Regulation of the Minister of Construction 14 July 2006 the obligations of industrial waste and the conditions for discharging wastewater into the sewage system Dz. U. 2006 No. 136, item 964.
- [5] <http://beskidy-wadowice.pl/>
- [6] Olejnik K., Kosińska K., *Wpływ jednostkowego zużycia wody świeżej w procesie roz-włókniania i mielenia na ilość substancji stałych i rozpuszczonych w wodzie technolo-gicznej*, Wydawnictwo SIGMA-NOT Sp. z o.o., Przegląd Papierniczy 67, Warszawa, lipiec 2011.
- [7] Effect of the specific consumption of fresh water in the reffining and grinding processes on amount of soil and dissolved substances in process water, SIGMA-NOT Publishing, Warsaw 2011, Paper Review No. 67, July 2011.
- [8] Michniewicz M., *Najlepsze dostępne techniki (BAT). Wytyczne dla branży celulozowo-papierniczej*, Ministerstwo Środowiska, Warszawa, sierpień 2005.
- [9] Best Available Techniques (BAT) – Guidance for Paper Industry, Ministry of Environment, Warsaw, August 2005.

