Sustainable Production: Treatment to Avoid Water Contamination by the Paper Mill in Uruguay

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***Abstract*—The UPM mill is designed to produce pulp from eucalyptus wood and is estimated to produce up to 2.1 million tons per year. This implies a great risk to the environment as the wastewater flows through the rivers. The solution we propose consists of wastewater treatment and we note that with proper treatment, river pollution can be significantly reduced.**

***Keywords:* paper mill, pulping process, wastewater, water recycling.**

***Resumen*— La fábrica UPM está diseñada para producir pasta de papel a partir de madera de eucalipto y se calcula que producirá hasta 2,1 millones de toneladas al año. Esto implica un gran riesgo para el medio ambiente, ya que las aguas residuales fluyen por los ríos. La solución que proponemos consiste en el tratamiento de las aguas residuales y observamos que, con un tratamiento adecuado, se puede reducir considerablemente la contaminación de los ríos.**

***Palabras clave*: papelera, proceso de celulosa, aguas residuales, reciclaje de agua.**

I. Introduction

The new United Paper Mills (UPM) plant is a leading Finnish company in the forest and forest products industry. Founded in 1996, it is dedicated to the production of pulp, paper, and related products.

In the specific case of Uruguay, UPM already operates a plant in the city of Fray Bentos since 2007. This plant is one of the main producers of pulp in the region and has generated significant impacts in terms of employment and economic development in the area. The new plant is located in Paso de los Toros, Uruguay, expanding UPM's presence in the country.

It is important to highlight that the plant is situated on the coast of the Rio Uruguay, which has raised concerns and controversy due to potential environmental risks associated with its construction and operation.

The operation of the new paper mill can be approached in the context of the United Nations Sustainable Development Goals (SDGs)[1]. Relevant SDGs will be analyzed, such as SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Production and Consumption), SDG 13 (Climate Action), and SDG 15 (Life on Land), to establish the foundations of our approach.

The purpose of this work is to address the challenge of environmental care in the operation of the new United Paper Mills (UPM) plant. Different proposals and concrete actions will be presented to contribute to achieving this objective, demonstrating that it is possible to achieve a sustainable and responsible operation of the UPM plant in Uruguay, and laying the groundwork for balanced and environmentally respectful industrial development.

This project is organized in three parts:
First, there is a brief introduction of the subject to be addressed and the environmental impactecond, the characteristics of the factory are described and the environmental problem generated by the paper mills is developed. Finally, the solution chosen to reduce pollution in the rivers is presented.

II. UPM risk to the environment

The Observatory of Multinationals in Latin America (OMAL) issued a report in which it stated that there will be contamination "even if emission levels are kept within the limits that they themselves set". "The accumulation of pollutants will transform the region with severe losses in the quality of life, depreciation of land and economic ventures, and deterioration of the health of the region's inhabitants," they detailed.[2]

UPM's mill is designed to produce pulp from eucalyptus wood and is estimated to produce up to 2.1 million tons per year, which implies the clearing of large areas of forest to supply its operation. In addition, the pulp production process generates various types of waste and polluting emissions that can affect the quality of the air, water, and soil in the area.

This implies a great risk to the environment since the effluents will flow through the Rio Negro and into the Rio Uruguay, in front of the fishing area of Entre Ríos in Costa Uruguay Sur.

III. Problem Approach

Taking into account the characteristics of Botnia, which has been in operation since 2007, we can have an approximate idea of what the new plant, called Botnia II, will be able to generate.

In one year of production, the plant operates 24 hours a day, from 340 to 350 days a year. In the case of Botnia Fray Bentos SA, 1,000,000 tons of paper per year are produced, at a rate of approximately 3,000-3,100 tons per day, so the new plant, by producing more than twice as much, will generate approximately 6,100-6,500 tons per day.

According to the report published in 2018 by the chemical engineer Elias Jorge Matta, there is a table summarizing the main data collected in the effluent of the pulp mill.

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Compound	Unit	Mean Value	Group
T. Sulfur	Kg/day	33,211.1	
AOX	Kg/day	147.5	
Phenolic S. (as Phenol)	Kg/day	0.1	
Total P	Kg/day	45.8	Group A
Total N	Kg/day	109.7	
Ca	Kg/day	10,973.1	
Chlorate	Kg/day	42.6	
Oils and fats	Kg/day	299.7	
As	Kg/day	0.159	
Cd	Kg/day	0.008	
Cu	Kg/day	0.269	
T. Cr	Kg/day	0.901	
Hg	Kg/day	0.002	Group B
Ni	Kg/day	2.829	
Pb	Kg/day	0.032	
Zn	Kg/day	0.520	
Al	Kg/day	15.730	
Mn	Kg/day	12.023	
TCDD	µg/day	48.4	
TEQ TCDF	µg/day	7.1	
PeCDD	µg/day	108.5	
HxCDD	µg/day	90.4	
HpCDD	µg/day	158.7	Group C
OCDD	µg/day	268.7	
PeCDF	µg/day	99.7	
HxCDF	µg/day	127.5	
HpCDF	µg/day	142.8	
OCDF	µg/day	188.6	

Group A: Process Compounds. AOX and Phenolic are typical of Bleaching. Total N, NH3 and total P, mainly originated in Secondary Treatment, but partly in Digestion and Chemical Recovery. Sulfur, Sulfides and Ca come from Washing and Chemical Recovery. Chlorates come from Chemical Preparation Area. Oils and fats come from every place in the mill, but some from dissolved wood.

Group B: Main Heavy Metals. Most of them come as traces with the chemical supply, although some metals are part of the dissolved wood. All are persistent and bio-cumulative

Group C: Dioxins, Furans and Dioxins-like compounds of very high toxicity. In this particular case, all compounds of this Table set are originated in Bleaching.

Total Group A	Kg/day	44,830
Total Group B	Kg/day	32
Total Group A+B	Kg/day	44,862
	t/year	15,926
Total Group C	µg/day	1,232
	µg/year	437,489

[3]Summary of main data collected at pulp mill effluent (see online version for colours)

Based on the data published in the table, we can see the large amount of toxic components that are disposed of in the river. All these components are used for the bleaching process of eucalyptus pulp, so they have a great importance during the pulping process.

A Research conducted by the Department of Microbiology in India and the Faculty of Life Sciences and Food Engineering in China [4], which deals with wastewater from paper mills and its contamination in the aquatic ecosystem, claims that these mills generate a high level of organometallic pollutants during the process of wood digestion and pulp manufacturing. This produces negative impacts on the morphological and physiological characteristics of flora and fauna.

Mutagenic, endocrine disrupting and carcinogenic properties were observed in some of the organometallic contaminants detected, making pulp mill wastewater highly toxic and unsuitable for the aquatic environment and human health.

IV. Water recycling process

A water recycling process will be implemented to reduce the pollution generated by wastewater discharge into the rivers. This process consists of 5 stages, as follows:[5][6]

1. Water collection and storage process: Water used in various stages of the production process is collected and stored for subsequent treatment and recycling.
2. Recycled Water Treatment: Recycled water often undergoes treatment processes that may include filtration, sedimentation, coagulation, flocculation and disinfection to remove suspended solids and microorganisms.
3. Mixture with Fresh Water: Treated recycled water is blended with fresh water in controlled proportions to maintain water quality at appropriate levels.
4. Reuse Process: Treated recycled water is reintroduced into the production process, where it is used in various stages, such as pulp preparation, sheeting and other processes.
5. Control and Monitoring: Control and monitoring systems are implemented to supervise the quality of the recycled water and ensure that it meets the standards required for the process.

In order to carry out the stages of the process it will be necessary to have different machinery and elements, these are:

- Water Storage Systems: Tanks and basins are used to store recycled water and fresh water prior to use.
- Water Treatment Units: These units include filtration equipment, clarification systems, chemical dosing and disinfection devices.
- Pumping Systems: Pumps are used to move water from storage tanks to points of use in the production process.
- Automated Control Systems: Automated control systems are implemented to regulate the mixture of recycled water and fresh water according to the needs of the process.
- Measurement and Analysis Systems: Measurement and analysis equipment is used to monitor key water parameters such as contaminant concentration and quality.

A. advantages and disadvantages

We will now present the advantages and disadvantages of implementing our adopted solution.

Some advantages of this method will be mentioned and enumerated according to the area they are connected with:

- Environmental Protection: Wastewater treatment significantly reduces water pollution, which benefits aquatic ecosystems and biodiversity.
- Regulatory Compliance: Paper mills must comply with strict environmental regulations related to water quality. Proper treatment helps to meet these legal requirements and avoid penalties.
- Water Recycling: Some paper mills recycle part of the treated water and reuse it in the production process, saving resources and costs associated with fresh water supply.
- Odor and Waste Reduction: Proper treatment can help reduce or eliminate unpleasant odors and toxic sludge, improving the quality of life in communities near the paper mill.
- Sustainability: Wastewater treatment is an important part of the paper industry's sustainability strategy, which can improve the company's image and reputation.

Some of the disadvantages of this method are listed below:

- Operating Costs: The implementation and operation of wastewater treatment systems can be costly due to the investment in equipment and energy required for the process.
- Sludge Waste: The treatment process produces waste sludge that requires proper disposal, which can be challenging and costly in itself.
- Maintenance Requirements: Wastewater treatment systems require regular maintenance to ensure their effectiveness and efficiency.

- Energy Consumption: Some treatment processes, such as aeration in activated sludge systems, can consume a significant amount of energy.
- Impact on Production: At times, the implementation of wastewater treatment systems can affect the efficiency of paper production and require process adjustments.

Successful implementation of water recycling requires efficient treatment systems and cooperation with water treatment experts. Water recycling reduces the demand for fresh water and minimizes the discharge of contaminated effluent into the environment.

V. Conclusion

In conclusion, we note that with proper wastewater treatment, river pollution can be significantly reduced since the treated water would be reused for production, avoiding direct discharge into the river and using a much lower percentage of freshwater.

Although the disadvantages, wastewater treatment in paper mills is essential to protect the environment and maintain the long-term viability of the industry. Many of the disadvantages can be mitigated through the adoption of more efficient technologies and effective resource management.

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