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Environmental Compliance through the Implementation of Effluent Treatment Plant at a Company in the Cosmetics Sector

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Abstract: The current water crisis is a governmental and a third sector reason for concern. The government tends to intensify its regulatory power mainly on companies that use water as raw material and generate wastewater from the production process. The search for loss reduction on consumption and water treatment alternatives and reuse has been of increasing importance in the cosmetics sector. Thus, a case study was conducted with the aims of evaluating the environmental and economic benefits of the adoption of wastewater and water treatment plant to a cosmetics company and analyzing environmental compliance regarding water quality for release into the environment after the treatment process. The results indicate feasible economic gain from investment and operation costs with the adoption of a wastewater treatment plant. Additionally, environmental compliance regarding the existing regulations due to reduction of the environmental impact was recognized. Therefore, the cosmetics industry company must implement the wastewater treatment plant to avoid legal penalties and also be capable to operate it.

Keywords: membrane separation process; wastewater treatment plant; economic and environmental feasibility

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1. Introduction

Environmental issues have become increasingly critical and frequent, mainly due to population growth and increased industrial activity. This degradation scenario can be seen by changes in the quality of soil, air and water [1–3].

In particular, contamination of natural water has received greater attention from modern society. In response to this problem, authorities have taken actions through laws and regulations to reduce water consumption; thus, water saving in production processes has gained special attention because of the value that has been assigned to the asset through principles, such as paying consumers and recently incorporated in our legislation, polluter pays [4–7].

However, the effluent treatment techniques used in Brazil are old and inefficient due to the importation of technologies that were optimized for companies located in countries with a non-tropical climate. In general, aerobic or anaerobic bioreactors are the most used technologies. However, in the last decade, technologies such as membrane separation processes and advanced oxidative processes have been tested, as they are very efficient in eliminating contaminating substances from water [5,6].

In this context, the implementation of an industrial wastewater treatment plant for reuse can provide economic and environmental gains, as already demonstrated in [4–7]. Therefore, this work aims to evaluate the environmental and economic gain from the adoption of a wastewater and water treatment plant for a cosmetics company and analyze the environmental compliance with respect to water quality for release into the environment after the treatment process. In this case study, a company installed a kit of microfiltration membranes that are applied at the end of the treatment of its effluents. After the traditional treatments with bioreactors, the effluents passed through a system of filtering membranes and the quality of the permeated effluent was evaluated in relation to Brazilian environmental standards [8–10].

2. Background

2.1. Wastewater Treatment Implementation as a Practice of Cleaner Production

In this section the importance of wastewater treatment implementation in the manufacturing plant will be reported, showing a practice of cleaner production to minimize pollution.

Cleaner production (CP) is the application of the technical, economic and environmental integrated with processes and products in order to increase efficiency in the use of raw materials, water and energy by non-generation, minimization and recycling of generated waste and emissions for environmental, occupational and economic health [1,2,11,12]. According to [13,14], the cleaner production practice has been greatly advocated in the industrial field, including for the sewage treatment process. In this context, the implementation of the wastewater treatment industry of focus on proper disposal in the sewer is intended to improve the quality of the effluent, allowing its reuse, which can be characterized as a CP technique [11–14].

Effluent is classified into two groups: sanitary effluent or sewage, which is derived from water use in cities, and industrial effluent, which is treated according to the physical, chemical and biological characteristics, according to the nature of the pollutants to be removed and/or the unit operations used for the treatment. The ideal process is indicated by the polluting load and the presence of contaminants [5,15]. Thus, the industry that generates the liquid waste that contaminates the effluents needs to implement a wastewater treatment plant on site in order to remove the chemical contaminant elements, among them heavy metals, not to impair the wastewater treatment process, making it possible to minimize water and energy consumption through the application of CP in order to evaluate the economic and environmental benefits [6,15,16].

On the other hand, the adoption of industrial wastewater treatment allows reuse of water at a lower cost in the wastewater treatment process, which contributes to the water crisis regarding the rational use of water [6,15]. Membrane filtration process is one of the most recent techniques to be used in the treatment of effluents and can be defined as a separation process that uses semi-permeable membranes to divide the flow into two portions: retentate or concentrate and permeate in order to separate the solid particles from the water [5,8,16–19].

In São Paulo, according to Brazilian Water Agency (ANA—*Agência Nacional de Águas*) [20], the consumptive use of water was divided as follows: 37% urban, 37% industrial, 22% irrigation, 3% animal and 1% rural use. In addition, 11% of its population in 2008 was not served by sewers and 38% of the volume of sewage collected was untreated, which represents a potential contamination vulnerability for water resources.

Thus, the release of industrial waste and untreated sewage causes water contamination and due to this many countries are developing legislation through public policies with an environmental focus on water scarcity [5,6,15].

2.2. Membrane Separation Process

Three recent separation process are aqueous two-phase system extraction, membrane separation and fluidized bed sorption [8,18,19].

Membrane separation process is an existing alternative among separation processes in recent years. A membrane is defined as a barrier to separate two phases with various chemical species transporting them between phases [8,18,19].

Figure 1 shows the types of membrane separation processes classified according to the pressure range or the pore size of the membrane. As noted, any substance can be separated in an aqueous medium simply by choosing the pore size according to the size of the molecules to be separated. In the membrane separation process, the feed flow containing the target molecules from the process is forced to pass through a highly porous medium (membrane) which separates by molecular size, allowing only molecules smaller in size to pass through the membrane pore. The liquid that passes through the membrane (or filtrate) is called permeate, while the liquid retained by the membrane is the concentrate layer (or cake) [8].

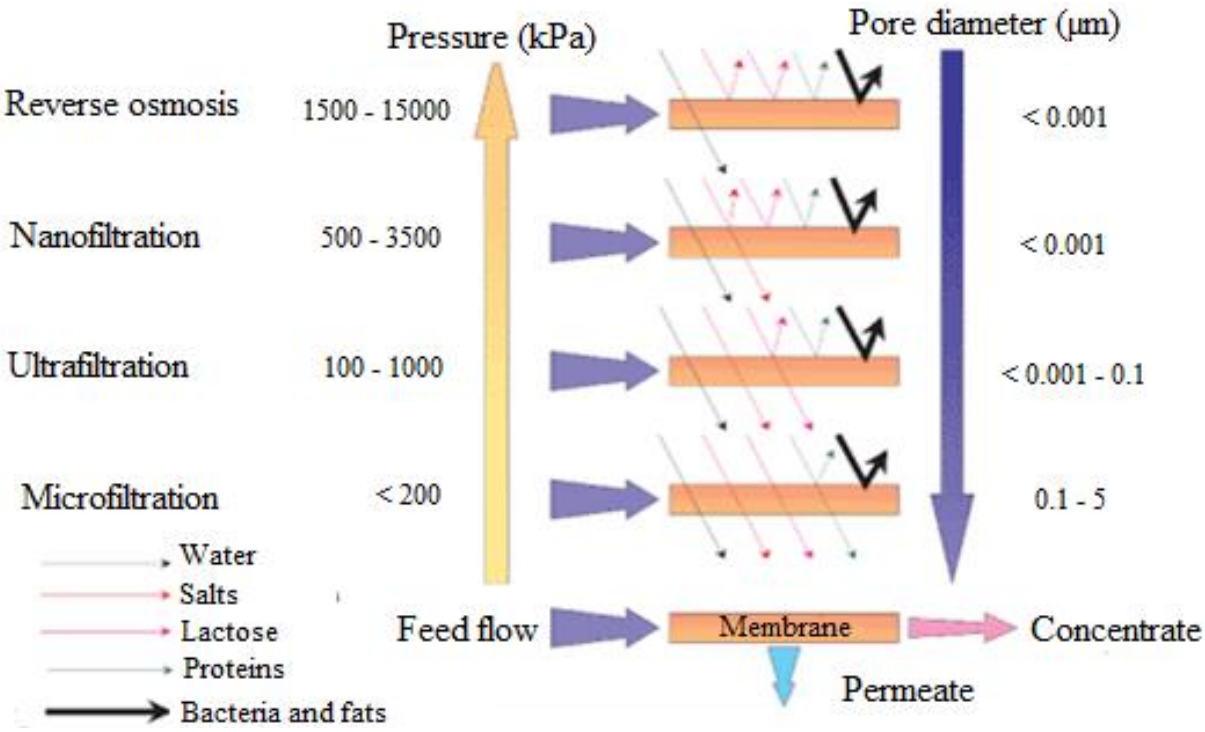

Figure 1. Separation membrane characteristics [18,19].

Processes with membranes become viable at an industrial scale with the adequate choice of membranes for the processing of each determined product. Therefore, its use in effluent treatment has been intensified in recent decades as already shown by [5,8,15].

2.3. Brazilian Environmental Laws about Consumption and Use of Water

Resolution No. 430 of the Brazilian Council for the Environment (*Conselho Nacional do Meio Ambiente*, CONAMA) presents the conditions and standards for the discharge of effluents in its Section 2—Conditions and Standards for Effluent Release. It determines in Article 16 that effluents from any polluting source can only be released directly into the receiving body provided that (a) there is (A) pH between 5 to 9; (B) temperature less than 40 °C; (C) sedimentable materials: up to 1 mL/L in a 1-h test in an Inmhoff cone; (D) discharge system with maximum flow rate of up to 1.5 times the average flow of the daily activity period of the pollutant, except in cases allowed by the competent authority; (E) oils and greases: mineral oils up to 20 mg/L and vegetable oils and animal fats up to 50 mg/L; (F) absence of floating materials; and (b) biochemical oxygen demand (BOD 5 days at 20 °C) with a minimum removal of 60% of BOD, and this limit can only be reduced if there is a self-purification study of the water body that proves meeting the targets of the receptor body [21,22]. Table 1 shows the required standard for effluent discharge.

Table 1. Standard for effluent disposal in sewage [21,22].

Inorganic Parameters	Maximum Values
Total Arsenic	0.5 mg/L As
Total Barium	5.0 mg/L Ba
Total Boron (not applicable for saline water release)	5.0 mg/L B
Total Cadmium	0.2 mg/L Cd
Total Lead	0.5 mg/L Pb
Total Cyanide	1.0 mg/L CN
Free Cyanide (distillable by weak acids)	0.2 mg/L CN
Copper dissolved	1.0 mg/L Cu
Hexavalent Chromium	0.1 mg/L Cr^{+6}
Trivalent Chromium	1.0 mg/L Cr^{+3}
Total Tin	4.0 mg/L Sn
Dissolved Iron	15.0 mg/L Fe
Total Fluoride	10.0 mg/L F
Manganese dissolved	1.0 mg/L Mn
Total Mercury	0.01 mg/L Hg
Total Nickel	2.0 mg/L Ni
Total Ammonia Nitrogen	20.0 mg/L N
Total Silver	0.1 mg/L Ag
Total Selenium	0.30 mg/L Se
Sulfide	1.0 mg/L S
Total Zinc	5.0 mg/L Zn
Organic Parameters	**Maximum Values**
Benzene	1.2 mg/L
Chloroform	1.0 mg/L
Dichloroethene (sum of 1.1 + 1.2cis + 1.2 trans)	1.0 mg/L
Styrene	0.07 mg/L
Ethylbenzene	0.84 mg/L
Total phenols (substances that react with 4-aminoantipyrine)	0.5 mg/L C_6H_5OH
Carbon tetrachloride	1.0 mg/L
Trichloroethene	1.0 mg/L
Toluene	1.2 mg/L
Xylene	1.6 mg/L

The companies that generate liquid waste pollutants must comply with these parameters according to Decree n° 3.179 of 21 September 1999, aiming for the appropriate environmental conduct of the company with risk of penalties stated in Section 3—Sanctions applicable to pollution and other environmental infractions, focusing on Article 41, which determines a fine of BRL 100,000 to BRL 5,000,000,000 for companies that do not comply with the standard established by CONAMA [21,22]. In the first paragraph, a company that causes water pollution is negligent in relation to the discharge of effluents, making an area, urban or rural, unfit for human occupation, including the prohibition of public beach, and especially when the company does not adopt measures of precaution in case of risk of serious or irreversible environmental damage. In the second paragraph, it is stated that fines and other penalties will be applied after a technical report prepared by a competent environmental agency identifies the extent of the damage resulting from the infraction [21,22].

Furthermore, the infringing company may be subject to Law No. 9605 of 12 February 1998, which is associated with the generation of pollution and environmental crimes by companies through Article 54, which provides for control over human health and the mortality of animals or destruction of flora. The penalty consists of imprisonment from one to four years and a fine. In the first paragraph, it is verified if the crime is indicted. If it is, the penalty provides for detention from six months to a year and a fine. It is covered in Section 2 that the company that pollutes water effluents that make an area, urban or rural, unfit for human occupation, including the contamination of beaches for bath, may be penalized with imprisonment of the owner of one to five years. Section 3 incurs the same penalties provided for in the previous paragraph, for those which fail to adopt, when required by the competent authority, precautionary measures in case of risk of serious or irreversible environmental damage [21,22].

Therefore, the implementation of a water treatment station (WTS) and effluents treatment station (ETS) by companies considered to be major consumers of water and generators of sanitary and industrial effluents become an important and obligatory factor for the preservation of the ecosystem.

3. Materials and Methods

This study is classified as of an empirical and exploratory nature, aiming to obtain information about the object of the study. The approach is quantitative since the analyzed variables are expressed in measurable values. The method adopted is the case study, developed for a cosmetics company. The empirical character of a case study stands out in the investigation of contemporary phenomena [13,14,23,24].

Data collection was performed through semi-structured interview and direct observation, appropriate means to obtain the necessary information for the research, both for understanding of the required data collection and for the visualization of the facts and actions related to the researched process. For the calculations of the economic and environmental evaluations Oliveira Neto's methodology [14,25,26] was applied.

In order to evaluate the economic advantage, we used (i) the return on investment (ROI), which represents the return for a given investment in a given period and (ii) the discounted payback, which provides the recovery period for the initial investment made available and updated by the minimum attractiveness rate (MAR) [2,3,7]. All economic parameters were calculated over a ten-year horizon. Equations (1) and (2) show how the return on investment (ROI) and payback were calculated:

$$\text{ROI} = (\text{Annual net income}/\text{realized investment}) \tag{1}$$

$$\text{Payback} = \text{Investment}/\Sigma\text{Profits to investment payment} \tag{2}$$

The evaluation of the environmental advantage was obtained using the methodology for calculating Mass Intensity Factor (MIF) adapted from the Wuppertal Institute [25] using Oliveira Neto's methodology [11–13,23,24]. MIF is calculated by considering the entire life cycle of products and represents the total material input that individuals move or extract from nature for the production of goods and the delivery of services. MIPS is measured in kg per service unit. The calculation of the MIF evaluates the positive or negative impact on the compartments (i) abiotic—the factors that influence living beings, such as light and solar radiation, temperature, wind, water, soil composition, pressure and others; (ii) biotic—representing living beings; (iii) water; and (iv) air [11–13,23,24,27].

The project started in January 2013 and ended in December 2022, so the feasibility calculations were based on data from that time. To measure the savings with water, energy and chemical consumptions, the prices charged by the Basic Sanitation Company of the State of São Paulo (SABESP), National Electricity Entity (ENEL) and the cosmetic company were used as references. According to SABESP [28], water was sold at BRL 24.09/m^3 in 2013 (currently it is BRL 50.00/m^3). According to ENEL [29], energy was sold at BRL 0.194/kWh in 2013. According to the cosmetics company from this case study, the average price of chemical products used in water treatment ($Al_2(SO_4)_3$, CaO, etc.) had an average cost of BRL 707/t in 2013 (dollar exchange rate was USD 1 = BRL 1 in 2013).

The methodology for calculating Mass Intensity Factor (MIF) was adapted from the Wuppertal Institute [25] with Oliveira Neto's methodology [11–13,23,24]. The environmental impact was calculated as follows: (i) the Intensity Factors (IF) described in Table 2; (ii) the Mass Intensity Factors (MIF), according to Equation (3); (iii) the Mass Intensity per Compartment (MIC), according to Equation (4) the sum of the MIF of each compartment is measured; and (iv) Mass Intensity Total (MIT), using Equation (5), measuring the total sum of the compartments.

$$\text{MIF} = \text{M} \times \text{IF} \tag{3}$$

$$MIC = \sum MIF \text{ of each compartment} \quad (4)$$

$$MIT = \sum MIC \quad (5)$$

Table 2. Factor of intensity of the materials involved in the process.

Component	Specification	Abiotic	Biotic	Water	Air
Barium	Approx. Calcium, limo	2.46		11.65	0.09
Boron	Approx. Boric acid	7.61		16.15	1.08
Lead	Primary	18.12		135.8	2.28
Cooper	Primary	348.47		367.16	1.6
Trivalent chromium	Approx. Chrome Iron	21.58		504.86	5.07
Dissolved iron	Approx. Iron Manganese	16.69		193.76	2.23
Total fluoride	Approx. Fluorite	2.93		7.92	0.06
Manganese dissolved	Approx. Iron Manganese	16.69		193.76	2.23
Nickel		141.29		233.34	40.83
Zinc	Electronic	22.18		343	2.28
Total phenols	Approx. Benzene	4.32		28.23	2.19
Electricity	Public network	3.15	0.04	57.64	0.514
Aluminum polychloride	Approx. Aluminum Chloride	8.61		110.63	1.15
Aluminum sulfate	Approx. Aluminum Chloride	8.61		110.63	1.15
Ferric Chlorine Sulphate	Approx. Chlorine	3.84		100.9	1.09
Polymer (acrylamide)	Approx. Aluminum Chloride	8.61		110.63	1.15
Crud limestone	Approx. Calcium, limo	2.46		11.65	0.09
Chlorine		3.84		100.9	1.09
Fluosilicic acid	Approx. Quartz Sand	1.42		1.43	0.03
Potable water		0.01		1.3	0

The economic gain index (ECGI) and environmental gain index (ENGI) were obtained by division of the sum of the total materials saved (MTE) for economic gain (EG) using the following equations:

$$ECGI = MTE/EG \quad (6)$$

$$ENGI = MIT/EG \quad (7)$$

MTE is the total mass of each resource that is not consume in internal processes and consequently, not extracted from nature, processed, delivered, used and depleted.

4. Results and Discussion

4.1. Case Study

The studied company is in the cosmetics manufacturing industry located in the state of São Paulo, Brazil. All water used in the company's facilities goes through the effluent treatment station (ETS) before being returned to the environment within the standards required by Brazilian environmental legislation shown in Table 1. Figure 2 illustrates the company's water cycle, which is initiated in groundwater and followed by treatment at the water treatment station (WTS); distribution through the company's facilities; treatment at the effluent treatment station (ETS); preliminary treatment of industrial effluent; treatment of organic effluents; and reuse of water.

In this stage a survey was conducted to verify the amount of emissions, residues or materials to be reduced or reused in the processes. It should be noted that 55% of the total effluent of the industrial plant, after passing through the membrane separation process (permeate), is reused as reuse water and 45% is returned to nature (river) in accordance with the effluent discharge standards [22].

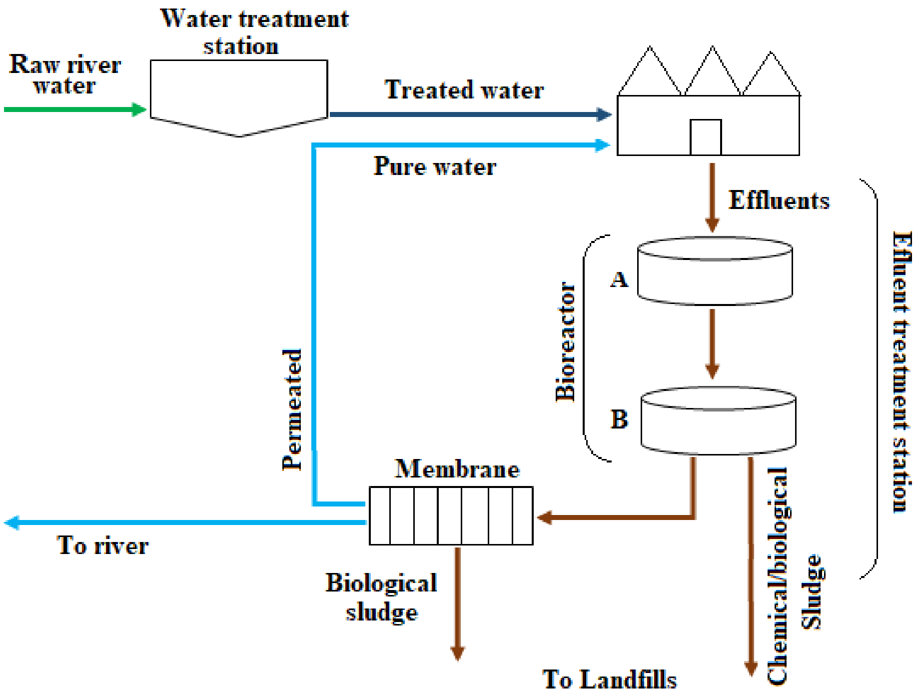

Figure 2. Process of the water cycle of the cosmetics company. Source: Company data.

The WTS of the company surveyed meets the requirements of CONAMA, as shown in Table 3, in addition to reusing water for toilets and remanufacturing of purified water in the production system. The effluent has two closed cycles: the sanitary and industrial effluents, which are sent to be processed in the ETS. Effluent derived from consumption in the company's internal processes were considered as industrial effluents and those generated in external facilities (bathrooms, cleaning, etc.) as sanitary effluents, as classified in [21,22].

Table 3. Comparison between the results of each stage of the effluent treatment process according to the CONAMA standard [21,22].

Analysis	Process Step	Average of Monitoring Analyses					Freshwater Class 2	Effluents/Sewage
		Jan/13	Feb/13	Mar/13	Apr/13	May/13		
pH	Bioreactor A	7.04	7.11	6.85	6.65	6.78	6 a 9	5 a 9
	Bioreactor B	6.98	7.02	6.74	6.52	6.69		
	Sanitary	7.58	7.28	8.39	6.90	6.85		
	Industrial	9.53	10.98	8.63	8.29	9.25		
	Permeate	**7.52**	**7.54**	**7.21**	**7.26**	**7.50**		
OD mg/L O_2	Bioreactor A.	1.15	0.91	1.05	0.70	0.55	>5	
	Bioreactor B	1.25	1.10	1.06	0.87	0.60		
	Permeate	**6.60**	**7.41**	**7.45**	**7.80**	**7.70**		
Temperature °C	Bioreactor A.	37.02	37.00	36.79	36.60	35.57		
	Bioreactor B	36.97	37.15	36.79	36.61	35.99	<40 ± 3 °C	
	Permeate	**31.86**	**26.67**	**26.06**	**23.70**	**23.31**		

Table 3. *Cont.*

Analysis	Process Step	Average of Monitoring Analyses					Freshwater Class 2	Effluents/Sewage
		Jan/13	**Feb/13**	**Mar/13**	**Apr/13**	**May/13**		
BOD_5; mg/L O_2	Sanitary	1527.40	1798.00	1446.00	1445.00	1433.50	5	Max. 120 mg/L or efficiency ≥ 60%
	Industrial	4548.20	4321.75	5276.75	5226.17	4891.33		
	Industrial treated	8194.20	2839.25	2538.00	2412.33	1977.00		
	Permeate	**43.80**	**37.00**	**45.50**	**41.67**	**43.00**		
N; mg/L	Sanitary	134.00	163.00	876.53	560.96	189.50	3.7, for pH ≤ 7.5 2.0, for 7.5 < pH ≤ 8.0 1.0, for 8.0 < pH ≤ 8.5 0.5, for pH > 8.5	20.0
	Industrial treated				3.83	5.36		
	Permeate	**17.88**	**16.13**	**16.53**	**23.20**	**17.20**		
P; mg/L	Sanitary P	60.75	69.70	399.80	54.97	151.90	up to 0.050	
	Industrial treated				0.24	0.29		
	Permeate	**0.24**	**0.72**	**0.58**	**0.68**	**0.40**		
OG; mg/L	Sanitary	184.45	136.00	114.20	132.88	211.50	virtually absent	100
	Industrial	771.40	485.50	319.40	941.95	581.40		
	Industrial treated	31.60	34.80	51.60	46.23	226.60		
	Permeate	**25.90**	**35.15**	**141.00**	**52.70**	**140.50**		
Turbidity; NUT	Industrial treated				4.64	6.38	up to 100	
	Permeate Turbidity				**4.35**	**3.28**		

Solid waste generated in the process, called physical-chemical sludge, is destined for the appropriate landfills. The results show that the permeate generated after the membrane separation process meets the main requirements of the resolutions that deal with the quality of the aquifers and CONAMA's conditions and effluent standards. It should be noted that the use of the membrane separation process was essential for the effluents to have their indexes in line with the standards and standards requirements [21,22].

Based on the amounts presented in Table 4 and CONAMA's standards for effluent releases, a quantitative projection of substances that could be released back into the environment was made.

Table 4. Indices obtained by the permeate difference with the possible launching according to legislation.

Parameter	Sanitary Effluent		Industrial Effluent		Permeate			
	Result (mg/L)	Annual Mass (Kg)	Result (mg/L)	Annual Mass (Kg)	Result (mg/L)	Annual Mass (Kg)	Difference (Kg)	Efficience (%)
Ba	0.035	216.755	0.042	224.055	<0.1	8.816	431.99	98.00
B	0.15	216.755	0.53	224.055	<0.01	0.882	439.93	99.80
Pb	0.12	21.675	0.009	22.405	<0.1	8.816	35.26	80.00
Cu	0.082	43.351	0.055	44.811	<0.05	4.408	83.75	95.00
Cr III	0.068	43.351	0.07	44.811	<0.05	4.408	83.75	95.00
Fe	1.02	650.265	1.85	672.165	0.3	26.448	1295.98	98.00
F	6.6	433.510	22	448.110	5.4	47.607	405.54	46.00
Mn	0.099	43.351	0.049	44.811	0.03	2.645	85.52	97.00
Ni	0.027	86.702	0.0298	89.622	0.17	14.987	161.34	91.50
Z	0.56	216.755	0.701	224.055	0.07	6.171	434.64	98.60
Phenols	0.11	21.675	11.71	22.405	0.08	7.053	37.03	84.01

Note: Source: Company data.

Results of the analyses of sanitary and industrial effluents and the annual amount of each chemical parameter are shown in Table 4. The results show that the parameters were already lower than required by the CONAMA resolution, but the use of this effluent as reuse water could still be considered. After the treatment of the effluents by the membrane separation process, the results obtained from the analysis of the permeate performed show the improvement of the indices in Table 4.

The difference between the values of each effluent parameter (industrial and sanitary) to the permeate is expressed in the penultimate column of Table 4. These differences correspond to the amounts that are no longer discarded in the environment. The difference between the values of industrial and sanitary effluents in relation to those obtained in the permeate is expressed in the penultimate column of Table 4 when compared to the indexes that could be released according to CONAMA standards [21,22]. These differences correspond to the amounts that are no longer discarded in the environment, exceeding 99% of the initial value.

4.2. Economic Evaluation

From the survey of electricity consumption and costs in the water and sewage treatment processes (Table 5) and the expenses with products in the treatment of water (Table 6), it was possible to perform the calculations, mainly because the company captures and treats its water demand and still reuses water generated by sewage treatment.

Table 5. Annual costs (BRL) with electric energy.

Annual Costs of Electric Energy Involved in the Process			
	m^3	**kWh**	**BRL**
Water collection in wells	124,000.00		
Water treatment		78,864.00	15,299.62
Industrial effluents generated	44,811.00		
Sanitary effluents generated	43,351.00		
Total effluents	88,162.00		
Effluents treatment		31,385.67	6277.13
Annual Value of Energy Saved			
	m^3	kWh	BRL
Used as reuse water	48,489.10	30,839.07	5982.78

Table 6. Annual costs (BRL) with water treatment product.

Consumption of Chemical in Plants				
Volume (m^3)	**Average Chemical Consumption (kg/m^3)**	**Average Cost (BRL/m^3)**	**Annual Consumption (kg/m^3)**	**Annual Cost (BRL/m^3)**
124,000	0.03405	0.707	4222.2	2987.16
88,162			−3001.92	−2122.35
Economics of Water Treatment Product by Reuse				
Reuse water (m^3)		Average cost (BRL/m^3)		Annual cost (BRL/m^3)
48,489.1		24.09		−1168,102.42

The results measure annual energy, chemical and water savings and add up to an economic gain of BRL 1.176 million/year. The initial investment for the deployment of WTS and ETS was around USD 3 million (1 USD = BRL 3.10), which is equivalent to BRL 9.3 million. Based on this information, 7.9-year payback was achieved with a 15% ROI. It should be noted that the surveyed company does not focus on the economic gain with the adoption of ETS and WTS in the production system, but is concerned about the fines and prohibition of the company before the public agencies according to Article 41, which determines a fine from BRL 1000.00 to BRL 50,000,000.00 for companies that do not meet the standard established by CONAMA [21,22].

4.3. Environmental Assessment

Table 7 shows the results of the environmental impact, summarizing the non-pollution of 66,066,081.69 kg, denoting that the cosmetics company contributes to sustainable development through the adoption of ETS in the manufacturing plant.

Table 7. Analysis of environmental impact reduction.

Component	Mass (kg)	Abiotic	Biotic	Water	Air
B	431.99	1062.7		5032.73	38.88
Bo	439.93	3347.85		7104.84	475.12
Pb	35.26	639		4788.96	80.4
Cu	83.75	29,185.72		30,751.08	134.01
Cr III	83.75	1807.41		42,283.99	424.63
Fe	1295.98	21,629.93		251,109.36	2890.04
F	405.55	1188.25		3211.92	24.33
Mn	85.52	1427.28		16,569.8	190.7
Ni	161.34	22,795.23		37,646.25	6587.37
Z	434.64	9640.29		149,081.06	990.98
Phenols	37.03	159.96		1045.3	81.09
Electricity	30,839.07	97,143.06	1233.56	1,777,563.86	15,851.28
$AlCl_3$	0.05	0.45		5.73	0.06
$Al_2(SO_4)_3$	0.9	7.78		99.92	1.04
$FeClSO_4$	0	0		0.13	0
Polymer (acrylamide)	0	0		0.06	0
Limestone	0.31	0.76		3.6	0.03
Cl	0.21	0.81		21.36	0.23
Fluosilicic acid	0.17	0.25		0.25	0.01
Potable water	48,489,100	484,891		63,035,830	0
MTE	48,523,435				
MIC		674,927.74	1233.56	65,362,150.19	27,770.2
MIT					66,066,081.69

4.4. Comparison of Economic and Environmental Gain

A comparison between the economic gain index (ECGI) and the environmental gain index (ENGI) was obtained by dividing the sum of the total materials saved (MTE) by the economic gain (EG) and by dividing the total intensity of materials (MIT) by economic gain (EG), respectively, according to Table 8.

Table 8. Indexes of economic and environmental gain.

Comparison of Economic and Environmental Gain	
MTE	48,523,435.46
MTI	66,066,081.69
EG	7150.88
ECGI = MTE/EG	6785.66
ENGI = MTI/EG	9238.87

The results show that the environmental gain index obtained surpasses the economic one. However, if we evaluate the absence of adoption of ETS and WTS by the company and the aggregated risks due to non-compliance with legislation, a consensus can be reached that, even at first glance, environmental gain is the most relevant factor, investment is essential, and the company needs to dilute costs in marketing the products and services.

5. Conclusions

The current water crisis that the state of São Paulo is undergoing causes measures to be taken to mitigate the risk of lack of water for human consumption. Of the total water treated in the state, only 37% is destined for residential and commercial consumption, even volume that is directed to the industries. It is added that 38% of the sewage collected is not treated, increasing the vulnerability of contamination of water resources.

The scenario of incentive to the treatment of sewage, mainly with the perspective of improvement of its effluent so that it can be reused, is more than a necessity; it is a duty for the whole company that seeks to be guided by environmental strategies in tune with their business strategies. Obtaining quality reuse water that can partially replace industrial or irrigation consumption, or even increase availability for human consumption, should be one of the priorities of Brazil and the world.

The results indicated that it was possible to meet the legal requirements for effluents to be discharged by a company in the cosmetics sector through the adoption of an ETS in the production system in addition to reducing the environmental impact to 66,066,081.69 kg, preventing the discharge of a large quantity of substances into nature. Although the initial investments to make water and sewage treatment possible are high, gains to the company's image, preservation of the environment and compliance with current legislation, avoiding sanctions by the responsible entities, means that cleaner production process implementations of this nature will become attractive.

The case study application can be considered a limitation of this research and for future studies because it is suggested to know the production system in more detail with the objective of implanting other CP practices.

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