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A Case Study for Evaluation of Treated Wastewater for Re-Use in A Plant Storing Chemical and Producing Ligno Product

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ABSTRACT

A wide range of industrial activities involve the use and storage of many different chemicals that can run-off into water and pollute it. These chemicals have the potential to generate a variety of chronic or acute impacts on the environment by the features of reactive, toxic or flammable in form of vapour, gas and solid. During storage facilities, chemical discharge to atmosphere, water and soil causes contamination of land resources and water in aquatic environment. Due to differences in industrial production and storage methods, the characters and amounts of waste water varies with the development of industry. So, wastewater treatment strategies for these differences should be identified separately. Therefore the usage of Sequencing Batch Reactor (SBR) process supported with chemical preliminary precipitation is considered as a practical and economically solution for such industries. So, in this study, a storing chemical products facility, located in the province of Tekirdag and having such a treatment system making a treatment via chemical preliminary precipitation followed by Sequencing Batch Reactor (SBR) process was investigated. Influent and effluent characterization of the treatment system were determined in terms of TSS, COD and color parameters and then removal efficiencies were evaluated of the running plant in terms of re-use of treated water within the plant. According to the results, wastewater occuring from chemical products s torage processes have strong influent characters in terms of COD, TSS and Colour parameters Furthermore, although the treatment system units' removal efficiencies, calculated as 64 % COD, 77% TSS, 36% Colour for Chemical precipitation and 78% COD, 61% TSS and 47% Colour for Sequencing Batch Reactor (SBR), respectively, were found consistent with the literature, but these values were inefficient to provide both Water Pollution Control Regulation (WPCR) Standarts and in plant reuse water quality. But this treated water quality was found to be agreegable to reuse for external washing of the transport vehicles such as tanker, truck and extc.carried out in the plant.

Keywords: Chemical storage, lingo production, reuse water, SBR

1. INTRODUCTION

The majority of human uses require fresh water. The world's supply of fresh water is steadily decreasing as ecosystems are threatened. Water pollution is not the future problem, is the problem of today. Water pollution is the contamination of natural water bodies by chemical, physical, radioactive contaminants. In developing products of the chemicals industry - such as dyes, detergents and adhesives among others – brings widespread consequences of water pollution upon ecosystems include species mortality, biodiversity reduction and loss of ecosystem services. Chemical water pollutants have been discharged into natural water bodies by activities of humans. Various facilities such as storage, packaging, transportation and handling of chemicals causing acute impacts on the environment; air, water and soil pollution. Leaking underground and above ground storage tanks can be considered point sources of toxic chemicals for fresh water sources. Storage and handling of dangerous chemicals in plants adjacent to populated areas pose major threats against public health and safety. In addition, wastewater discharge into natural watercourses has left water unsafe for potable use and impairing industrial use without major and costly treatment. The current low cost end-of-pipe treatment approach will become increasingly expensive as effluent discharge standards become more stringent. Reusing wastewater is an attractive economic alternative and helps conserve an essential commodity for future generations. The potential for industrial wastewater reuse is dependent on a variety of factors and differs from one industry to another [1]. So, wastewater treatment strategies for these differences should be identified separately.Excessive nutrient discharge into natural water systems in which the final regulations, to accomplish together denitrification and nitrification process for removal of organic carbon and phosphate, have required modifications of sequencing batch reactor systems. Therefore the usage of Sequencing Batch Reactor (SBR) process supported with chemical preliminary precipitation is considered as a practical and economically solution for such industries [2]. Wastewater of the Plants Storing Chemical Products can contain a wide variety of pollutants. Therefore wastewater characterization includes many parameters. General wastewater characterization of the plants storing chemical products are shown in Table

1. Wastewater formation in chemical products storage plant is generally composed of water utilized for washing tools in warehouses, for the processes of washing tanks and tankers and domestic use of plant employees. In addition to all, tipping situations, such as tank rupture or tanker accidents, can be evaluated within the resources that constitute the wastewater. Percentages of wastewater formation, in such kind of facilities storing chemicals, are given in Table 2 [3].

Tablo 1. Wastewater Characterization of the Plants Storing Chemical Products [3]

Parameter	Unit	Range
Biochemical Oxygen Demand (BOD_5)	mg/L	250-800
Chemical Oxygen Demand (COD)	mg/L	1000-5000
Suspended Solids (SS)	mg / L	500-3000
Oil - Grease	mg / L	10-40
Total Phosphorus	mg / L	<10
Total Chromium	mg / L	<20
Chromium (Cr^{+6})	mg / L	<5
Lead (Pb)	mg / L	<3
Total Cyanide (CN^-)	mg / L	<0.1
Cadmium (Cd)	mg / L	<0.3
Iron (Fe)	mg / L	20-500
Fluoride (F^-)	mg / L	30-200
Copper (Cu)	mg / L	<7
Zinc (Zn)	mg / L	<15
Sulfate (SO_4^{-2})	mg / L	<1700
Total Kjeldahl Nitrogen	mg / L	5-50
Color	Pt-Co	40-500
pH	-	2-14

Table 2. Rate of wastewater formation, in the plant storing chemicals [3]

Process	Percentages of wastewater formation
Washing issues inside of the tanks	%25
Washing issues of tanker ve trucks	%65
Domestic usage	%8
Possible Accidents: Tank Explosion, Tanker Roll Over, Fire.	%2

Liquid chemicals, accepted in the plant, are transferred to aboveground tanks. After emptying these tanks have been used for storage of other chemicals. Waste water formation, due to washing issues inside of the tanks, constitutes 25% of waste water of chemical storing plants. In order to reduce this rate to a minimum level, as much as possible the chemicals need to be stored in the same tanks [3]. Facilities, storing chemical products, that also presents logistics service facilities the washing of trucks and tanks used for this purpose is one of the important factors for wastewater generation. To studies, wastewater generation due to washing issues of tanker ve trucks is approximately 65% of total wastewater formation. Transportation of the chemicals by the same tankers and trucks is very important for water conservation [3]. Such kind of wastewater has been generated by the use of plant employess. Since nearly half of employees are drivers in the chemical storing plants, it is assumed that the amount of water needed, in the two-hour time period for the drivers, is 5 L/day for the calculation of domestic water consumption. According to researches domestic water use in a typical storage facility is %8 of the total amount of wastewater [3].

Accidents that are often seen in chemical products storage facilities are tank explosions, tank tipping and fires. As the wastewater as a result of these kind of accidents would have dangerous effects on environment and human, risk analysis has to be carried out and precautions should be applied in case of accidents in advance. In this plant, wastes resulting from accidents have been sent to treatment plant directly or after a storage in a tank. According to researches, the amount of wastewater resulting from accidents is 2% of total wasteeater in this type of facilities [3]. In general, wastewater of the storage facilities in chemical products, have high amounts of organic matter, inorganic material, dissolved suspended solids and special contaminants (iron, chromium).
The main purpose of this study is identification and evaluation of facility making a treatment via chemical preliminary precipitation followed by Sequencing Batch Reactor (SBR) engaged in experimental studies. Influent and effluent characterization of the every treatment unit were determined in terms of TSS, COD and color parameters and in terms of re-use of treated water within the plant. The obtained data have been compared with the literature and Water Pollution Control Regulations (WPCR). In the case of treatment efficiency is lower than the literature value, possible factors reducing efficiency have been investigated and discussed.

2. MATERIAL AND METHODS

2.1. Facility description

This study was carried out in the treatment system of a storing chemical products facility ,serving tank terminal in Tekirdag M.Ereglisi based on the area of. 42,000 m^2, located in the province of Tekirdag. This facility stores products imported from abroad and offers for sale in the form of package or as a bulk ch emicals which used on textile, detergent, paper, food and construction sectors. Furthermore, concrete accelerator additive is also engaged in this manufacturing for construction sector. There are Ligno Building, Level Building, Electrical Building, Boiler Room, Car Wash Area, Fire Water Tank, Scales, Water Treatment Plant, Administrative and Social Buildings are located in the facility area. The Facility is capable of storing
70 400 m^3 (coated and uncoated 69 tanks built from steel and carbon steel at capacity of ranging 20 m^3 to 1545 m^3) composed of caustic (sodium hydroxide), hydrochloric acid, phosphoric acid, phosphoric acid, phosphoric acid (technical), castor oil, DOP, DINP, NP 10 (nonylphenol etoxilat 10), PEA (poly ethanol amine), liquid lignosulphonate. Investigated plant has Ligno Production is an enclosed system in where Sodium Lignin Sulphanate and aqueous solutions of various chemical substances (Formaldehide, nipacide, calcium) are prepared. Ligno Production flow chart is illustrated in Fig. 1 [4].

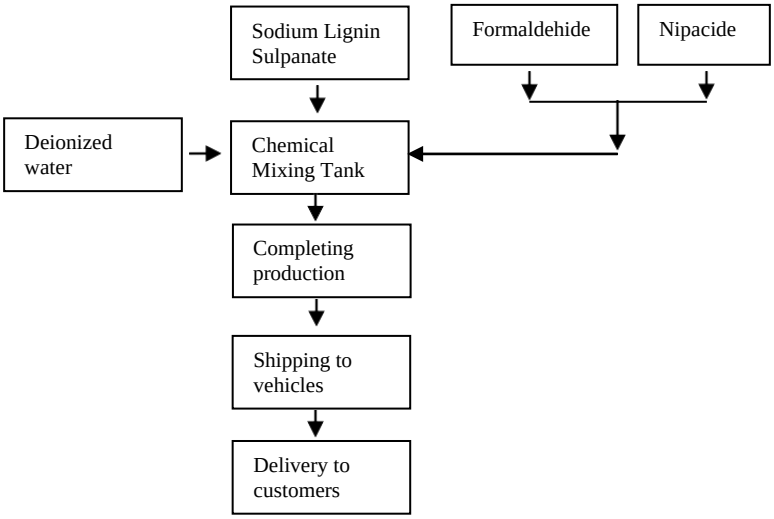

Fig 1. Ligno Production flow chart[4]

Treatment plant of the facility investigated has average 70 m^3/day and maximum 84 m^3/day treatment capacity and composed of physical, chemical and biological un its treating municipal and industrial wastewater together. Influent and effluent characterization of the every treatment unit were determined in terms of TSS, COD and color parameters and then removal efficiencies were evaluated of the running plant, making a treatment via chemical preliminary precipitation followed by Sequencing Batch Reactor (SBR) process, in terms of re-use of treated water within the plant. Wastewater treatment plant flow diagram is in Figure 2 [4].

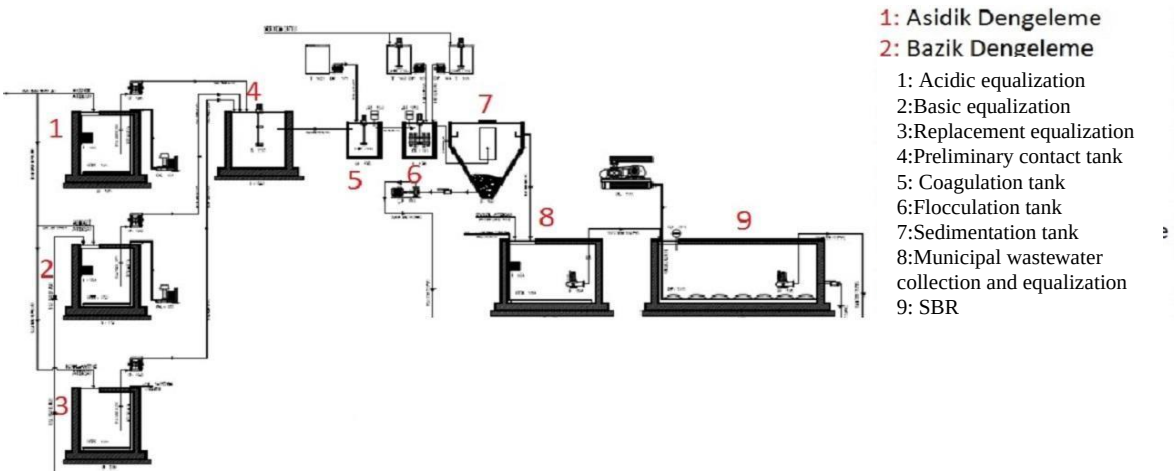

Fig. 1 Wastewater treatment plant flow diagram of investigated plant [4].

2.3. Sampling and Conventional Characterization

Sampling is carried out on the days of washing tanks in order to define the general

operation and production characterization. Samples are taken as 500 ml per hour and during 8 hours totally 4 lt. Samples were preserved in the refrigerator at 4 ° C during the test experiments. The first sample is taken from the entrance of chemical treatment. The second one is taken from the final settling tank at output of the che mical treatment. The third sample is taken from the point where the effluent is mixed with the domestic waste water before sending to biological treatment reactor. The last fourth sample is taken from output of the SBR. Characterization studies were carried out at WWTP more than three months and involved two different representative samples. All measurments were done according to standart methods [5] except Colour. Colour measured according to both EN ISO 7887 method and Pt-Co methods [5,6].

3. RESULTS AND DISCUSSION

3.1. Experimental Study Results

The analysis results carried out at WWTP are given Table 3.

Table 3. Experimental Analysis reuslts of Treatment Units' Efficiency [4]

PARAMETER		**CHEMICAL TREATMENT UNIT**				**SBR UNIT**			
	Unit	**Influent**	**Effluent**	**Efficiency**	**Literatur e**	**Influent**	**Effluent**	**Efficienc y**	**Literatur e**
Experimental Study 1									
SS	**mg/L**	4205	1093	77 %	80 %	810	364	55 %	96 %
COD	**mg/L**	11124	6786	39 %	64 %	6395	1599	75 %	94 %
Color	**(m^{-1})**	290	188	35 %	77 %	173	104	40 %	64 %
Experimental Study 2									
SS	**mg/L**	4425	1062	76 %	80 %	850	289	66 %	96 %
COD	**mg/L**	12920	7333	43 %	64 %	6890	1203	82 %	94 %
Color	**(m^{-1})**	297	184	38 %	77 %	170	90	47 %	64 %

Each experiment has been repeated two times in terms of the margin of deviation can be seen and checked in the results of experimental studies. The impurity concentration known reference solutions are included to all experiments. The results of experimet having deviation more tan 5% have not been accepted, just repeated. For the experimental study 1, Chemical Treatment efficiency is %77, %39 and %35 respectively in terms of SS, COD and Color. Biological Treatment efficiency is %55, %75 and %40 respectively in terms of SS, COD and Color. For the experimental study 2, Chemical Treatment efficiency is %76, %43 and %38 respectively in terms of SS, COD and

Color. Biological Treatment efficiency is %66, %82 and %47 respectively in terms of SS, COD and Color.

For the experimental study 1; resullts showed that chemical treatment efficiency has been approached in terms of only SS parameters. Treatment efficiency of COD and color parameters are far below literature based values. On the other hand; COD, SS and color parameters in biological treatment efficiency is far below literature based values. For the experimental study 2; resullts showed that chemical treatment efficiency has been increased at the rate of %2, %4 and %3 respectively in terms of SS, COD, and color parameters, however they are below literature based values. On the other hand biological treatment efficiency has been increased at the rate of %11, %7 and %7 respectively SS, COD, and color parameters, however they are below literature based values. The obtained data have been compared with the literature and Water Pollution Control Regulations, and then interpreted in terms of in plant reusable potential. The comparative of experimental analysis results are given Table 4.

Table 4. Comparing the results of analysis with WPCR of experimental studies [4]

	SS				**COD**			
	WWTP Effluent	**WPCR**		**Treatment Req.**	**WWTP Effluent**	**WPCR**		**Treatment Req.**
	mg/L	**(2 h)**	**(24 h)**	**(24 h)**	**mg/L**	**(2 h)**	**(24 h)**	**(24 h)**
Experimental Study 1	**364**	100	200	72 %	**1599**	400	300	81 %
Experimental Study 2	**289**			65 %	**1203**			75 %

According to the results, wastewater occuring from chemical products storage processes have strong influent characters in terms of COD, TSS and Colour parameters which are the values were determined as 12022 mg/l COD, 4315 mg/l TSS and 293 m^{-1} Colour, respectively, since it includes chemical raw materials and chemical products. These values were found extremely high when compared to other conventional industrial wastewater such as textile, leather, food exct. Furthermore, although the treatment system units' removal efficiencies, calculated as 64 % COD, 77% TSS, 36% Colour for Chemical precipitation and 78% COD, 61% TSS and 47% Colour for Sequencing Batch Reactor (SBR), respectively, were found consistent with the literature, but these values were inefficient to provide both Water Pollution Control Regulation Standarts (Table 19: Mixed industrial wastewaters discharge standarts for receiving bodies-Small and Large Organized Industrial District and the other industries which can not be determined in terms of sectoral base) [7] and in plant reuse water quality determined for ligno production, equipment and ground washing and exct. But this terated water quality was found to be agreegable to reuse for external washing of the transport vehicles such as tanker, truck and extc.carried out in the plant.

The water , used in production processes, is not discharged to any surface sources after treatment. The primary objective of the plant to use, the water coming from treatment plant, for ligno production. But the result of the experimental analysis reveals that effluent water quality does not meet the water quality required for producing ligno. Comparison of the plant effluent water and properties of the water used in ligno production is given on Table 5.

Table 5. Comparison of the plant effluent water and properties of the water used in ligno production [4]

Properties	**Acceptance Requirement**	**Plant Effluent Water Quality**
Color	Apart from the recovered water should be apparent from the color light yellow	Plant effluent water has a 124 m^{-1} high value which is not suitable for the desired properties.
Suspended Solid	Apart from the recovered water amount of solution should be less than 40 mg/L	Effluent wastewater has a 330 mg/lt which is not suitable for the desired properties.
Odor	Other water should not smell except that drinkable water shall be any odor. After hydrochloric acid adding it should not have any hydrogen sulfur odor.	Plant effluent water has a bit bad odor which is not suitable for the desired properties of drinkable water odor.
Acids	pH ≥ 4 should be.	Plant effluent water pH is 8 which is suitable for the desired properties.
Organic matter	Amount of organic matter COD 100 mg / l should not be more.	Value of the plant wastewater effluent water is well above and which is suitable for the desired quality.

Wastewater that has not been used even Ligno Production, is used in the external washing of trucks and tankers and after that it is collected and sent back to the treatment plant.

3. CONCLUSIONS AND RECOMMENDATIONS

As a result of the studies, it is evident that chemical and biological treatment unit of the plant could not be operated efficiently. According to the experiments carried out at Chemical Treatment Unit, SS values are closed to the value mentioned in literature for chemical treatment unit. But on the other hand, this part of the system is quite inefficient in terms of COD and color removal and on the base of these parameters, it could not reduce pollution concentration significantly. On the other hand, experiments carried out at Biological treatment unit, it is observed that COD and color removal of Biological

Treatment unit are closer to literature values than the other parameters although they are insufficient. On the other hand SS removal efficiency is substantially lower than the values mentioned in the literature.
At the scoe of the study, chemical storing plant is unable to handle both the discharge to receiving environment according to the limit values of WPCR and reuse for the ligno production process. Especially, SS and COD parameters of effluent wastewater of the plant are well above the limit values. In these circumstances to make a discharge of effluent into the superficial receiving environment will significantly adversely affect of live aquatic life due to relatively high pollution concentrations [7]. But, this treated water quality was found to be agreegable to reuse for external washing of the transport vehicles such as tanker, truck and extc.carried out in the plant.
On the other hand, COD treatment efficiency of the biological treatment unit is under the values mentioned in the literature. However, in order to increase the efficiency especially SBR should be operated at higher sludge rate or at longer aerobic aeration time and should be evaluated by applying analysis again.

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