Evaluation of Methods and Efficiencies of Industrial Wastewater Treatment in Turkey

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Geliş Tarihi: 28/07/2010 Kabul Tarihi: 31/12/2010

Abstract: This study examined wastewater characterizations and treatment processes of thirteen different factories selected among the country's four common sector and its example industries. These sectors were selected as; metal, food, textile and chemistry. In addition, attempts were made in this study to examine the effectiveness of treatment processes applied in these factories and their efficiency was evaluated. These experiences are described concerning the application of physical, chemical and biological processes in the treatment of industrial wastewater in combination with other advanced processes.

It was determined that different parameters were significant in different industries. The wastewater generated from various industrial activities was highly contaminated with organic matters as indicated by Chemical Oxygen Demand (COD) (2106 – 8546 mg/l), Suspended Solids (SS) (895 – 2300 mg/l) and oil & grease (75 – 500 mg/l). All overall appraisals of the analytical data from the industrial wastewater indicate that treatment is required for all industrial sectors to achieve compliance with the "Turkish Water Pollution and Control Regulation" which requires effective treatment of industrial wastewater prior to its discharge.
Keywords: *Industrial Wastewater Treatment, Method, Efficiency, Discharge*

Türkiye'de Endüstriyel Atık Su Arıtma Yöntemleri ve Verimliliklerinin Değerlendirilmesi

Özet: Bu çalışmada, ülkemizin dört ana sektöründen seçilen 13 farklı endüstrinin ve örnek tesislerinin atık su karakterizasyonları ve arıtma prosesleri incelenmiştir. Bu sektörler; metal, gıda, tekstil ve kimya olarak seçilmiştir. Ayrıca çalışmamızda yürütülen denemelerde, endüstrilerde uygulanan arıtma proseslerinin etkinliği araştırılmış ve verimleri değerlendirilmiştir. Bu araştırmalar, endüstriyel atık su arıtımında fiziksel, kimyasal ve biyolojik proseslerin diğer ileri arıtma yöntemleri ile birlikte uygulandığını ortaya koymaktadır.

Her endüstride farklı parametrelerin ön plana çıktığı belirlenmiştir. Çeşitli endüstriyel faaliyetlerden kaynaklanan atık sular, Kimyasal Oksijen İhtiyacı (2106 – 8546 mg/l), Askıda Katı Madde (AKM) (895 – 2300 mg/l) ve yağ & gres (75 – 500 mg/l) ile belirlenen yüksek organik içeriğe sahiptir. Çalışmamızda elde edilen veriler, endüstriyel atık suların alıcı ortama deşarj edilebilmesi için "Su Kirliliği Kontrolü Yönetmeliği"ne uygun olarak arıtılması gerektiğini göstermektedir.
Anahtar Kelimeler: *Endüstriyel atık su arıtımı, Metot, Verim, Deşarj.*

1. INTRODUCTION

Turkey is not only a large industrial market but also a densely populated industrial zone with strategic geopolitical and commercial connections between Europe and Asia. Turkey has a majority urban population which is concentrated in heavily industrialized areas. Therefore, new employment opportunities create new kinds of dwelling areas. In Turkey, lots of industrial foundations have been working in different sectors, at different geographical locations. These sectors include metal, food, textile and chemistry and are mostly located near to the coast, lakes and rivers. Most industries are established near the international highways, maritime corridors and organized industrial zones, for reasons of transportation and logistics. In particular, high capacity harbors situated on the western coasts of Turkey present these industries with access to international markets.

The amount of water used by various industries varies according to the process and sector specialties of industries. The characterization and amount of wastewater identify type, dimensions and process of industrial plants [1]. Industries established in Turkey include iron and steel, metal coating, galvanoplasty, machine spare parts and automotive in metal sector; milk and meat in food sector; leather, wool washing and dying in textile sector and detergent, battery and dye in chemistry sector. It is obligatory for determine treatment processes and methods for these industrial facilities [2]. Up to now, in order to determine treatment processes and methods, conventional treatment processes such as coagulation/flocculation process [3], chemical/physical oxidation [4], activated sludge [5; 6] and adsorption [7] and advanced treatment methods such as advanced oxidation [8], membrane process [9], fenton process [10], electrochemical oxidation [11], electrolytic treatment [12] and reverse osmosis [13] have been applied.

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One of the major problems facing these populations is the potential health risk and environmental hazard posed by industrial wastewater. In general, effluents from industrial activities contain a variety of toxic and harmful substances. These wastes can damage the sewerage system and interfere with water treatment facilities. The undesirable effects of the hazardous chemicals can be avoided by pre-treatment of the wastewater prior to discharge into the sewerage system [14].

Industrial wastewaters are conveyed to the wastewater sewage network after appropriate methods of purification and then discharged to receptor environment. "Turkish Water Pollution and Control Regulation" indicates to discharge standards for surface waters and sewerage at each industry for Turkey [15]. Discharge standards for surface waters and sewerage for each industry in Turkey are determined by the "Turkish Water Pollution and Control Regulation" (effective from 31/12/2004), as amended by subsequent EU Directives.

Especially, the industries that their waste streams discharge to the surface water have to operate a suitable treatment plant configuration.

The present study investigated wastewater characteristics, treatment processes, treatment plant flow diagrams and characteristics of wastewater plant discharges in Turkey. Wastewater treatment processes consist of physical, biological and chemical systems according to the wastewater and industry type. Wastewater from the metal, food, textile and chemistry industries usually contains different concentrations in organic and inorganic matter. Since the characteristics of industrial wastes are usually different enough from those of domestic sewage, pre – treatment is required to produce an equivalent effluent. Many industries have considered advanced water treatment processes following the conventional treatment processes so that they meet the relevant discharge standards for discharge or for recycling.

2. MATERIALS and METHODS

For this study, thirteen factories were selected, representing four common industrial sectors in Turkey. The factories were located in Marmara and Aegean region in cities Istanbul, Bursa, Canakkale, Balikesir, Izmit and Izmir. All the participating factories were well – established and economically – important facilities.

Laboratory experiments were carried out to recommend an appropriate form of wastewater pre – treatment. Composite samples for 2 hours from the influent and final effluents were collected. Physico-chemical analyses were carried out according to the Standard Methods [16].

2.1. Drawing Flow Diagrams of Wastewater Treatment Plants

First, standard flow diagrams were produced, representing the wastewater treatment facilities of the factories included in the study. Flow diagrams were then drawn using Microsoft Visio 2003 program, based on the data recorded for each factory [17, 18].

2.2. Data Collection

Data about the wastewater treatment facilities and the treated effluents were evaluated in accordance with the influent values of the regulation.

The characteristics of the samples taken from influent and effluent of each industrial treatment plant and were determined. The solid matter fractions were analyzed in accordance with standard methods [16]. Chemical Oxygen Demand (COD) analyses were performed in accordance with the standard methods by applying open reflux determined in 5220 B [16]. Oil & grease analyses were carried out in accordance with the standard methods determined in 5520 B (Oil & Grease Parameter-Partition Gravimetric Method) [16]. TKN and NH4 – N analyses were conducted in accordance with the standard methods determined in 4500 B [16]. Concentrations of heavy metals were determined in accordance with the standard methods specified in 3111 A [16].

3. RESULTS AND DISCISSION

In this study; industrial wastewater parameters of pH, COD, SS, TKN, CN, oil&grease and heavy metal parameters are come front. High percentage of removal efficiencies can be realized by the processes of flow equalization, neutralization, chemical oxidation, coagulation/flocculation and precipitation.

3.1. Metal Sector

3.1.1. Iron and Steel Industry

This industry takes iron and steel in their raw forms and produces iron-steel products such as construction iron, plaques and iron plates, etc. The analyses of the influent and effluent samples of the wastewater treatment plant for this industry are shown in Figure 1. The pH values of the influent and effluent samples were 7.0 and 7.0 - 7.5 respectively. 35 mg/l COD and 110 mg/l SS were measured, and 85.70% COD and 90.90% SS was removed by means of the treatment processes applied in the factory.

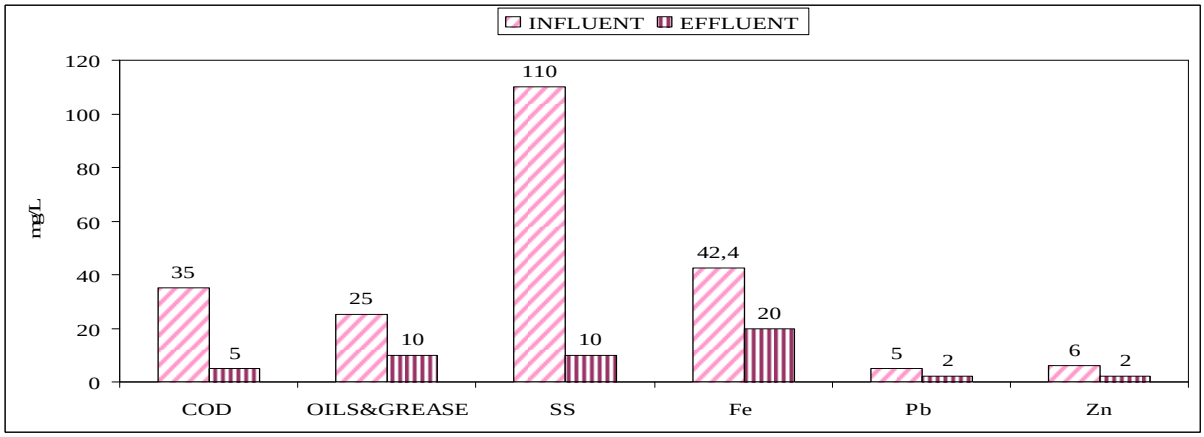

Figure 1. Characteristics of Influent and Effluent Wastewater from Iron and Steel Industry

Wastewater treatment within the industry consists of physical and chemical treatment processes. An anionic 15050 trade mark polyelectrolyte is used in the chemical treatment. The flow diagram of the wastewater treatment plant within the iron and steel industry is shown in Figure 2.

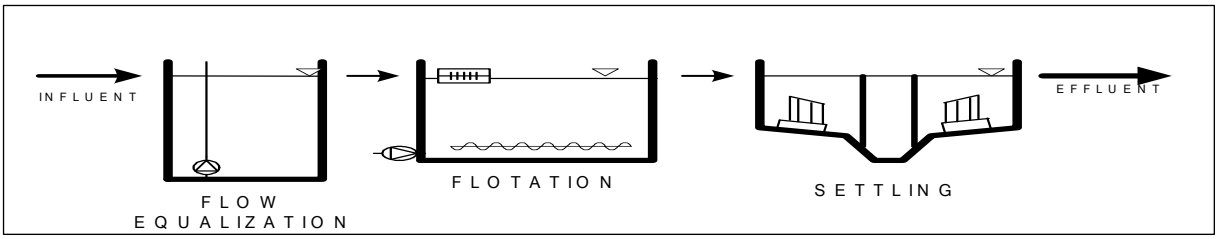

Figure 2. Flow Diagram of Wastewater Treatment Plant for Iron and Steel Industry

3.1.2. Metal Coating Industry

This industry applies surface-coating to metal products via electrolysis. End products include chrome-plated sub-components of automobiles and machinery. The process results in two types of wastewater. Therefore, treatment processes are carried out on two different canals and are then combined in the same canal. The analyses of the influent and effluent samples of the wastewater treatment facility for the industry are shown in Figure 3. The COD value was 980 mg/l and the pH value was 11.5 in the influent sample, whereas these values were 100 mg/l and 7.0-7.5, respectively, in the effluent sample. Analysis of the wastewater of the industry showed 128 mg/l TKN, 130.7 mg/l Zn and 290 mg/l SS. As a result of the treatment processes applied in the factory, 89.80% COD, 98.40% total CN, 97.70% Zn and 56.90% suspended solids were removed from the wastewater prior to discharge.

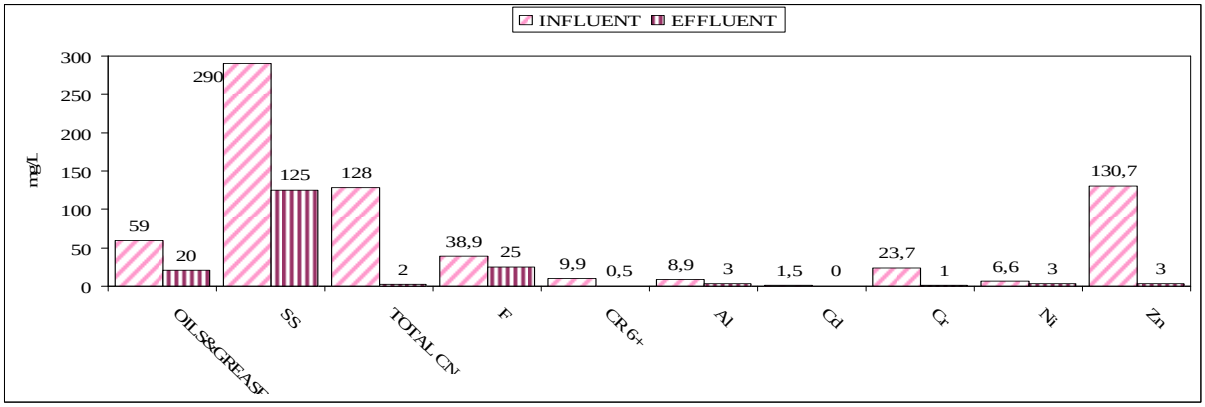

Figure 3. Characteristics of Influent and Effluent Wastewater from Metal Coating Industry

Both types of wastewaters are treated using chemical treatment methods. However, the chemicals used in the treatment process differ for wastewaters containing CN and acids. Lime, NaOH, HCl, $FeCl_3$, sodium metabisulfide, and anionic 15050 trade mark polyelectrolyte are used in the chemical treatment processes. The flow diagram of the wastewater treatment plant within the metal-plating industry is shown in Figure 4.

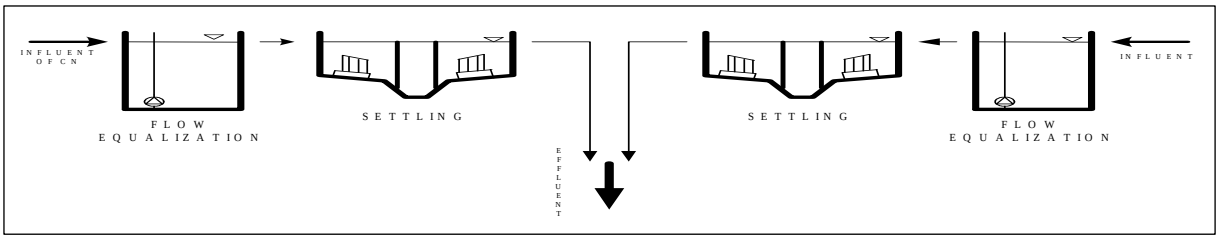

Figure 4. Flow Diagram of Wastewater Treatment Plant for Metal Coating Industry

3.1.3. Galvanoplasty Industry

This industry, which is a branch of the metals sector, deals with galvanizing and metal-plating processes. Ready-made metal parts (screws) are zinc-plated. The analyses of the influent and effluent samples of the wastewater treatment plant are shown in Figure 5. COD values of influent and effluent samples are 930 mg/l and 200 mg/l, respectively. The pH values were recorded as 7.0 for the influent and 7.5 for the effluent samples. Zinc and suspended solids were measured to be 115 mg/l and 310 mg/l in the wastewater, respectively. 78.50% COD, 95.70% Zn and 59.70% SS were removed as a result of the treatment processes of the factory.

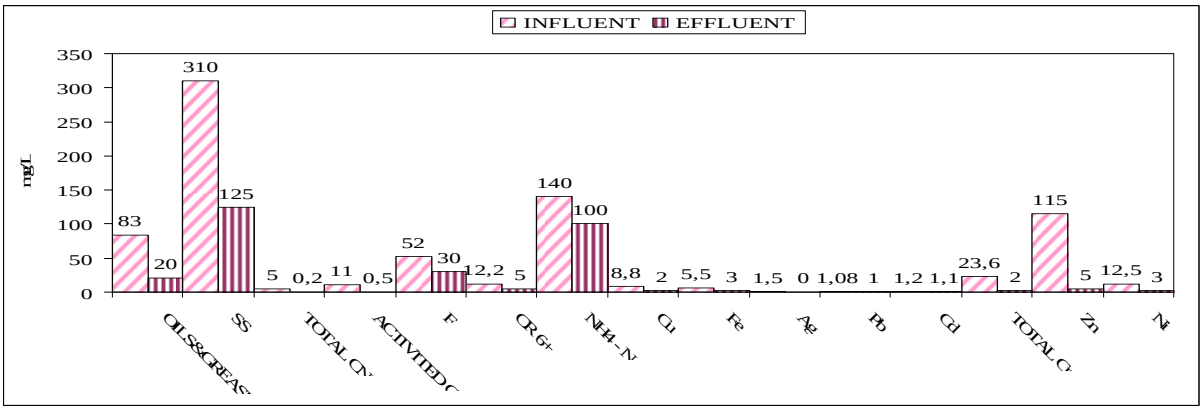

Figure 5. Characteristics of Influent and Effluent Wastewater from Galvanoplasty Industry

Wastewater treatment is conducted via chemical separation followed by chemical treatment processes. An anionic 15050 trade mark polyelectrolyte is used in the course of the chemical treatment process. The flow diagram of a wastewater treatment plant within the galvanoplasty industry is shown in Figure 6. In this process, Cr^{+6} reduced to Cr^{+3} by known chemical process, sodium meta bisulfide was used for precipitate as $Cr(OH)_3$.

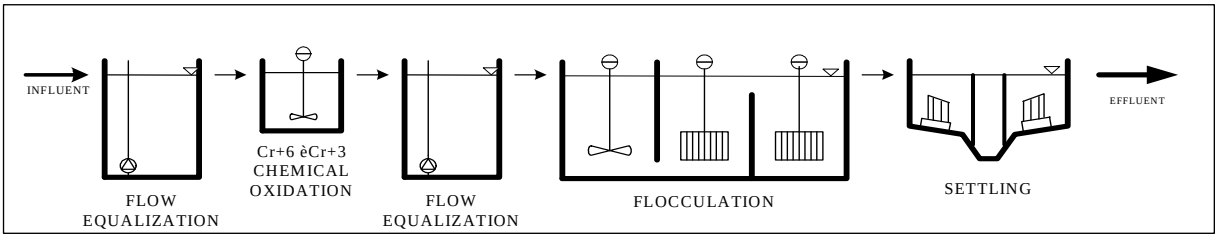

Figure 6. Flow Diagram of Wastewater Treatment Plant for Galvanoplasty Industry

3.1.4. Machine Spare Parts Industry

Iron plates, steel, etc are used as raw materials in the production facilities of the machine industry. Factories produce machine parts and spare parts for the vehicle such as automobiles, tractors and lorries. The analyses of influent and effluent samples of the treatment plant are shown in Figure 7. COD values of influent and effluent were 1015 mg/l and 250 mg/l, respectively, whereas their pH values are 9.0 and 7.2, respectively. 75.40% COD and 84.80% oil and grease were removed as a consequence of the treatment processes.

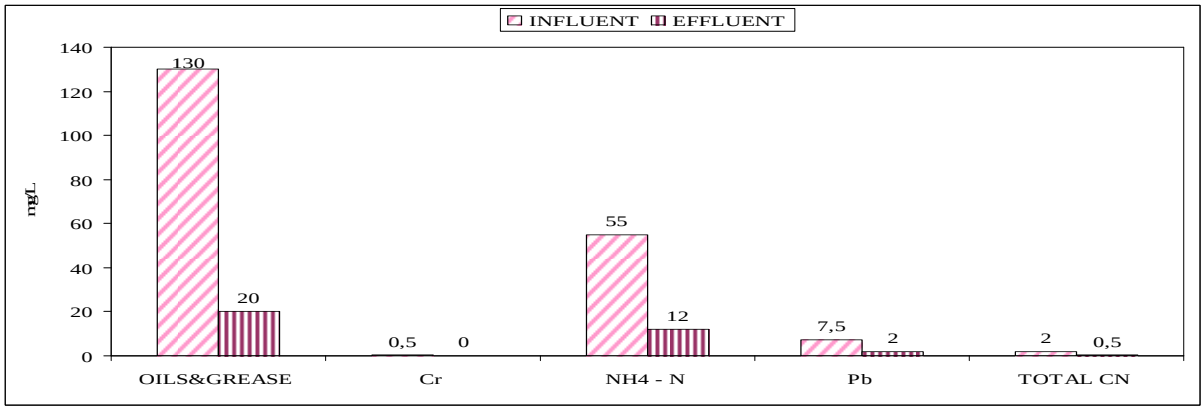

Figure 7. Characteristics of Influent and Effluent Wastewater from Machine Industry

The treatment process of the automotive component industry included only chemical treatment processes. $FeCl_3$ and an anionic 15050 trade mark polyelectrolyte are used in the chemical treatment process. The flow diagram of a wastewater treatment plant for the machine industry is shown in Figure 8.

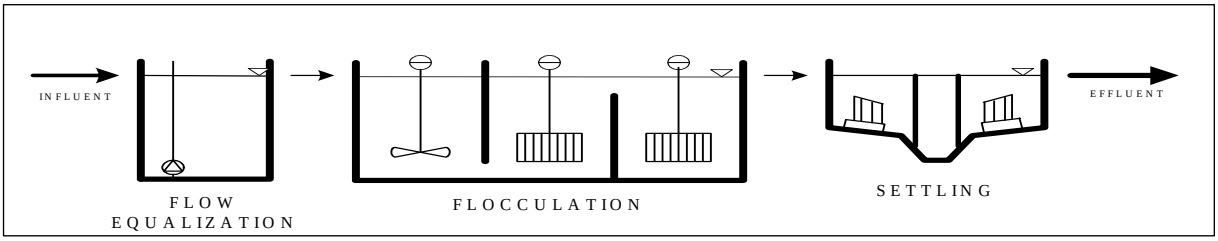

Figure 8. Flow Diagram of Wastewater Treatment Plant for Machine Industry

3.1.5. Automotive Industry

The automotive industry produces automobiles using a wide range of raw materials, including iron plates, steel, copper, plastic, iron and zinc. A sector indicated that the major sources of pollution were degreasing, phosphate and painting operations. In particular, analyses of wastewater discharged from the painting department were characterized by a high content of organic compounds. In the present study, the analyses of influent and effluent from the WWTP are shown in Figure 9. COD was measured to be 3480 mg/l and pH was measured to be 7.0 in the influent, whereas these values in the effluent were found to be 400 mg/l and 6.5-7.5, respectively. It was determined that 88.50 % COD, 91% SS and 96% oil and grease content was removed as a result of the treatment processes applied in the factory.

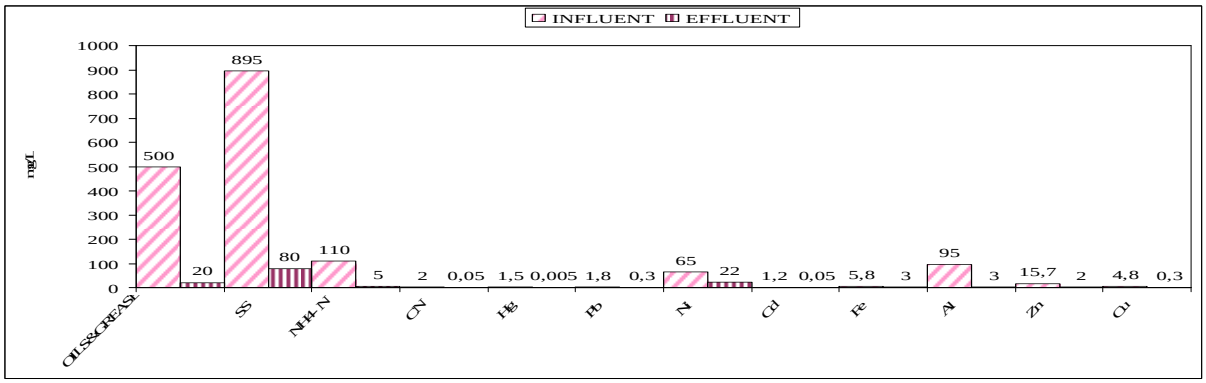

Figure 9. Characteristics of Influent and Effluent Wastewater from Automotive Industry

The sector covers physical, chemical and biological treatment processes. Lime, ferrous chloride (III), an anionic 15050 trade mark polyelectrolyte and caustic soda are used during the chemical treatment process. The flow diagram of the wastewater treatment plant within the automotive industry is shown in Figure 10.

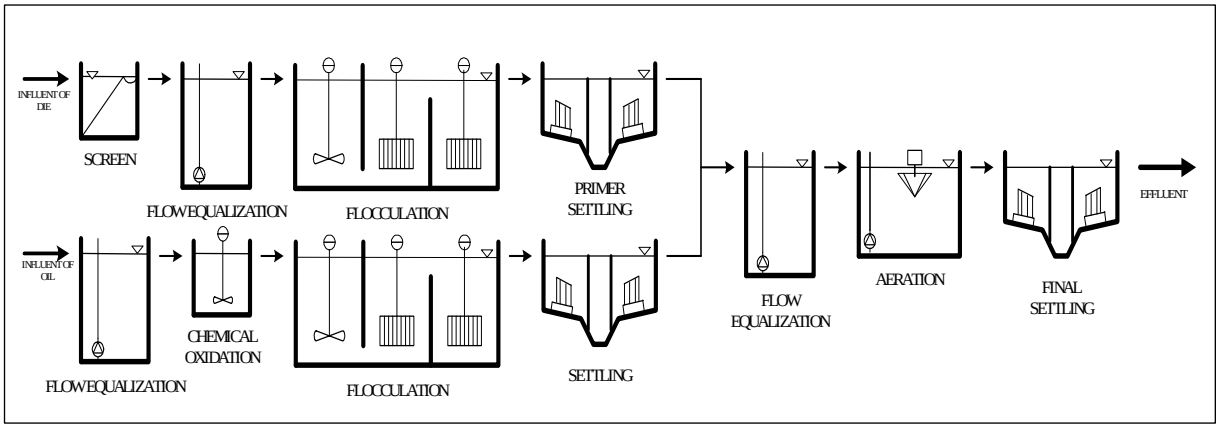

Figure 10. Flow Diagram of Wastewater Treatment Plant for Automotive Industry

Table 1. Wastewater **C**haracteristics of Selected Metal Sector Industries

	COD (mg/l)		SS (mg/l)		Oil&Grease (mg/l)		Fe (mg/l)		Zn (mg/l)		Pb (mg/l)		Total CN (mg/l)		Cr^{6+} (mg/l)	
	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.
iron and steel	35	5	110	10	25	10	42,4	20	6	2	5	2	-	-	-	-
metal coating	980	100	290	125	59	20	-	-	130,7	3	-	-	128	2	9,9	0,5
galvanoplasty	930	200	310	125	83	20	5,5	3	115	5	-	-	5	0,2	12,2	5
automotive	3480	400	895	80	500	20	5,8	3	15,7	2	1,8	0,3	2	0,05	-	-

Wastewater derived from metal sector especially contains heavy metal, oil & Grease, CN and NH_4-N. Neutralization, chemical oxidation and precipitation processes were applied with the aim of suitable treatment methods. Different oxidants and flocculants; like lime and $FeCl_3$ were used for increase the efficiency of plants.

3.2. Food Sector

3.2.1. Milk Industry

The raw material of the dairy industry, milk, is subjected to a range of processes to produce milk products such as yogurt, cheese and butter. The analyses of influent and effluent taken from the milk-sector treatment plant are shown in Figure 11. The pH values of influent and effluent were 5.5 and 7.0, respectively. The treatment process reduced COD by 98% and oil and grease by 80%.

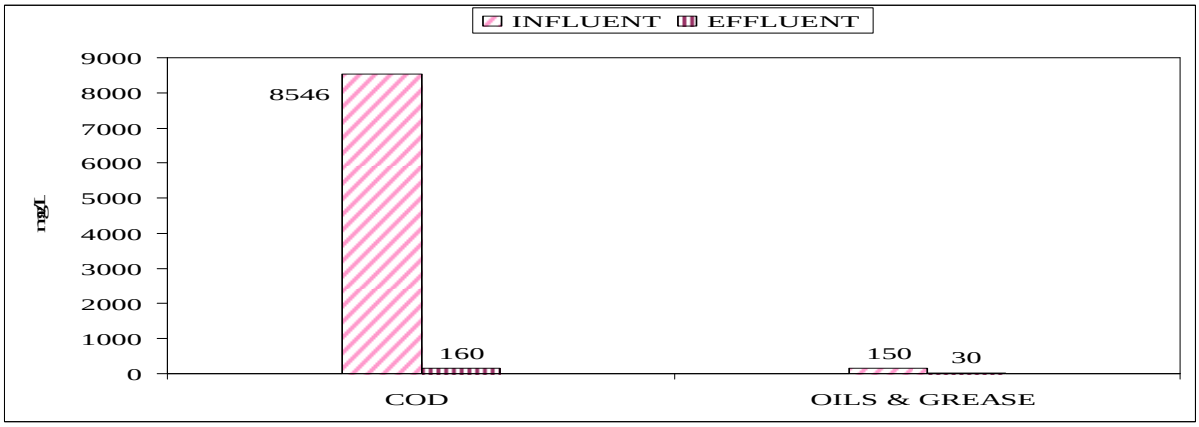

Figure 11. Characteristics of Influent and Effluent Wastewater from Milk Industry

The treatment configuration of the milk sector considered in the study consisted of chemical treatment processes followed by anaerobic biological treatment. An anionic 12040 trade mark polyelectrolyte and caustic soda are used in the chemical treatment process. The flow diagram of the wastewater treatment plant for the milk industry is shown in Figure 12.

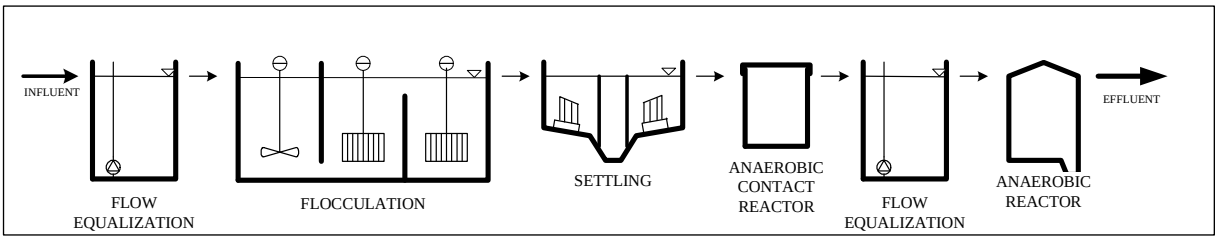

Figure 12. Flow Diagram of Wastewater Treatment Plant for Milk Industry

3.2.2. Meat Industry

The meat industry is represented within the study by a poultry facility that both breeds chickens and produces chicken products. The analyses of the influent and effluent of the WWTP are shown in Figure 13. The pH values of the influent and effluent were 6.6 and 6.5-7.5, respectively. The wastewater treatment processes used in this industry removed 93.90% COD, 94.70% SS and 93.50% oil grease.

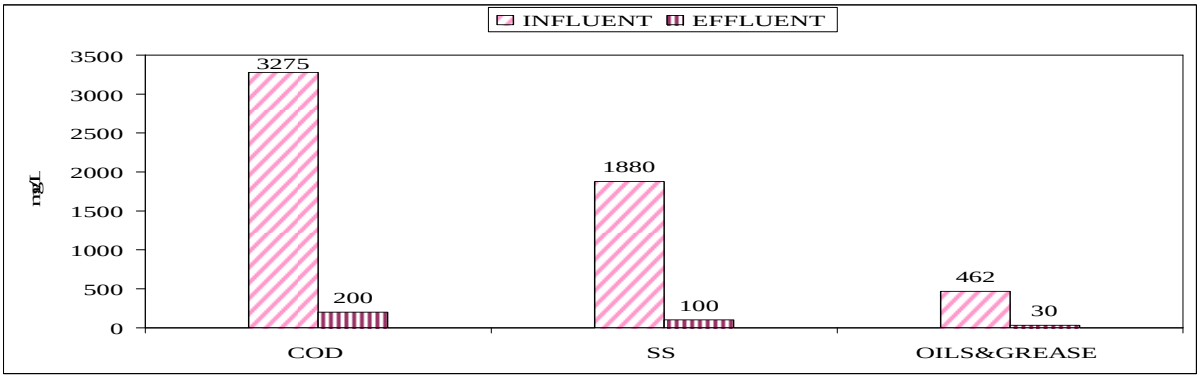

Figure 13. Characteristics of Influent and Effluent Wastewater from Meat Industry

The wastewater treatment system used in the industry consists of physical and biological treatment, an active mold system. The flow diagram of the wastewater treatment plant is shown in Figure 14.

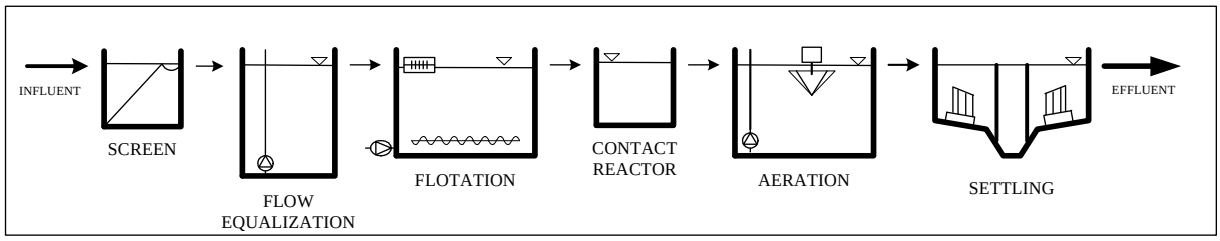

Figure 14. Flow Diagram of Wastewater Treatment Plant for Meat Industry

Table 2. Wastewater characteristics of selected food industries

	COD (mg/l)		SS (mg/l)		Oil&Grease (mg/l)	
	inf.	eff.	inf.	eff.	inf.	eff.
milk	8546	160	-	-	250	30
meat	3275	200	1880	100	462	30

Biological treatment plants are preferred for the treatment of food sector wastewaters that contains highly content of COD, oil & grease and suspended solids. High efficiency in treatment plants were obtained from well treated aerobically and anaerobically plants. In food sector plants, oil removal and inhibition of biological systems take attention.

3.3. Textile Sector

3.3.1. Leather Industry

The leather industry treats raw leather and produces related materials and goods. Chrome, caustic soda and other chemicals are commonly used in the leather industry, especially during the treatment process, produce wastewater with high levels of pollutants. The analyses of influent and effluent of the WWTP are shown in Figure 15. While the pH value of the influent was 8.0, it reduced in the range of 6.5 to 7.0 in the effluent

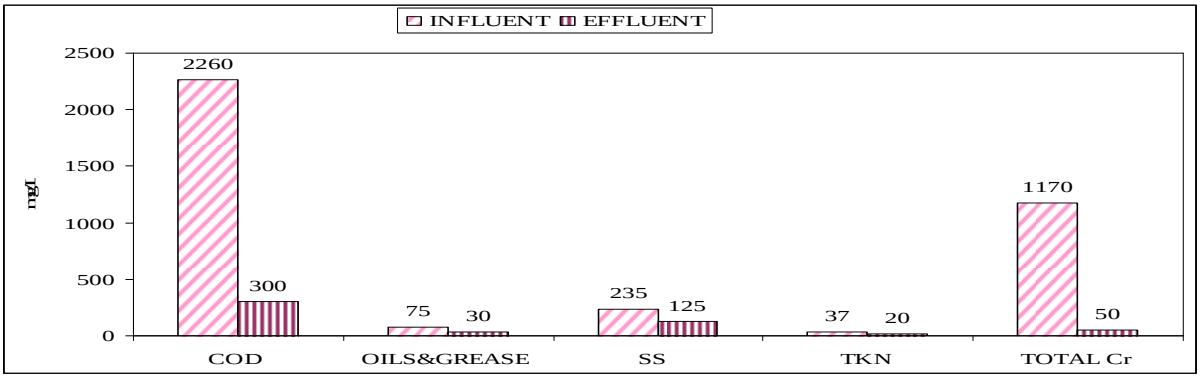

Figure 15. Characteristics of Influent and Effluent Wastewater from Leather Industry

The leather industry employs both physical and chemical treatment processes. Caustic soda and an anionic 12040 trade mark polyelectrolyte are used in the chemical processing of the leather. The flow diagram of the WWTP in the leather industry is shown in Figure 16.

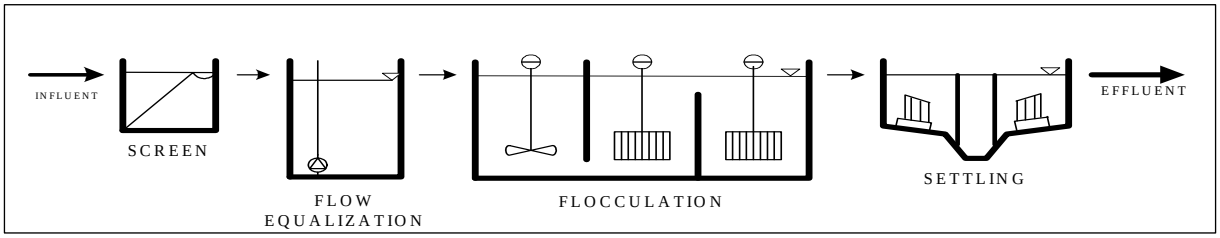

Figure 16. Flow Diagram of Wastewater Treatment Plant for Leather Industry

COD and total Chromium (Cr) were measured to be 2260 mg/l and 1170 mg/l in the wastewater of leather industry. Following the treatment process, 86.70% COD and 95.70% chromium removed from the system.

3.3.2. Wool Washing

Within the textile industry, raw materials such as wool are processed to make woolen yarn and woolen clothes. Textile production includes washing and other processes, which introduce pollutants such as COD and suspended solids into the wastewater.

The textiles industry employs both chemical and biological wastewater treatment processes. Alum and an anionic 12040 trade mark polyelectrolyte are used during the chemical treatment process. The flow diagram of the WWTP studied in the study is shown in Figure 17.

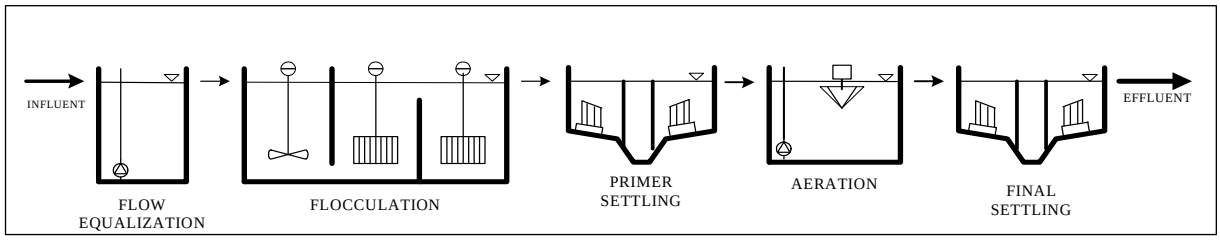

Figure 17. Flow Diagram of Wastewater Treatment Plant for Wool Washing Industry

The analyses of the samples taken from the influent and effluent are shown in Figure 18. The pH value of the influent was 7 and the pH value of the effluent was 7-7.5. It was analyzed COD as 2160 mg/l and suspended solids as 1980 mg/l in the influent of the WWTP, and 81.50% of COD and 79.80% SS (suspended solids) was removed.

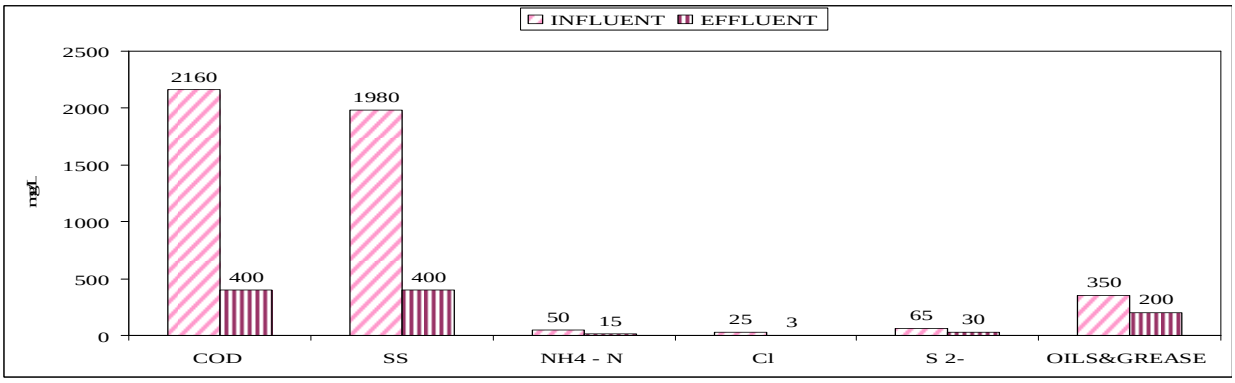

Figure 18. Characteristics of Influent and Effluent Wastewater from Wool Washing Industry

3.3.3. Cotton Dying

Fabrics made of raw yarn (cotton, wool and polyester) are generally dyed before being ready to use. These are the main processes of the textile dying material industry. The results of the analyses of the influent and effluent of the WWTP are shown in Figure 19. The pH values are 7 and 7.5, respectively in influent and effluent. The wastewater contained 2590 mg/l COD and 2300 mg/l SS, and the treatment accomplished the removals of 84.60% COD and 93.90% SS.

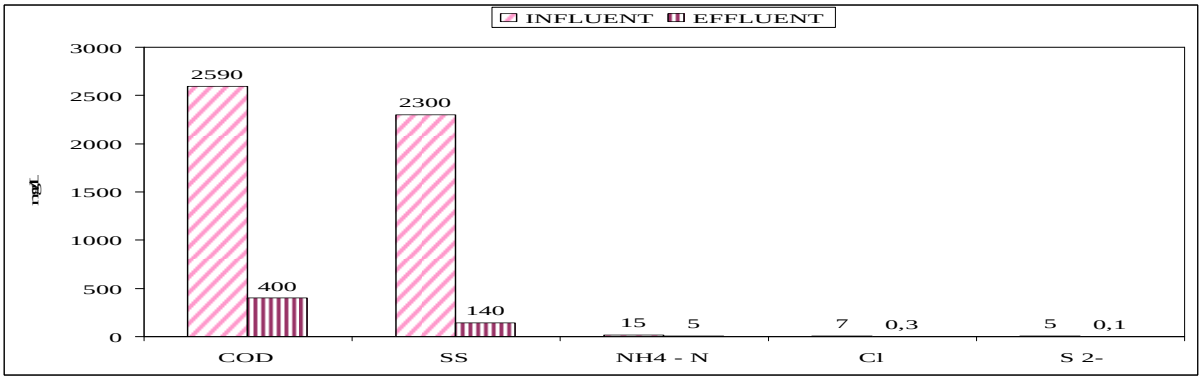

Figure 19. Characteristics of Influent and Effluent Wastewater from Cotton Dying Industry

HCl and $FeSO_4$ are used in the course of the chemical treatment process. The flow diagram of a wastewater treatment plant within the textile dying industry is shown in Figure 20.

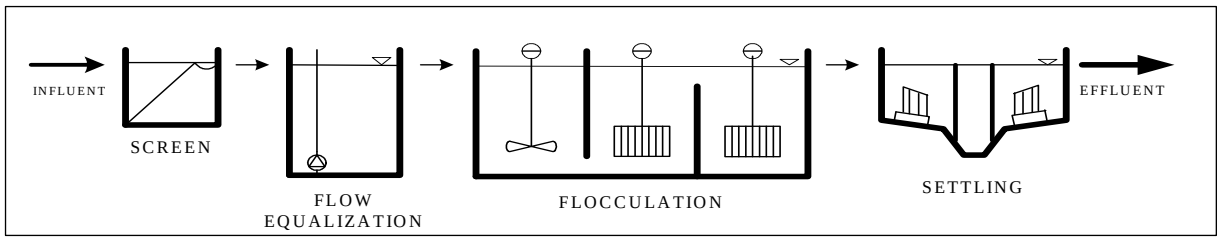

Figure 20. Flow Diagram of Wastewater Treatment Plant for Cotton Dying Industry

Table 3. Wastewater characteristics of selected textile industries

	COD (mg/l)		SS (mg/l)		Oil &Grease (mg/l)		TKN (mg/l)		Total Cr (mg/l)		NH_4-N (mg/l)		Cl^- (mg/l)		S^{2-} (mg/l)	
	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.
leather	2260	300	235	125	75	30	37	20	1170	50	-	-	-	-	-	-
wool washing	2160	400	1980	400	350	200	-	-	-	-	50	15	25	3	65	30
cotton dying	2590	400	2300	140	-	-	-	-	-	-	15	5	7	0,3	5	0,1

Especially according to wide product types of this sector, wastewater from these plants includes high amount of COD, SS, NH_4-N and trace pollutants. Both chemical and biological processes are applying in these types of plants and reaches to high percentages of efficiency in aerobic treatment with using neutralization and chemical oxidation processes together. In these chemical oxidation types of plants caustic, alum and ferrous salts are used.

3.4. Chemistry Sector

3.4.1. Detergent Industry

The production of domestic cleaning products utilizes chemicals such as linear alkyl benzene sulphonate acide (LABSA), lauryl alcohol, sodium laureth ether sulphate, formaldehyde, caustic soda and scent, etc. in accordance with several treatment processes. The products of the detergent industry are liquid detergents, liquid and solid soaps, etc. Analyses of the influent and effluent in the WWTP are shown in Figure 21. The influent wastewater showed a COD value of 49800 mg/l, pH 6.8 and SS value of 1060 mg/l,

whereas the effluent wastewater sample were of 200 mg/l COD, 7.0 pH and 150 mg/l SS, so 99.60% in COD and 85.80% in SS efficiency achieved.

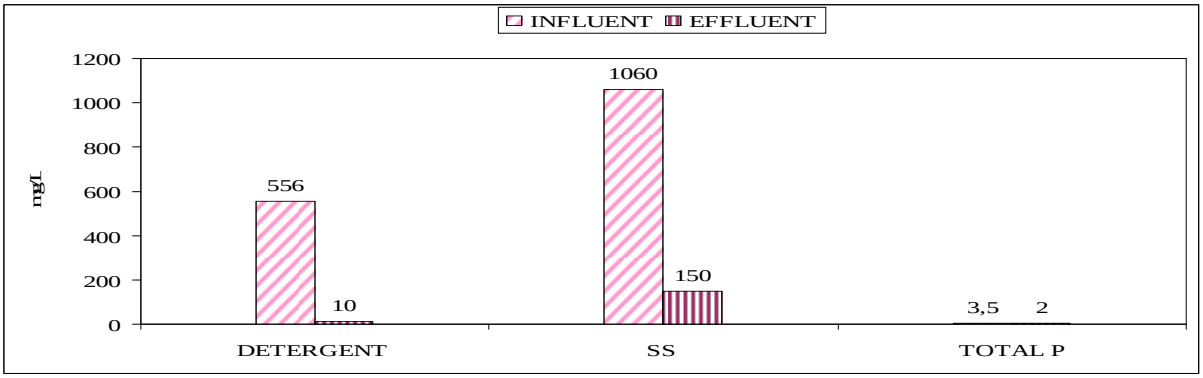

Figure 21. Characteristics of Influent and Effluent Wastewater from Detergent Industry

Physical and chemical treatment processes in the WWTP are followed by biological treatment processes in the detergent industry. Alum and a cationic 33040 trade mark polyelectrolyte are used in chemical treatment units. The flow diagram for the wastewater treatment plant within the detergent factory studied in the study is shown in Figure 22.

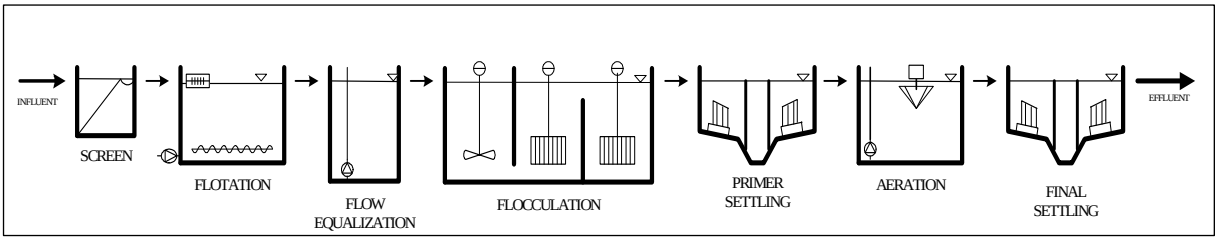

Figure 22. Flow Diagram of Wastewater Treatment Plant for Detergent Industry

3.4.2. Battery Industry

Production of electrical batteries is also a branch of the metal sector. Batteries are composite products, whose structures include plastic, metal and sulfuric acids. The raw materials are, at the same time, chemicals. The analysis of influent and effluent of a battery production facility is shown in Figure 23. While the pH value was measured as 8.0 in the influent, this value was found to be approximately 7.0 in the effluent. The wastewater from the battery production process included COD as 289 mg/l, NH4- N as 175 mg/l and SS as 127 mg/l, reaching the treatment capacity to be 77.50% COD, 28.60% NH4- N and 49.60% SS.

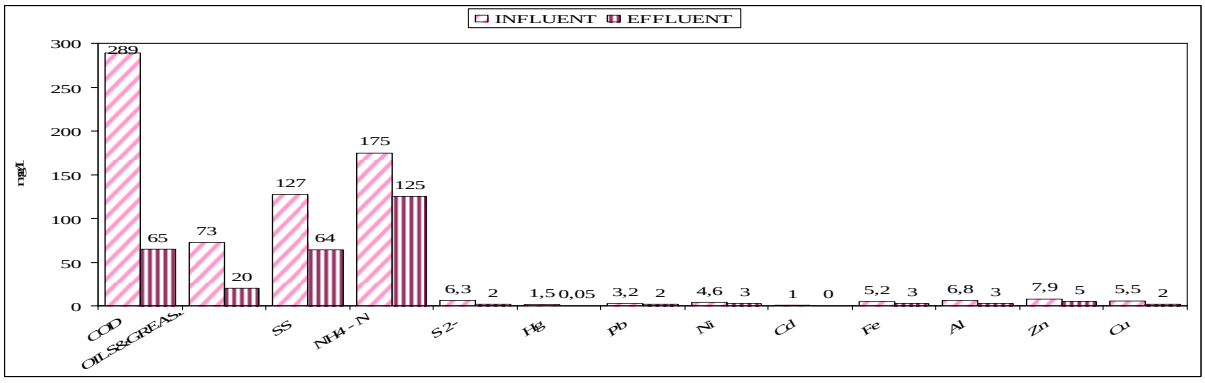

Figure 23. Characteristics of Influent and Effluent Wastewater from Battery Industry

Chemical treatment processes were used in treating the wastewater of the battery industry, using lime, HCl and a cationic 33040 trade mark polyelectrolyte. The flow diagram of the wastewater treatment plant within the battery industry is shown in Figure 24.

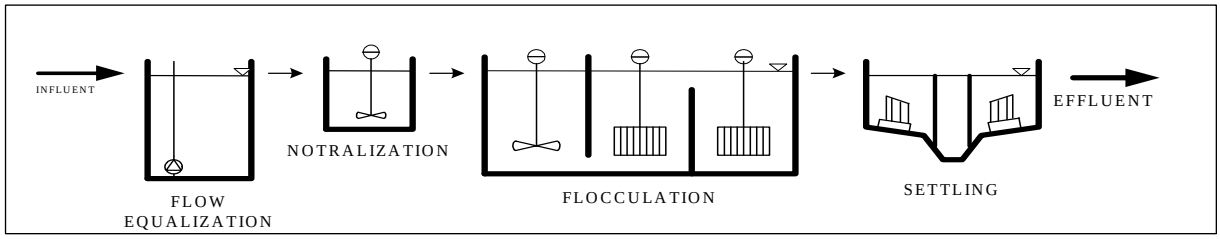

Figure 24. Flow Diagram of Wastewater Treatment Plant for Battery Industry

3.4.3. Dye Industry

The chemical industry produces chemical materials that are used as inputs by other sectors. Such products include dyes, pigments, fabric paints and denim enzymes. Not only are COD values high in the wastewater of the chemical industry, but some heavy metals also occurring in the wastewater. The analyses of the influent and effluent of WWTP are shown in Figure 25. COD values of influent and effluent were 10920 mg/l and 200 mg/l, respectively, 98.20% COD, 99.20% Cr and 94.70% Zn reduction was achieved as a result of the treatment processes.

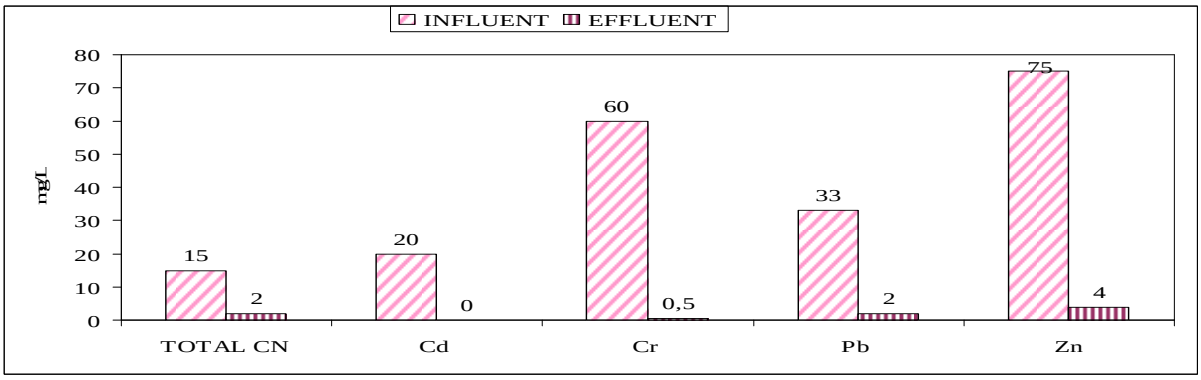

Figure 25. Characteristics of Influent and Effluent Wastewater from Dye Industry

When treating wastewater from the chemical sector, chemical treatment processes are utilized first followed by filtration processes. Iron sulfate, a cationic 33040 trade mark polyelectrolyte and lime are used in the course of the chemical treatment process. The flow diagram of the wastewater treatment plant within the chemical industry is shown in Figure 26.

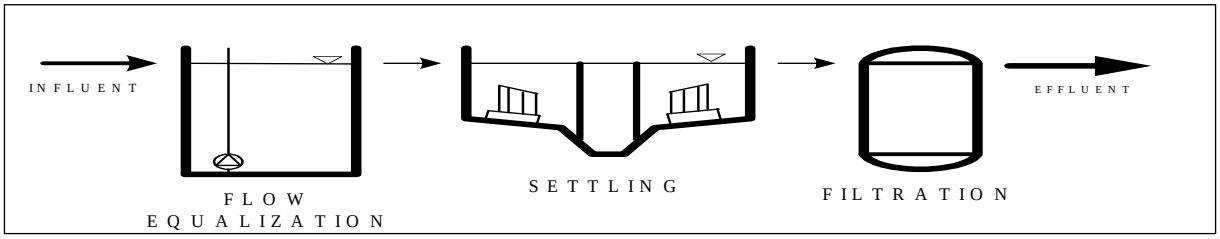

Figure 26. Flow Diagram of Wastewater Treatment Plant for Dye Industry

Table 4. Wastewater characteristics of selected chemistry industries

	COD (mg/l)		SS (mg/l)		NH_4-N (mg/l)		Cr (mg/l)		Zn (mg/l)	
	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.	inf.	eff.
detergent	49800	200	-	-	-	-	-	-	-	-
battery	289	65	127	64	175	125	-	-	-	-
dye	10920	200	-	-	-	-	-	-	-	-

Different types of products in this sector make the wastewater treatment difficult. In this study, COD, SS, NH_4-N and trace pollutant parameters were defined in wastewater collected from selected chemical industries. Neutralization and chemical oxidation processes were used in specific type treatment plants and high treatment efficiencies were determined according to chemicals used in plant like lime, alum and ferrous salts.

4. CONCLUSIONS

The study has shown that different industries use a wide range of physical, chemical and biological processes in the treatment of wastewater. In this study, four common sectors that are metal, food, textile and chemistry were selected and examined the process types. Treatment efficiencies were determined according to "Water Pollution and Control Regulation" and COD, oil & grease, suspended solids and heavy metal content parameters were researched.

In metal sector industries, wastewater treatment plants are used equalization tank, chemical oxidation tank, flocculation and precipitation tank processes. In plants, 89.79% of COD, 96% of oil & grease, 91% of the suspended solids and remarkable amount heavy metal was removed.

In food sector industries, equalization tank, floatation, flocculation, pre-precipitation, activated sludge, anaerobic contact reactor and precipitation tanks are used for treatment. Treatment plants have about 98% COD, 94% oil & grease and 95% suspended solids removal efficiency.

Textile sector wastewater treatment plants have screens, equalization tank, flocculation, activated sludge and precipitation processes. In plants, 87% of COD, 94% of suspended solids and 96% Cr^{6+} was removed successfully.

In the chemistry sector, like another similar sectors, screens, floatation, equalization tank, neutralization, flocculation, pre-precipitation tank, activated sludge system, precipitation and filtration processes are used. Treatment plants have 98% COD, 96% oil & grease and 86% suspended solids removal efficiency.

Various treatment processes and methods are being used for industrial wastewater plants. However, 70-95% COD removal and 50-75% heavy metals removal were determined in neutralization and chemical coagulation/flocculation processes. In order to removal of specific wastewater constituents, 50-60% oil&grease, 40-70% TKN and CN removal efficiencies were achieved in flotation and chemical oxidation respectively.

Although the different types of industries and their wastewater, true processes were preferred and planned for treatment of industrial wastewater. For the best treatment efficiencies plants have to operate well.

Environmental problems can be preventing by using industrial wastewater treatment plants efficiently. Data, obtained in this study, displays the industrial treatment plants and their efficiencies in Turkey.

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