Journal of ENVIRONMENTAL Treatment Techniques

J. Environ. Treat. Tech.
ISSN: 2309-1185

Journal web link: http://www.jett.dormaj.com

Optimization of Coagulation/Flocculation for Treatment of Wastewater

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Received: 19/04/2015 Accepted: 08/06/2015 Published: 30/06/2015

Abstract

One of the industrial areas in the south of Iran is Bandar Imam Petrochemical Economic Zone which has a lot of petrochemical complex, Farabi Petrochemical complex is one of those places. Coagulation/flocculation could be a typical methodology in water and wastewater treatment that a number of chemicals are added to assist the coagulation/flocculation and causes to the sedimentation. In this paper, the sampling and measurement of characteristics wastewater containing turbidity, pH, COD, TDS and etc. were done, also Efficiency of coagulant was assessed in terms of the COD, TDS and turbidity also the optimum concentration to determine the coagulant and the pH effluent were investigated.The results show that the optimum coagulants for decreasing organic matters of wastewater, the amount of coagulant is 10mm per liter of wastewater. With this amount can be reduced by more than 50% of COD.

Keywords: Wastewater, effluent, Farabi Petrochemical complex, coagulant, jar test

1 Introduction

Industrial wastewater containing organic material which enters to the groundwater or surface water is an environmental concern. Due to characterization of these pollutants such as non-biodegradable, high toxicity, cumulative and carcinogenic effects are considered. Discharge of effluents containing organic material is not only harmful to aquatic life and plants, but also, is very dangerous due to ecosystem changes [1].

Due to the increasing applications of petrochemical products, destructive and negative effects on the environment caused by the production of wastewater, solid waste and gas emissions to the environment should be considered.

Coagulation/flocculation could be a typical methodology in water and wastewater treatment [2, 3, 4& 5] that a number of chemicals are added to assist the coagulation/flocculation and causes to the sedimentation. Mentioned chemical materials are sodium hydroxide to regulate the pH range, metallic ions and commercial anionic or cationic-based poly-electrolytes (PEs) [6].

Coagulation process was found to be economical, easy to work and uses less energy than various treatment methods. Coagulation is extensively utilized in several water treatment plants and has been found to be desirable in the treatment of wastewaters from petroleum refineries and industrial treatment plant [7, 8].

In recent years, due to vast oil and gas resources in the country and and the government's economic policies, the petrochemical industry has developed considerable, and Recent research has strongly implies that the Persian Gulf is seriously polluted with toxic metals and oil.

In recent years, in many parts of the country, using wastewater for irrigation of farmlands in most cases due to lack of water and increasing of wastewater is inevitable [9]. The management of wastewater and leachate from landfill for irrigation or using energy leads to costs reduction. [10, 11] Also, it would increase agricultural production, especially in dry climates and less water situation. With respect to the notes, the development of green space is one of the advantages of the effluent [12].

Considering shortage of water in arid and semi-arid areas, reusing of unconventional water including municipal and industrial wastewater and at the same time in compliance with environmental considerations, is necessary. For reusing of wastewater in different parts, quality of wastewater effluent and standards should be considered [13]. Presence of heavy metals in wastewater treatment and the accumulation of these metals, especially cadmium and lead in soil, are considered as important environmental issues [14].

In the present study, at first the quantity of the wastewater after each stage and the amount of overall wastewater was analyzed. Efficiency of coagulant was assessed in terms of the COD, TDS and turbidity also the optimum concentration to determine the coagulant and the pH effluent were investigated.

2 Materials and Methods

In this study, firstly identifying of Farabi petrochemicals production process, consumables chemicals and research for identifying the amount of wastewater production at each stage and whole process was investigated. Then, the sampling and measurement characteristics of wastewater are done that containing pH,

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COD, TDS, … and the effectiveness of coagulant test (poly aluminum chloride) and jar test was studied to determine the optimum concentration of coagulant and suitable pH range for the final wastewater. It should be mentioned that, the tests were carried out according to the APHA standard [15]. All tests were repeated three times and the mean values are showed in this paper.

2-1- specifications of the region under study

2-1-1- Farabi petrochemical facility specifications

Farabi petrochemicals department with an area of 20 acres on the northwest side of the Persian Gulf, port of Imam Khomeini and in the vicinity of Imam Petrochemical port, Razi and at petrochemical special economic zone are located.

Now, in this department, wastewater without any settling was entered in Khor Mousa River and then Persian Gulf. According to the carcinogenic of food and substances productive and since the fish, birds, plant tissue and finally human are in danger so it is necessary for wastewater settling and disposal of organic materials. Figure 1 shows map of khor mousa and Farabi complex and Figure 2 shows Wastewater treatment process diagram.

2-2- Characteristics of wastewater

Characteristics of total wastewater have been measured. Wastewater flow was 720 m^3/day and temperature of wastewater was 250 °C. table 1 shows characteristics of total wastewater.

Fig.1- Khor Mousa and Farabi complex

Table 1- Characteristics of wastewater

Fecal Coliform (Mpv/100 ml)	Ec µs/cm	pH	Total Hardness ($CaCO_3$) mg/l	TDS mg/l	BOD_5 mg/l	COD mg/l	SS mg/l
1100	3878	6.8	700	2000	800	2677	0.1

2-3- Sampling

The effluent samples were collected from Farabi Petrochemical wastewater discharge to the Khor Mousa rever.

Sampling and measurements of various characteristics of wastewater were conducted in according to the standard methods for the examination of treated water and wastewater [15].

2-4- Jar tests

The jar test was used to optimize the addition of coagulants and flocculants and poly aluminum chloride coagulant were utilized in different dose. For coagulation test, 200 rpm was used for mixing in five minutes and for flocculation, slow mixing rate (40 rpm) was used for five minutes also settling time was 30 minutes. Two series of jar tests were taken accordance with the standard test methods [16].

3 Results and Discussion

In this section the results of water quality and quantity of the wastewater and effectiveness of the coagulant (poly aluminum chloride) were provided then the jar test were done to determine the optimum concentration of coagulant and a suitable pH range for maximum efficiency.

3-1- Results of quality and quantity of wastewater

The following chart compares the volume of wastewater produced and COD effluent compared to the output in the different processes.

Figure 3 shows that highest amount of organic material is related to the washing process. Esterification, recycling and dewatering stages have an organic load between 3000-4000 mg/l.

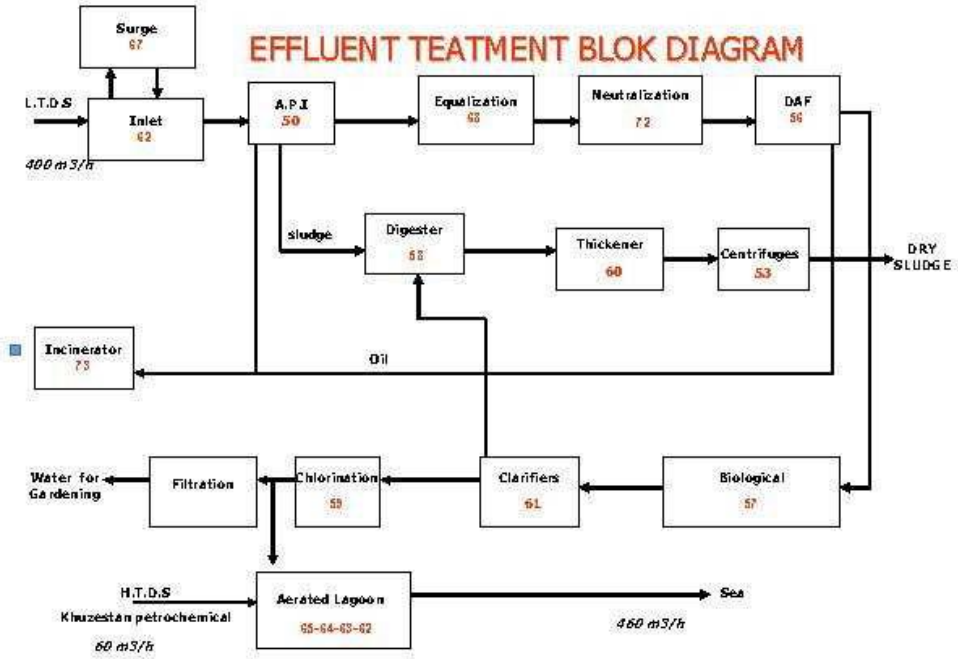

Figure 2: Wastewater treatment process diagram

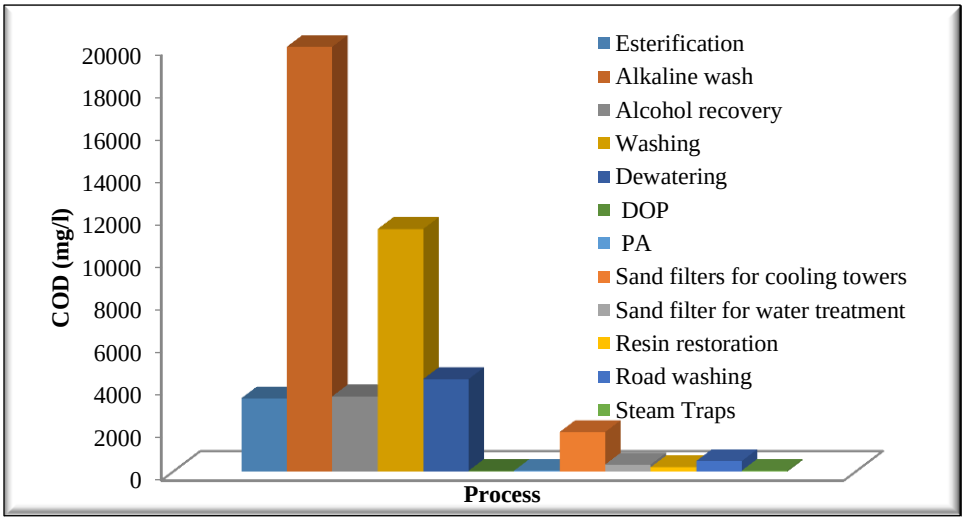

Figure 3: comparing of effluent COD in different processes

According to Figure 4, the maximum volume of wastewater production are form resin restoration, road washing, backwashing of sand filters and steam traps respectively.

3-2- Effect of coagulants on wastewater

Table 2 shows the results of the effect of coagulants on the removal of COD and turbidity. As can be seen, removal percentage of COD and turbidity was 38% and 99% respectively, which both test results were acceptable.

3-3- Jar test results

Sampling (6 samples every 2 hours, 1 liter for each time) was done from the second pond of treatment plant.

COD and TDS of the raw wastewater were 1870 and 3290 mg/l also in pH of 6.4, turbidity was 970 NTU. Jar test No. 1 shows the optimum pH in a fixed dose of coagulant. According to the table 2, the best result for COD removal is occurred in pH of 9. Jar test number 3: shows the optimum dose of coagulant – in a fixed pH. According to the table 4 the best dose of coagulant is 10ml. Jar test No. 3 shows the optimum pH in the fixed optimum dose of coagulant with a higher pH.

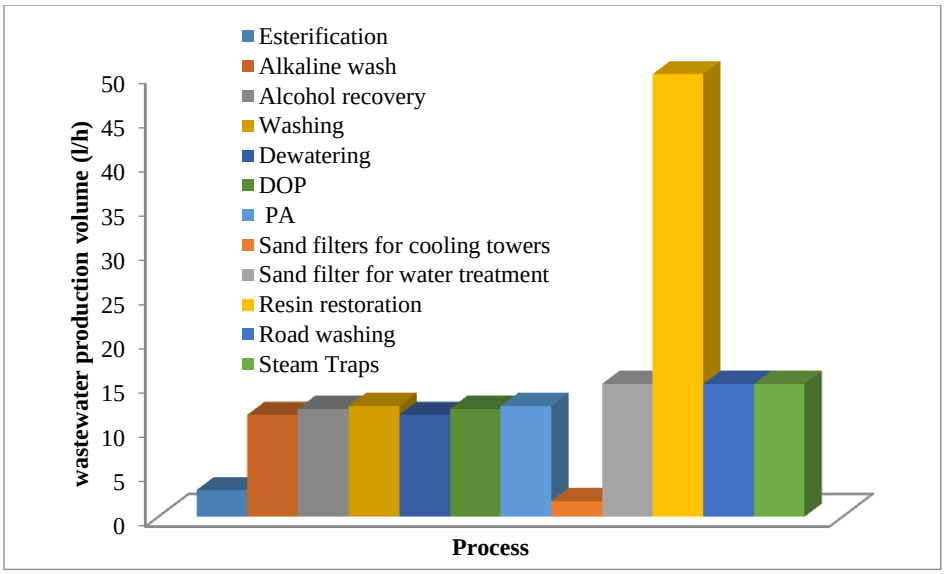

Figure 4: comparing of wastewater production volume (liters per hour) in the effluent of processes

Table 2: Results of coagulants tests on wastewater

Sample	pH	Turbidity NTU	EC (µs/cm)	TDS (mg/l)	T(°C)	COD (mg/l)	TSS (mg/l)
Control	8.5	461	4875	2830	29.5	1060	1540
6 cc coagulants	7.55	3	5158	3010	29.8	673	-
10 cc coagulants	7.06	4.6	5565	3260	29.1	684	-

Table 3- Jar test results – fixed dose of coagulant –sample temperature: 15 C°

Sample	Coagulants mg	primary pH	Turbidity NTU	TDS mg/l	Final pH	COD mg/l	Reduction% COD	Sludge volume ratio
1	10	6	160	4160	4	1270	32	Normal
2	10	7	240	4260	4.1	1235	34	Normal
3	10	7.5	213	2200	4.1	1310	30	Normal
4	10	9	93	3310	4.4	810	57	High

Table 4- Jar tests result- fixed pH, sample temperature: 15 C°

Sample	Coagulants mg	Coagulants (%)	primary pH	Turbidity NTU	TDS mg/l	Final pH	COD mg/l	Reduction (%) COD	Sludge volume ratio
1	2	0.01	9	21	3820	6.69	1640	13	Normal
2	5	0.02	9	26	3260	5.25	1120	40	High
3	10	0.05	9	105	3240	4.34	910	51	High
4	15	0.07	9	167	3390	4.14	1120	40	Normal

Table 5: Jar test results - optimum dose of coagulant - sample temperature 15 C°

Sample	Coagulants mg	pH primary	Turbidity NTU	TDS mg/l	pH Final	COD mg/l	Removal percentage	Volume ratio of sludge
1	10	8	210	2240	4.1	1320	29	Normal
2	10	9	90	3298	4.4	821	56	Normal
3	10	10	120	3100	4.5	952	49	High
4	10	11	138	3207	4.7	998	45	High

According to the table 5 the best range of pH for maximum COD removal is 9. According to the results obtained in the three jar test, it can be said that the experimental error was less than 10%.

4 Conclusions

At analyzing of output characteristics of wastewater over a period of 6 months, was determined that in most cases, organic pollution is far more than the designed (COD=2677mg/l), so serious attempt should be made to the

wastewater settling. Because the system of DOP production is a batch system and because the current volume of wastewater storage tank (90m3), every day at least 8 times wastewater is discharged in to the Khor. And a simple sampling can't determine the characteristics of outcome wastewater so composite sampling is required. In this study, the effect of chemical coagulation by poly-aluminum chloride coagulants of on wastewater as pre-settling was tested in the laboratory. According to the current test results indicate that the optimum coagulants for decreasing organic matters of wastewater, the amount of coagulant is 10mm per liter of wastewater. With this amount can be reduced by more than 50% of COD. According to the wastewater production rate at the maximum (currently) 700 cubic meters per day, in this case for pre-settling 7000 liters of coagulant 2% or 1000 liters of coagulant 14% should be consumed.

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