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ORIGINAL ARTICLE

Application of Process in Removal of Soluble Phosphate in the pilot scale

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ABSTRACT
Phosphorus and nitrogen are nutrients for algae growth. Entering of phosphate with nitrate into the water resources environment causes the eutrophication phenomenon. Phosphate is usually one of the main controlling factors of the eutrophication phenomenon. For this purpose it is necessary to reduce phosphate in urban and agriculture wastewater using appropriate methods. Biological and chemical deposition methods are the main methods used to remove phosphate. In this study, electrocoagulation method for phosphorus removal in a pilot scale with continuous flow system was used. 2195gr of potassium dichromate (KH_2PO_4) was used to prepare 50mgl Initial concentration of phosphate. The results showed that all factors considered, including retention time, salt concentration, electric current and all interactions are significant in the removal of phosphate. The results showed that the highest rate of phosphate removal of 95% is related to the retention time of 20 min. 20 grams of salt concentration and flow rate of 1.6amp.
Key Words: *Phosphate, Eutrophication, Urban and agricultural wastewater, Electrocoagulation*

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INTRODUCTION

Nowadays, global warming followed by reduced rainfall, indiscriminate and without management use of water resources in all sectors have led to dramatic reduction of water resources [1]. Also, produced wastewaters with various qualities enter into the environment especially aquatic ecosystems. The agricultural sector has the highest share in consumption of water resources. Agricultural runoff is containing nitrogen, phosphorus and pesticides [3, 4]. Phosphorus and nitrogen are nutrients for algae growth. Phosphorus is found in sewage in different forms such as ortho-phosphate, polyphosphate and organic phosphorus. Phosphate is one of the essential micronutrient for cyanobacteria and photosynthesis algae growth. Entering of phosphate with nitrate into the water resources environment causes the eutrophication phenomenon [5]. Phosphate is usually one of the main controlling factors of the eutrophication phenomenon. For this purpose it is necessary to reduce phosphate in urban and agriculture wastewater using appropriate methods [6]. Biological and chemical deposition methods are the main methods used to remove phosphate. Biological methods due to the long retention time, relatively efficiency and operational problems today are less used. In chemical deposition methods, aluminum and iron salts are used for phosphate precipitation [6, 8]. Due to relatively low efficiency and high sludge production of chemical deposition methods, many researchers are used electrochemical methods such as electrocoagulation for wastewater treatment. Electrocoagulation process compared with usual coagulation and flocculation processes requires small facilities, its treatment duration is short, no chemicals are used and also the amount of sludge production is less. In electrochemical process using current metal ions are formed in solution.By formation of these metal ions in solution, chemical coagulation and coagulation operation are performed that result in the removal of pollutants and waste water treatment[9]. The most important factors affecting the efficiency of this process are environment PH, flow density, contact time and type of electrodes arrangement.

METHODS AND MATERIALS

Potassium dichromate salts (KH2PO4) was used to prepare 50 mg l initial concentration of phosphate. 2195gr of this substance produces 50mg/lit phosphate. In order to conduct each experiment 6lit solution was prepared. Values (10,15,20) g/L NaCl was used to prepare the salt concentration in experiments. Considering previous studies the optimum PH value was controlled in the neutral condition. Using a power supply, current density at three levels (.8,1.2,1.6) amps and for contact times of 5,10,15 and 20 minutes at a constant voltage of 9.5 were performed. The electrodes are made of aluminum and there is 1.5 cm distance between them and the number of electrodes in the pilot is 10 with a surface equal to (2 x 10) square centimeters. After the solution phase, a part of the built solution enters into the tank and other parts to the reactor and electrodes connect to the power supply, thus the solution in the reactor will be subjected to phosphate removal process. After filtering, the sample places in the spectrophotometer (DR5000) and phosphate level will be read. At each step, to measure phosphate a phosphate reagent is used. The sample should be diluted 10 times to reduce the experiment percent error in high concentrations.

RESULTS AND DISCUSSION

Significance level of all factors that fitted as a factorial design showed that all factors including retention time, salt concentration, electric current and all interactions are significant.

Table (1) Variance Analysis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	38304.713[a]	35	1094.420	1720.486	.000
Intercept	476255.467	1	476255.467	748698.551	.000
detention_time	20818.144	3	6939.381	10909.071	.000
concentration	995.181	2	497.591	782.238	.000
Amper	5568.808	2	2784.404	4377.229	.000
detention_time * concentration	2645.414	6	440.902	693.122	.000
detention_time * Amp	6730.828	6	1121.805	1763.536	.000
concentration * Amp	204.939	4	51.235	80.544	.000
detention_time * concentration * Amp	1341.399	12	111.783	175.729	.000
Error	22.900	36	.636		
Total	514583.080	72			
Corrected Total	38327.613	71			

By investigating of effective factors in the removal of phosphate coagulation factors phosphate removal in continuous electrocoagulation systems, Duncan test was used to find optimal combination of variables. The results of retention time influence on the removal of phosphate were fitted in 4 classes. So the highest percent of phosphate removal (97.13) is related to retention time of 20 minutes and the lowest removal percent 52.9 is related to retention time

Table (2) Duncan test, effect of retention time on the removal of soluble phosphate

Time(min)	N	Subset			
		1	2	3	4
5	18	52.90			
10	18		84.57		
15	18			90.71	
20	18				97.13
Sig.		1.000	1.000	1.000	1.000

Considering phosphate removal percent depending on the used salt concentration, it is observed that the highest percent of phosphate removal (84.4) is related to concentration salt of 20gr and the lowest percent (76.1) is related to 10 g/L.

Table (3) Duncan test based on the salt concentration

Concentration(gr/lit)	N	Subset		
		1		
10	24	76.10	83.48	
15	24			84.40
20	24		1.000	1.000
Sig.		1.000		

Considering phosphate removal percent on the current rate, it is observed that the highest percent of phosphate removal (92.34) is related to 1.6amp and the lowest percent (70.81) is related to 0.8amp.

Table (4) Duncan test based on initial concentration of phosphate

A	N	Subset		
		1	2	3
0.8	24	70.81		
1.2	24		80.83	
1.6	24			92.34
Sig.		1.000	1.000	1.000

CONCLUSIONS

By increasing of retention time the removal percent of phosphate was increases. In this study, time of 20 minutes was estimated as the most appropriate time. The results showed that by increasing of the phosphate initial concentration the optimum contact time will also be increased. The electro coagulation method is based on the presence of salts for creating electrical conductivity. It is observed that as the salt concentration is higher the phosphate removal percent will increase. The amount of electric current as one of the most influential factors in the process of phosphate removal, in the amount of 1.6amp, showed its optimum effect.

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