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Survey of Dissolved Air Flotation System Efficiency for Reduce of Pollution of Vegetable Oil Industry Wastewater

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Abstract: The aim of this research was to sudy the reduction of pollution of vegetable oil manufacturing wastewater with DAF system. At first phase of this examination, the optimum dosage of the coagulants was determined. The coagulants that used in this study were Alum and Ferric Chloride. The second phase was flotation in this series of examinations, oil, COD , total solid, volatile solid, fixed solid and suspended solid measured in raw wastewater and the effluent of the DAF pilot. Optimum value of pH for alum and ferric chloride obtained 7.5 and 5.5, respectively. Optimum dosage for these obtained 30 and 32 mg L^{-1} in this research. Mean removal for the parameters of oil, COD, total solid, volatile solid, fixed solid and suspended solid obtained 75.85, 78.27, 77.32, 82.47, 73.52 and 85.53%, respectively. With pressure rising from 3 to 4 and 5 atm removing rate of COD, total solid, volatile solid, fixed solid parameters reduced , but oil and suspended solid have increase. In addition, following increase of flotation time up to 120 sec all of the measured parameters have increase in removing rate. Optimum A/S for removal of COD, total solid, volatile solid, fixed solid parameters obtained 0.001 and for oil and suspended solid obtained 0.0015.

Key words: Dissolved air flotation, pollution, vegetate oil industry, alum, chloride ferric

INTRODUCTION

Air flotation was used as one of methods for separation of mine ore in 1990 (Zobouis and Avranas, 2002). Flotation is a physical treatment method which is used for separation of solid or liquid particles from a liquid phase. Separation is carried out through introducing of gas fine bubbles, mostly air, into liquid phase. Air bubbles attach to solid particles and floating force of particles, gas bubbles are high enough to cause particle rise to surface. Thereby, particles with density more than liquid density can be forced to raise surface (Rubio *et al*., 2002). Basic advantage of flotation over sedimentation is more complete and rapid removal of very small or light particles which are precipitated slowly (Chin and Dahlber, 1995).

In Dissolved Air Flotation (DAF) system, bubbles are formed due to decrease of air saturated water pressure in pressure more than atmospheric pressure. Air is dissolved in wastewater under pressure of several atmospheres, then pressure decreases to atmospheric pressure (Metcalf and Eddy, 2001). Overall flow remains in a pressure vessel for many minutes to provide opportunity for air dissolution. Then, flow under pressure passes across a pressure breaker valve and reaches to flotation vessel, where air in form of fine bubbles is exited through overall liquid volume. Dissolved Air Flotation (DAF) is widely used for separation of suspended solids, oil, grease and fiber (Roux and Badenhorst, 2005). Successful examples for application of this process include removal of algae from stabilization ponds, final treatment of treatment plant effluents, excess activated sludge thickening and separation of fat and proteinous materials.

Edible oil and fats are essential commodity items. Vegetable fats and oils are substances derived from plants that are composed of triglycerides. Oils extracted from plants have been used in many cultures, since ancient time. Many vegetable oils are consumed directly in food. The total current production in Iran is around 1.5 million tones annually with a growth rate of about 6% per annum. One of the vegetable oil mills in Iran is Naz vegetable oil mill. This mill located in Isfahan, the total current production is about 30 thousands tones annually.

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This mill vegetable oil mills cotton, soybean and sunflower. The wastewater of this mill is high organic load level, suspended solids, oil and fat, which decrease of these parameters during treatment must be considered. Because of high concentration of effluent contaminants and lack of a suitable pretreatment, dissolved air flotation system with coagulation process for decrease of pollution load of this mill wastewater was investigated. In this study, pretreatment of Naz vegetable oil mill wastewater by DAF method was evaluated.

MATERIALS AND METHODS

This investigation was carried out on a pilot study. The dissolved air flotation reactor constructed with stainless steel and located in school of health in Isfahan medical science university. This pilot reactor had two vessels; a pressurized vessel (saturator) and a floater vessel and air required for flotation operation was provided by a 60 L air compressor. pH of sample effluent was 2.8 to 3.2, which by additional of 1 N caustic soda to it pH reached to optimum level for doing of flotation operations.

Water in saturator vessel located in pressures of 3, 4 and 5 atmosphere. Then, air was allowed to dissolve in water completely. One the other side, coagulation process was carried out on wastewater in flotation vessel. Then, pressurized water was arrived to flotation vessel through a pressure breaker valve and flotation times of 5, 60 and 120 sec were applied on wastewater that finally wastewater dilution due to addition of pressurized water was calculated in order to calculate level of intended parameters removal. Experiments were carried out mostly in two series including jar test and flotation experiments. Optimum dose and optimum pH of used coagulants were determined by jar test. Alum and ferric chloride were used as coagulant in this investigation. Flotation experiments consisted of parameters COD, fat, total solids, inorganic solids, organic solids and suspended solids which were measured according to standard methods (APHA, AWWA, WPCF, 2000).

All sampling condition and experiments were according to of standard methods for water and wastewater experiments (APHA, AWWA, WPCF, 2000). Fat was measured by soxhlet method, COD was measured by spectrophotometric method, total solids and suspended solids were measured by oven in temperature 103-105°C and organic solids and inorganic solids were measured in temperature 550±50°C. Firstly, intended parameters in sample taken from mill effluent were measured and then same parameters were measured in pilot effluent in order to determine efficiency of pilot.

Air/Solids (A/S) ratio has important influence on dissolved air flotation. Higher A/S ratio is required for maintenance of removal efficiency for wastewater containing lower suspended solids. A/S ratio 0.05 is required for wastewater containing suspended solids lower than 1000 mg L^{-1}. A/S ratio was calculated by following formula (Roux and Badenhorst, 2005):

$$A/S = Cs\,[f\,(p/14.7+1)-1]/si$$

Where:

Cs = Air dissolution (mg L^{-1})
f = Ratio of air dissolution in wastewater to air dissolution in water
P = Measured pressure (psig)
s = Influent suspend solids (mg L^{-1})

RESULTS AND DISCUSSION

Results of showed that optimum pH for alum and ferric chloride was 7.5 and 5.5, respectively. The optimum dosage of coagulation for alum was 30 and ferric chloride was 32 mg L^{-1}. The influence of flotation time and pressure influence with usage of alum and ferric chloride on efficiency of COD, oil , total solids, volatile solids, inorganic total solids and total suspended solids removal was shown in Table 1-3.

Table 1-3 and experiment results show that, pressure increase from 3 to 4 and 5 atmosphere resulted in increase of oil and suspended solids removal , while had negative influence on removal efficiency of parameters as COD, total solids, inorganic solids and organic solids. In addition, alum efficiency in removal of mentioned parameters in all used saturation pressure and flotation time is better than ferric chloride. It was concluded that increase of flotation time to 120 sec resulted in removal increase of mentioned parameters, so that level of pollutant removal was considerably more in 120 sec in comparison with 5 and 60 sec. Statistical analysis also indicate significant difference between these pressure ($p<0.05$).

Optimum pressure and A/S ratio for removal of parameters as COD, total solids, organic solids and inorganic solids were 3 atmospheres and 0.013, respectively while optimum pressure and A/S ratio for removal of parameters as oil and suspended solids were 5 atmospheres and 0.02. Optimum flotation time for removal of all mentioned pollutants was 120 sec.

At concentration 30 mg L^{-1} alum and 32 mg L^{-1} ferric chloride as optimum dose, optimum removal efficiency for parameters as COD, oil, total solids, organic solids, inorganic solids and suspended solids was 75, 85, 52.73, 47.82, 32.77, 27.78 and 53.85%, respectively.

Table 1: The comparison of type of coagulations in COD, oil, TS, VS, MTS and TSS removal at pressure of 3 atmospheres

Time of flotation (sec)	Type of coagulations (mg L^{-1})	Removal (%)					
		COD	Oil	TS	VS	MTS	TSS
5	30 of alum	48.72	45.33	37.41	46.32	35.32	19.09
	32 of ferric chloride	9.86	35.55	17.31	40.65	14.73	11.13
60	30 of alum	67.77	70.25	69.27	77.31	65.25	66.77
	32 of ferric chloride	12.68	50.97	48.30	66.77	38.00	58.27
120	30 of alum	75.85	77.12	77.32	82.47	73.52	79.27
	32 of ferric chloride	32.40	63.07	62.77	76.57	49.48	72.27

Table 2: The comparison of type of coagulations in COD, oil, TS, VS, MTS and TSS removal at pressure of 4 atmospheres

Time of flotation (sec)	Type of coagulations (mg L^{-1})	Removal (%)					
		COD	Oil	TS	VS	MTS	TSS
5	30 of alum	43.95	47.12	34.95	42.90	31.42	20.02
	32 of ferric chloride	12.30	37.97	13.20	30.85	20.96	13.65
60	30 of alum	60.12	71.85	63.73	72.22	57.70	67.85
	32 of ferric chloride	24.85	53.75	39.95	40.12	38.79	42.55
120	30 of alum	67.85	76.42	76.76	80.95	67.32	80.70
	32 of ferric chloride	32.80	64.70	56.02	61.52	47.45	56.27

Table 3: The comparison of type of coagulations in COD, oil, TS, VS, MTS and TSS removal at pressure of 5 atmospheres

Time of flotation (sec)	Type of coagulations (mg L^{-1})	Removal (%)					
		COD	Oil	TS	VS	MTS	TSS
5	30 of alum	8.87	63.25	33.26	41.57	30.20	46.07
	32 of ferric chloride	14.50	64.80	11.12	12.13	20.63	20.80
60	30 of alum	18.63	71.11	60.99	70.68	54.66	72.61
	32 of ferric chloride	30.66	84.22	33.25	23.22	36.35	29.20
120	30 of alum	33.07	78.27	75.26	76.90	68.18	85.53
	32 of ferric chloride	34.75	89.60	54.59	52.78	56.36	52.83

A/S ratio amount has direct association with pressure increase; A/S amount for removal COD was 0.013, that has correspondence with studies done by other investigators in similar grounds. In investigation done by Rubio *et al.* (2002) on soybean mill wastewater, DAF process with coagulation was studied in pilot scale that COD removal was done in A/S 0.012. Investigation of Chin and Dahlber (1995), on wastewater palm oil mill by same system showed COD removal was obtained in A/S 0.015.

These results was shown that, increase of flotation time from 5 to 60 sec and then 120 sec result in increase of removal of all parameters, that is, have positive influence on removal efficiency of all these parameters that difference among flotation time was significant statically($p<0.05$).

REFERENCES

APHA., AWWA. and WPCF., 2000. Standard Methods for the Examination of Water and Wastewater. 20th Edn., American Water Works Association, Washington DC. USA., ISBN 0875532357, pp: 125-136.

Chin, K.K. and A.G. Dahlber, 1995. Design and Operation of Wastewater Treatment Plants Instrumentation, Control and Automation. 1st Edn., Elsevier Science Ltd., ISBN: 0080425496.

Metcalf and Eddy, 2001. Wastewater Engineering: Treatment, Disposal and Reuse. 7th Edn., McGraw-Hill Book Co. Inc., Boston, MA., ISBN 9780072545470.

Roux, M.P. and J. Badenhorst, 2005. Fungal treatment of an edible-oil-containing industrial effluent. World J. Microbiol. Biotechnol., 21: 947-953.

Rubio, J., M.L. Souza and R.W. Smith, 2002. Overview of flotation as a wastewater treatment technique. J. Mineral Eng., 15: 139-155.

Zobouis, A.I. and A. Avranas, 2002. Treatment of oil in water emulsions by coagulation and dissolved air flotation. J. Mineral Eng., 15: 100-105.