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Industrial Wastewater, Recycle and Reuse, Using Hybrid Process

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ABSTRACT

Industrial wastewater contains a lot of pollutants and therefore needs special treatment processes. The treatment process may contain mechanical, biological, chemical, physical and physiochemical such as Coagulation – Flocculation process. The goal of this experimental work was to investigate the effects of coagulation-flocculation and dissolved air flotation as a hybrid process of industrial wastewater. A jar test is used as a first step to determine the type and dose of coagulant for this wastewater. Then the effluent of first step used to further treatment by using Dissolved Air Flotation pilot. Results of coagulation-flocculation process show that ferric chloride is more effective on turbidity and COD removal than alum and quick lime. Also in dissolved air flotation, increasing pressure in pressure tank compared to the kind of mixing air-wastewater causes to further remove of NTU and COD. Also, using both Coagulation-Flocculation and Dissolved Air Flotation (DAF) as a hybrid process can drastically reduce the impurities. For example, using ferric chloride in Coagulation process and 5 bar pressure in pressure tank causes removing turbidity and COD respectively 98% and 92%. So it can be concluded the hybrid process is very effective to recycle and reuse industrial wastewaters.

KEYWORDS: industrial wastewater treatment, wastewater reuse, coagulation, Dissolved Air Flotation

INTRODUCTION

In the food sector, the water quality which can be used in the different processes is always linked to product safety issues. Hence, many of these requirements are specified in national regulations [1-3]. The main issue here is the product quality and how this is affected by the quality of the inlet water. In industries once water has served, it must be treated to be recycled or reused. Also it must be treated to enter the city utility wastewater treatment process to the environment in a manner consistent with water quality regulations [4-6].

Industrial wastewater contains a lot of pollutants and therefore needs special treatment processes. Also, the emission limits for industrial wastewater effluent are constantly being tightened up [7-9]. Recycling and product recovery in various processes are becoming an increasing priority among manufacturing industries. These activities represent an additional contribution to the protection of environment and aquatic ecosystems. Therefor possess great cost-cutting potential. Industrial wastewater treatment is closely related to the standards for the industrial effluent quality. Various wastewater treatment processes are designed to achieve improvements in the quality of the industrial wastewater. The treatment process may contain mechanical, biological and physiochemical such as filtration and Coagulation - flocculation process steps. Coagulation and flocculation involves the removal of suspended colloidal particles and turbidity from wastewater to prepare it for reuse or further treatment. The process of coagulation-flocculation is used whenever the natural settling rate of suspended particles is too slow to provide effective sedimentation and clarification. Various coagulants are used to neutralize suspended particles negative charge, bringing the particles together to provide flocs. To generate flocs for faster settling, coagulant aides as a high molecular weight is generally used in combination with primary coagulants. Also dissolved air flotation process (DAF) is an effective physiochemical technology for treating a variety of industrial and municipal wastewater. DAF systems are commonly used for the removal of oils, greases and suspended particles of wastewater to meet a variety of treatment goals [9-11].

The goal of this experimental work was to investigate the effects of Coagulation- Flocculation and dissolved air flotation as a hybrid process on carwash wastewater as an industrial wastewater.

MATERIAL AND METHODS

Raw wastewater:

The properties of raw wastewater are shown in table 1. The raw wastewater is obtained from a carwash of Quchan city.

Table 1: Raw wastewater properties of carwash industry

103 NTU	Turbidity
233 mg/l	TSS
1147 mg/l	TDS
248 mg/l	COD
7.6	PH

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Chemical coagulants:

Trivalent ions such as salts of Al, Fe and quick lime are used as coagulants in industrial and municipal wastewater treatment. When coagulants such as salt of Al(III) and Fe(III) are added to wastewater, it dissociates to yield trivalent ions, which hydrate to form aquometal complexes $Al(H_2O)_6^{3+}$ and $Fe(H_2O)_6^{3+}$. These complexes form a variety of species such as Al $(OH)^{2+}$. These new species coagulants products are very effective as they adsorb strongly onto the surface of most negative charge colloidal particles.

Jar test:

The jar test contains four or six jars is an experimental laboratory procedure used to determine the coagulant kind and the optimum operating conditions such as pH for water or wastewater treatment. This method allows adjustments in, variations in primary coagulant or coagulant aid dose, alternating mixing speeds, on a small scale in order to predict the functioning of large water treatment systems.

Dissolved air flotation pilot:

Oil, grease and other pollutants are removed through the use of dissolved air flotation process. In this process air injects under pressure into tank of DAF system and recycles the effluent stream to combine with influent wastewater in pressure tank. The dissolved air comes out of solution in the form of very small bubbles that attach to the oil and other contaminants. The bubbles tend to rise with contaminants to the surface of flotation basin and form a floating bed of material that is removed by a surface skimmer. The components of DAF are shown in Fig.2.

Fig.2: The components of DAF system

The experimental procedure:

The first step of this experimental work is coagulation-flocculation for remove most suspended particles from raw wastewater. A jar test is used to determine the optimum operating conditions and type and dose of coagulant for the wastewater treatment. This method allows choosing the suitable type of coagulant among alum, ferric chloride and quick lime. Then the effluent of first step used to further treatment by using Dissolved Air Flotation pilot. The independent variations are pressure, kind of feed air to wastewater and retention time in flotation basin, and the end of each experiment the properties of treated wastewater such as turbidity, COD and TDS will be measured.

RESULTS AND DISCUSSION

Fig.3 shows the effect of coagulant kind in variation dose on turbidity removal of wastewater. As shown in Fig.3, increasing of coagulant dose cause to more turbidity removal and the optimum dose of for each coagulant is near to 120 mg/l. Also ferric chloride compare to other coagulant can reduce more suspended solids and turbidity.

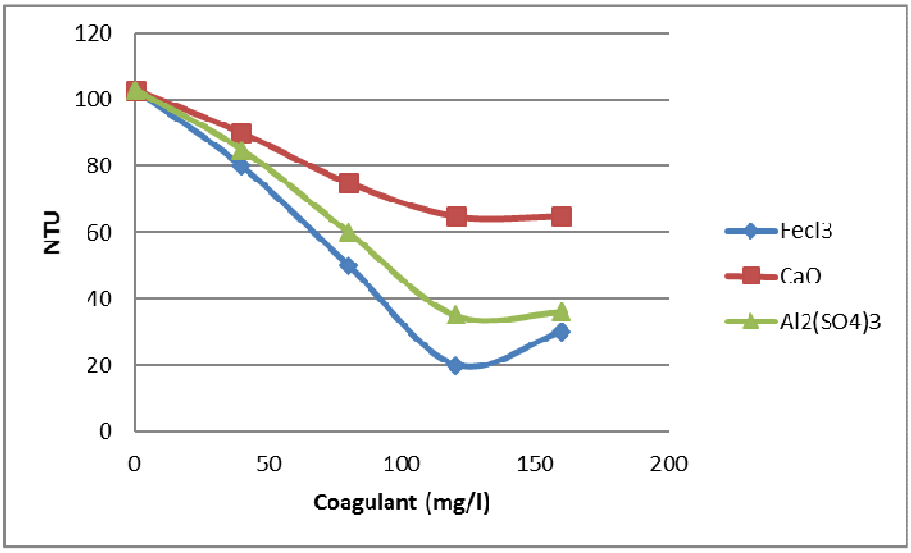

Fig.3: The effect of coagulant on turbidity removal

Also Fig.4 shows the effect of coagulants on COD removal. The ferric chloride can reduce the COD nearly to 50 percent and it can be concluded that the half of total COD related to suspended particles.

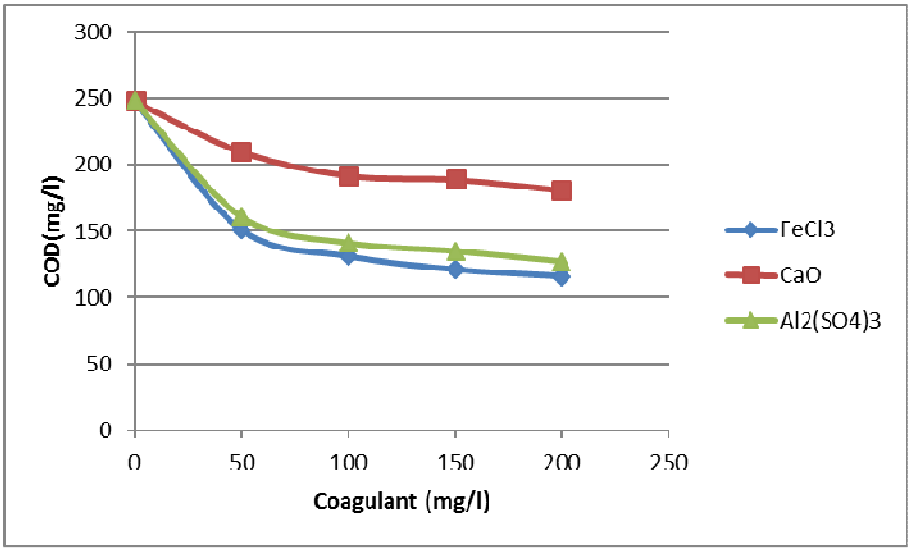

Fig.4: The effect of coagulant on COD removal

The effluent of first step treated wastewater used for dissolved air flotation process as the second step. The air can be feed from the top and bottom to the pressure tank. And the level of wastewater in pressure tank is 70 percent, so the kind of mixing air and wastewater is different. Fig.5 and Fig.6 show the effect of dissolved air flotation in various tank pressures and retention times on NTU removal. Comparing this two figures show the effect of increasing pressure is more effective than kind of feed air on NTU removal. Also the results of dissolved air flotation for COD removal are like to NTU as shown in figures 7 and 8.

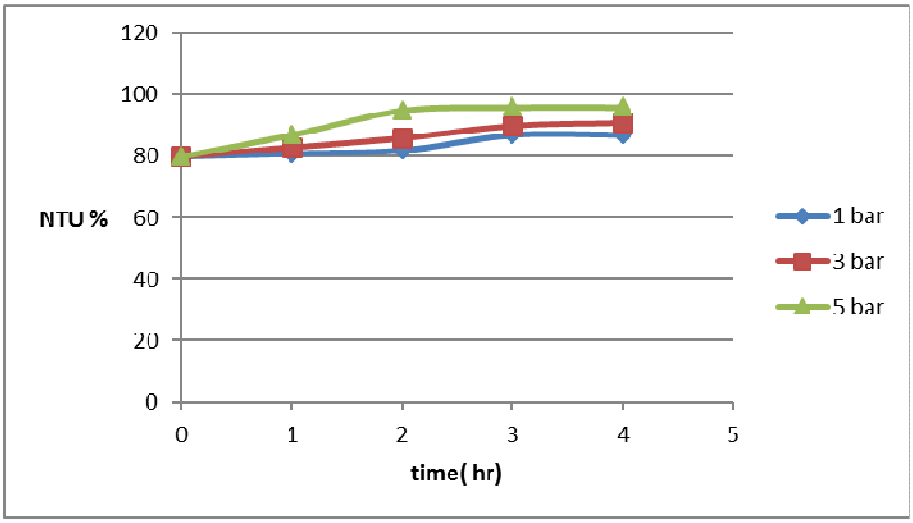

Fig5: The effect of dissolved air flotation process on turbidity removal for top feed air

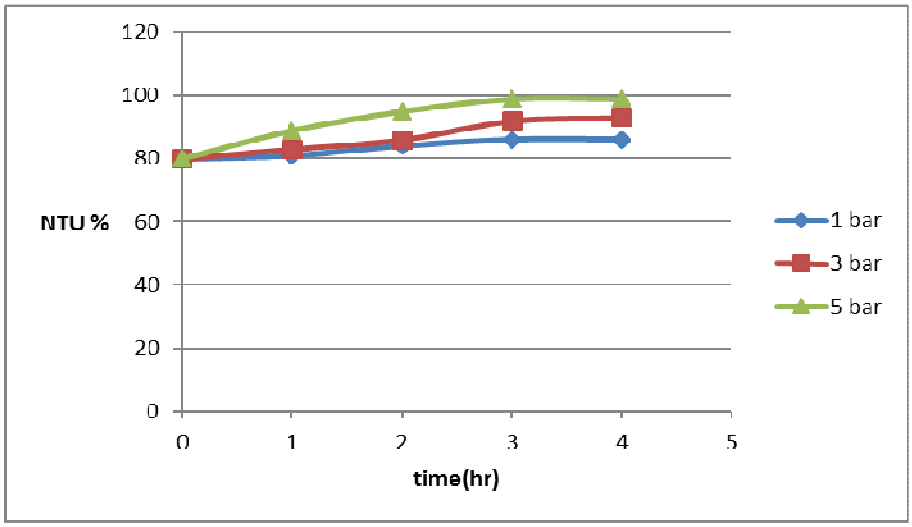

Fig6: The effect of dissolved air flotation process on turbidity removal for bottom feed air

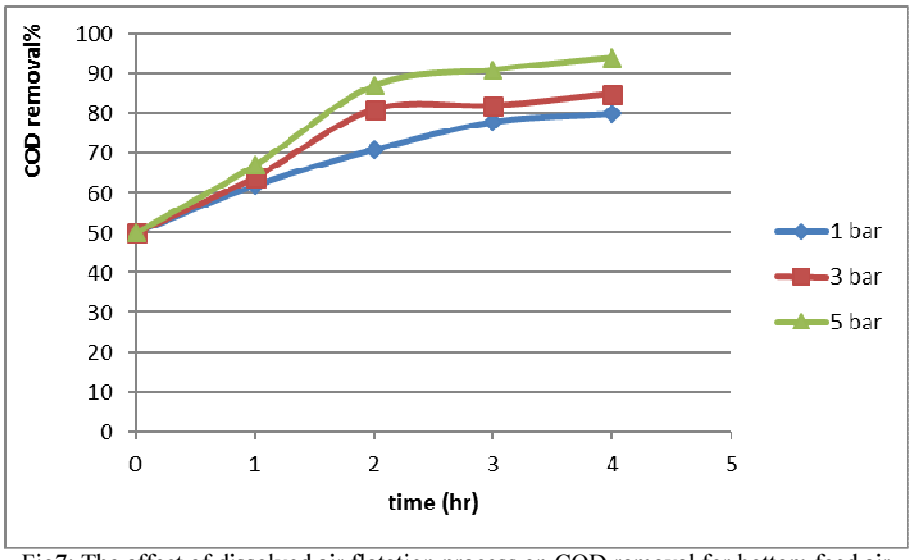

Fig7: The effect of dissolved air flotation process on COD removal for bottom feed air

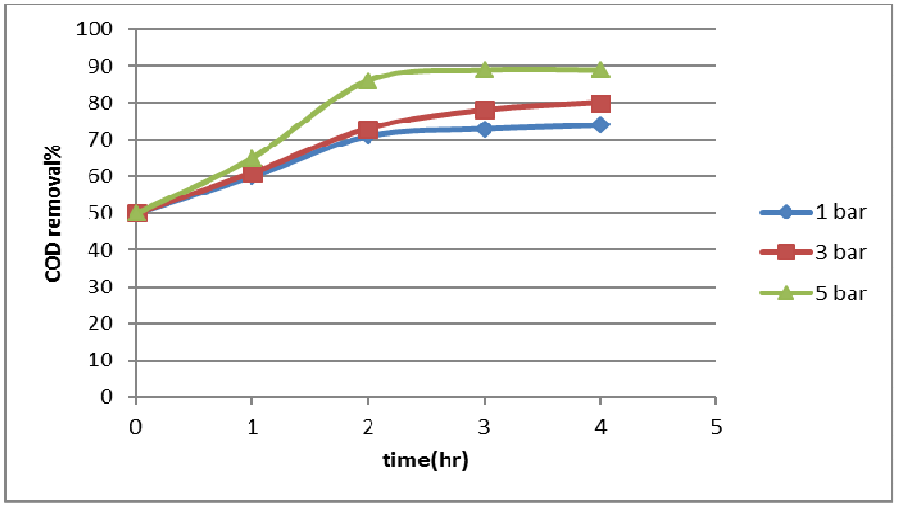

Fig8: The effect of dissolved air flotation process on COD removal for top feed air

Conclusion

The hybrid process such as Coagulation- flocculation and Dissolved Air flotation is more effective to recycle and reuse for industrial wastewaters. Results of coagulation-flocculation process show ferric chloride is more effective on turbidity and COD removal than alum and quick lime. Also in dissolved air flotation increasing of pressure in pressure tank compare than kind of mixing air-wastewater causes to further removal of NTU and COD. And the final results show using both Coagulation-Flocculation and Dissolved Air Flotation as a hybrid process can drastically reduce the impurities. For example, using ferric chloride in Coagulation process and 5 bar pressure in pressure tank cause to remove 98% and 92% of turbidity and COD respectively

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