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Effects on Effluent Quality of Industrial Waste Water using Coagulation and Flocculation

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***Abstract* - Now a day's industrial waste water pollution increases due to suspended and dissolved solids present so there is a need of alternative for such problems. Coagulation and flocculation processes are used to separate the suspended solids portion from the water. In the present study different coagulant such as alum, lime, polyelectrolyte, ferrous sulphate and their combination is used to improve parameters like colour, pH, COD, BOD, TSS and water sludge etc. Standard jar test with modification was used in the laboratory experiment. The procedures included rapid mixing, followed by slow mixing and settling. It was found that the potential of coagulant and their combination to reduced parameters from industrial effluent is good. Maximum flocks produces at pH 9 and pH10 and composition of lime, ferrous sulphate and polyelectrolyte gave best result and remove colour, BOD, COD, TSS and water sludge. Coagulation and flocculation is use to pretreated the water and helps the industries in easier control of water pollution as well as cleaner environment.**

Keywords: Coagulation, COD, BOD, TSS, Water Sludge, Effluent Waste Water.

I. INTRODUCTION

In India, the chemical industry is one of the most important industries of the country. However, large volumes of wastewater are generated during the process. Different conventional physicochemical and biological treatments have been used to treat the effluent wastewater. The pollutants in the wastewater are different salts, surfactants, heavy metals, mineral oils and others. This wastewater can cause serious environmental problems due to their high color, large amount of suspended solids, and high chemical oxygen demand. So, they have to be removed before being discharged into the environment. Because of the nature of the colloidal suspension, these particles will not sediment or be separated with conventional physical methods (such as filtration or settling) unless they are agglomerated through coagulation and flocculation. Colloid particles are removed from water via coagulation and flocculation processes.

Coagulation indicates the process which colloidal particles and very fine solid suspensions are destabilized, so that they can begin to agglomerate if the conditions are appropriate. Flocculation refers to the process by which destabilized particles actually conglomerate into larger aggregates so that they can be separated from the wastewater. The colloids commonly found in wastewater are stable because of the electrical charge that they carry. The charge of colloids can be positive or negative. However, most colloidal particles in wastewater have a negative charge. In addition, coagulation can also produce the removal of particles larger that colloidal particles due to the entrapment of such particles in the flocs formed during coagulation. In most water treatment plants, the minimal coagulant concentration and the residual turbidity of the water are determined by the Jar-Test technique. Coagulation or flocculation process was conducted for the treatment of industrial wastewater to achieve maximum removal of COD, BOD, water sludge, colour and TSS. Aluminum sulfate (alum), ferrous sulfate, ferric chloride and ferric chloro-sulfate were commonly used as coagulants.

At India there are about one thousand chemical based industries. These industries discharge industrial effluent without any prior treatment but these discharge effluent enter into CETPs for proper Treatment. These CETPs established basically to treat for cotton based industrial effluent. At present time Synthetic cloths are dyeing and printed here. These changing of process of that area and using of synthetic dyes, large quantity of effluents cause failure of CETPs.

By the using of proper dosing and new Technology we can treat this industrial waste water properly. Hydrate Lime, Ferrous Sulphate and Polyelectrolyte mostly using by CETPs but their dosing process, poor quality of chemicals and oldest technology failed to proper treat these effluent.

Therefore, the effect of coagulant dose, polyelectrolyte dose, pH of solution and addition of polyelectrolyte as coagulant aid and found to be important parameters for effective treatment of industrial wastewater.

II. LITERATURE SURVEY

In this study, coagulation-flocculation process was used to treat detergent wastewater with ferric chloride as coagulant. The improvement of the process by using polyelectrolytes and clay minerals (montmorillonite and bentonite) as coagulant aids was also investigated. The results of the wastewater characterization showed that the concentration of organic matter expressed as chemical oxygen demand (COD) was as high as 24.3 g/L while the biochemical oxygen demand was low. Chemical treatment can be considered as a suitable option for treatment of detergent wastewater due to the low ratio of BOD5/COD. Coagulation/flocculation and precipitation studies were performed in a conventional jar-test apparatus. The coagulant dosage of ferric chloride ranged between 0.5 g/L and 3 g/L, whereas the concentrations of polyelectrolyte and clay minerals varied between 5-75 mg/L and 25-750 mg/L, respectively. The optimal condition was obtained at the dosage 2 g/L ferric chloride at pH 11 with the COD removal efficiency of 71%. Addition of coagulant aids provided higher removal efficiencies. Using clay minerals at the dose of 500 mg/L

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with ferric chloride provided 84% of COD removal and the removal efficiency of COD increased with using polyelectrolyte, resulting in an efficiency of 87%. The maximum removal efficiency was obtained with the addition of polyelectrolyte and it was found that the ferric chloride combination with coagulant aids, at certain pH and agitation speed, provided higher removal efficiencies compared to coagulation with ferric chloride alone.[1]

This investigation considers the study of pH system in Common effluent treatment plant (CETP). For this purpose, Perundurai Common Effluent Treatment (PCETP) is taken for study. Waste from textile industries is rarely neutral. Certain processes such as reactive dyeing require large quantities of alkali but pre-treatments and some washes can be acidic. It is therefore necessary to adjust the pH in the treatment process to make the wastewater neutral. This is particularly important if biological treatment is being used, as the microbes used in biological treatment require a pH in the range of 6-8 and will be killed by highly acidic or alkali wastewater. In PCETP, the wastewater is mostly alkali wastes (high pH). For this purpose, hydrochloric acid (HCl) is added to maintain the pH value from 7.5 to 7.8 to save the microbes used in biological treatment as well as to reduce the wastage of chemicals.[2]

Due to aesthetic aspects, use of colored water even approved hygienically, is not acceptable worldwide. Consumers prefer to use colorless water. Color in water is usually associated with aromatic compounds produced from decay of natural herbal substances. Undesirable taste and odor and disinfection by products are of the reasons of color existence in water. The present study was performed using jar apparatus, lime and NaOH as softener agent and for increasing the pH of the process. Alum and ferric chloride coagulants were used to increase the size of flocs in various pH and color removal from water. It was tried to simulate the conditions of water treatment plants. Coagulant and lime doses, initial color and pH were studied. After the process, the residual color, as well as pH and electrical conductivity of water were measured. The results showed a significant increase in color removal with increasing pH. The highest percentage of color removal was 75% using 40mg/L of alum and ferric. The best efficiency of color removal was 86.68% and 94% by 12(g/L) lime for methylene blue and ferrochrome black T, respectively. However, during the procedure, the electrical conductivity of water increased. [3]

This paper discusses fast yet simple method of treating effluents of textile industry by simple chemicals. Textiles industry produces substantial toxic, often loaded with color (from residues of reactive dyes and chemicals), acidic and alkaline contaminants having high pH, high concentration of organic materials etc, which requires proper treatment before being released into the environment. Removal of such toxic materials from waste water is more important because the presence of small amounts of dyes in effluent disposed into the land and river water reduces the depth of penetration of sunlight into the water environment, which in turn decreases photosynthetic activity and dissolved oxygen (DO). The adverse effects can spell disaster for aquatic life, soil, and detrimentally affects the water quality. In this research work different coagulants like Alum, Lime, Ferrous Sulphate, Ferric Chloride, and poly-electrolytes for flocculation were employed to select the most suitable composition which has optimal removal efficiency. Settling characteristics of the flocs formed in the coagulation process were studied at laboratory scale.[4]

This paper presents guidelines for the selection and use of polyaluminum chloride (PACl) coagulants and alum in terms of raw water quality and treatment method. The concentration of natural organic matter (NOM) was found to be the most important parameter affecting coagulant dose. The solids separation process used for treatment was also found to be important for coagulant selection. Raw waters coagulated with PACls containing sulfate were found to have the best settling characteristics, but showed the highest headloss rates in direct filtration applications. Dissolved air flotation (DAF) performance was relatively insensitive to coagulant type.[5]

The motivations for treatment of wastewater are manifold. Treatment and reuse of wastewater conserves the supply of freshwater and this presents clear advantages with respect to environmental protection. The main objective of this paper was to perform a preliminary comparative study between some coagulants on the removal of suspended solids and organic matter from mixed industrial wastewater. Samples were collected from the inlet of 10th of Ramadan City stabilization ponds, Egypt. The 10^{th} of Ramadan City, as one of the major industrial cities in Egypt, suffer from serious environmental problems arise from the flooding of polluted wastewater to the Shabab Canal and Wady El Waten Drain.

Standard jar test with minor modification was used in the laboratory experiment. The procedures included rapid mixing, followed by slow mixing and settling. Supernatant was taken for determination of transitivity and chemical oxygen demand (COD) tests. The coagulants used included aluminum sulfate, ferric sulfate, lime, and ferric chloride with wide dosages range up to 250 mg/l. The best transmittance of treated wastewater was 100% with the use of alum and ferric chloride coagulant. It was found that the aeration of the coagulant and settled samples improved the COD removal efficiency than that the samples were not coagulated by about 41%.[6]

The wastewater arising from pulp and paper mills is highly polluted and has to be treated before discharged into rivers. Coagulation-flocculation process using natural polymers has grown rapidly in wastewater treatment. In this work, the performance of alum and Polyaluminum Chloride (PACl) when used alone and when coupled with Fenugreek mucilage on the treatment of pulp and paper mill wastewater were studied. The effectiveness of Fenugreek mucilage was measured by the reduction of turbidity and Chemical Oxygen Demand (COD). The results show that the combination of PACl and Fenugreek mucilage is more effective than alum, PACl and alum + Fenugreek mucilage. It can achieve greater than 97% of turbidity reduction and greater than 98% of COD reduction at low dosage of PACl (50 mg/L) and Fenugreek mucilage (100 mg/L). The results indicate that lower quantities of PACl are needed to obtain an acceptable reduction in turbidity and COD in the treatment of pulp and paper mill wastewater.[7]

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The physico-chemical properties of tannery effluents such as BOD5, COD, TSS, pH, Ammonia Nitrogen, Total Chromium were studied. The overall objective of this study was to develop technology options one for physico-chemical process and other for biological process for treatment of tannery effluent including Chromium separation through application of simple technology. The effluent of tannery wastewater sample was collected from leather complex located in the eastern part of Kolkata. The outcome of this study showed that there was a possibility of removing Chromium from tannery sludge by applying different processes and technologies. A bench scale model was fabricated and installed at the laboratory of School of Water Resources Engineering, Jadavpur University and it was continuously run for a period of 180 days. The effluent tannery wastewater was placed into the bio-reactor. The wastewater sample was aerated by using defuse aeration system. The supernatant samples were taken out daily 4 L from the bioreactor and at the same time the alum (Aluminium Sulphate) having concentration 200 mg/L was injected into the bioreactor. The study results revealed that the removal efficiency of BOD5, COD, are 85.5%, 88.9% respectively inoculated for a period of 7 days whereas the MLVSS and MLSS ratio between 52.6% and 64% which indicating satisfactory presents of bio-solids. 98.5% total Chromium removal was possible by using defuse aeration system.[8]

The objective of this study was to develop a treatment system that can effectively reduce the concentration of colloidal particles in raw water that can greatly reduce the cost of treatment and improve the subsequent steps of treatment. Aluminum sulphate (alum) and ferric chloride as a coagulant and anionic polymer as coagulant aid were used in the process that changed the scale of particles from nanoscale to microscale and larger by a physico-chemical process. The influence of PH, temperature, coagulant and coagulant aid dosages on the coagulation process was studied and conditions were optimized corresponding to the best removal of organic matters, viruses, colloids, bacteria, color and decrease in turbidity. 85-98% reduction of turbidity from raw water can be achieved by using the optimum coagulant dosage (8ppm, ferric chloride/10 ppm, alum) in the optimum PH range (9.2, ferric chloride/8.5, alum) in the optimum temperature (20°C, ferric chloride/24°C, alum). Ferric chloride produced better results than alum. Higher dosages did not significantly increase pollutant removal and were not economical. The results provide useful information for raw water treatment.[9]

In primary treatment the Colour of these effluents mostly Red-Black or Dark green to change into yellow or Light Green. The Chemical Oxygen Demand are 60% decrease, Total Suspended Solids 50% decrease, Hardness 20% decrease but Total Dissolve Solids 32% increase due to addition of Lime solution.The flock Produced by iron salt with lime at pH 10 to 11is heavier and can remove more percentage of Suspended Solids than Alum in a very short time period. Iron salt (ferrous sulphate and ferric sulphate) makes 90% treated water and 10% sludge. The Sedimentation of Sludge is very fast by Iron salt than Alum. Being good oxidizing agents, the Iron salts can remove Hydrogen sulphide, hydrogen sulphate and its corresponding Odour and tastes from water.[10]

III. MATERIALS AND METHODS

3.1 Sample Collection and Materials:

Sample of effluent wastewater was collected from a CETP,Butibori company, which is situated in Nagpur, India.
Chemical coagulants like Alum, Lime, Polyelectrolyte, ferrous sulphate, aluminium chloride, ferric chloride and caustic soda were purchased from Chemical Company.

3.2 Coagulant preparation

Stock solutions of Alum, Lime, Polyelectrolyte, ferrous sulphate, aluminium chloride, ferric chloride and caustic soda should be prepared before starting the experiment.
The solutions were prepared by dissolving 10g of each substance in distilled water and the solution volumes were increased to 1 liter. Each 1 ml of these stock solutions was equivalent to 20 mg/L when added to 500 mL of wastewater. They have been prepared in different concentrations, i.e. 10, 20 upto 150mg/L into distillated water.

3.3 Generalised Methodology and Experimental Set up

The present Work was divided into three parts. All these tests were performed at temperature (25ºC ± 2) because temperature is one of the effective parameters on density, viscosity and therefore retained volume of coagulant used.
PART 1: Only lime is used.
PART 2: Only alum is used.
PART 3: Combination of different coagulants
a. Lime (20% Sol) + Ferrous Sulphate (10% Sol) + Poly-electrolyte (0.2% Sol)
b. Lime (20% Sol) + Aluminum Chloride (10% Sol) + Poly-electrolyte (0.2% Sol)
c. Caustic (20% Sol) + Ferric Chloride (10% Sol) + Poly-electrolyte (0.2% Sol)
d. Lime (20% Sol) + Alum (10% Sol) + Poly-electrolyte (0.2% Sol)
All the experiments were conducted using the jar testing method to determine the optimum pH value and coagulant dose for further tests like BOD, COD, TSS and volume of sludge. Glass jars apparatus were positioned on magnetic stirrers and 0.5 liter of effluent was treated with a specified dose of coagulant. The sample was stirred rapidly for 2 Minute and then stirred slowly for 40 minutes for flocculation. To promote the formation of flocs in water that contains suspended solids, polymer flocculants (poly-electrolytes) were applied.
These polymers have a very specific effect, dependent upon their charges, their molar weight and their molecular degree of ramification. The polymers are water-soluble and their molar weight varies between 105 and 106 g/mol. Flocs formed were allowed to settle for an hour minutes before withdrawing the sample. The effect of coagulants on effectiveness colour removal, and maximum sludge sedimentation in short time period was analyzed by using of very low amount of dosing chemicals.
All Experimental parts used same procedure during experiment and observe the parameter like PH, BOD, COD,

TSS and sludge volume using analytical method. PH can be calculated by using PH meter available in laboratory during experimental work.

IV. RESULT AND DISCUSSION

4.1 Effects of lime and alum dosage on PH concentration:

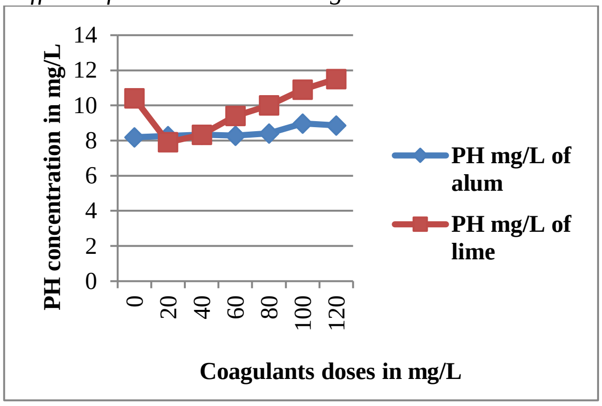

Fig. 4.1 Optimization of pH

As it was observed above fig.4.1 experiments that the color removal efficiency improves when lime was used for adjusting the optimum pH, hence, it indicates that lime alone as coagulant/coagulant aid can give a certain degree of color. For all the combinations, 120 mg/L lime dosage was found to be sufficient to attain the optimum pH. The solution of pH is dependent factor for determination of Physico-chemical process of effluent sample, and it also affected by precipitating agent. Fig 4.1 showed that increasing the alum dose, pH of the solution also increase. Initial pH of the effluent or zero concentration of alum dosing sample was 8.20 after the addition of alum 20mg/L, pH increased to 8.28. The maximum rate of increase pH 8.5 to 8.9 then alum dose were 800 – 100 mg/L sample. And pH increased means alum dosing also increased but also observed that more than 100 mg/L alum dosing sample was not removed BOD5, COD. TSS removal was possible, because of more concentration of alum dosing made more coagulant formation but other parameter removal was not possible.

4.2 Effects of lime dosage on BOD, TSS, COD and sludge volume:

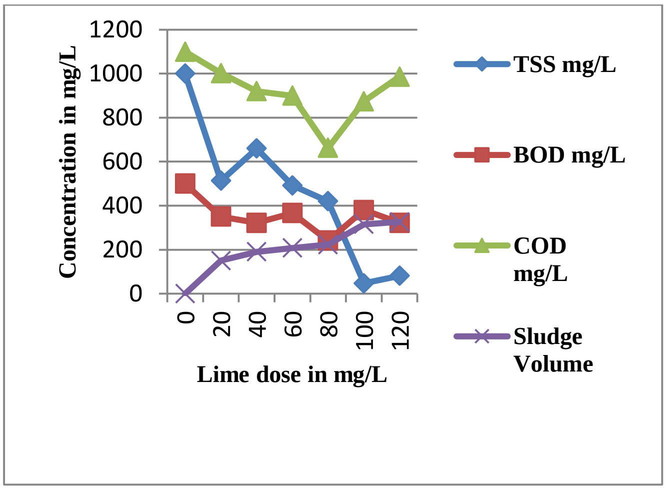

Fig.4.2 Optimization of Lime dosages for BOD, TSS, COD and sludge volume

It showed that in fig.4.2 that TSS removal of maximum at 100mg/L of lime dosing after that it again increase as dosing increases. However BOD and COD reduction of maximum at 80mg/L lime dosing then it will increases and maximum sludge produced at 120mg/L of lime concentration was found during experiment.

4.3 Effects of alum dosage on BOD, TSS, COD and sludge volume:

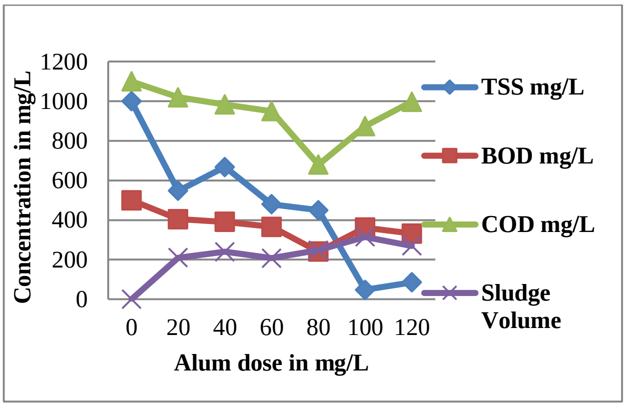

Fig.4. 3 Optimization of Alum dosages for BOD, TSS, COD and sludge volume

Hence, it indicates that Alum alone as coagulant/coagulant aid can give a certain degree of color, BOD, TSS as well as COD reduction for treatment of Effluent wastewater. Therefore, treatment efficiency of alum alone as a coagulant was investigated using different lime dosages (mg/l). For all the combinations, 100 mg/L alum dosage was found to be sufficient to attain the optimum pH, which produced 48 mg/L TSS removal, 362mg/L BOD reduction and 874mg/L COD reduction for different dosage of alum in wastewater used in this study.

However, considering the very high quantity and volume of sludge generation that is 315mg/L and avarage degree of decolorization efficiency than that of the appreciable range, alum as a coagulant alone can be recommended for decolorization of effluent wastewater.

It showed in fig. 4.3 that BOD, COD, TSS removal was most effective in 100 mg/L of alum dosing sample when the pH was 8.97. According to, Pearson correlation, there is strong negative correlation [R= (-)0.784, (-)0.841, (-)0.764 respectively], which means the rate of BOD, COD, TSS decreased then the pH was increased and also increased the removal of BOD, COD, TSS. So, it was found from the experimented result that 100 mg/L concentration of alum dosing is the best alum dose for removal of Physico-chemical parameters.

4.4 Effects of combination of coagulants dosage on BOD, TSS, COD and sludge volume:

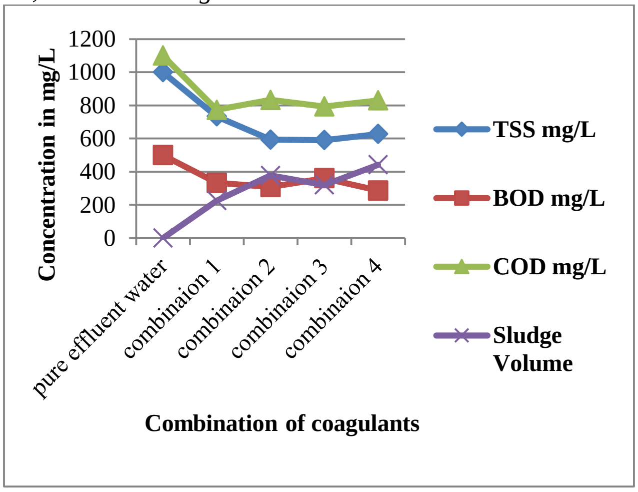

Fig.4. 4 Optimization of Combination of dosages for BOD, TSS, COD and sludge volume

Form the above fig.4.4 it is quite evident that Composition A (Lime (20% Sol) + Ferrous Sulphate (10% Sol) + Polyelectrolyte (0.2% Sol)) gave the best results. It was also observed that combination A formed maximum flocks between pH 9 and 10. These flocks settled in quick time when dosed with polyelectrolyte which is a highly viscous solution. On reducing pH below 9 results in decrease flocks size which did not settle sludge effectively. It is also Observed that COD, TSS, BOD decrease was maximum is composition A. However TDS increases. This may be due to addition of lime which makes light weight floating flocks, whose specific gravity is very low, so they float at water surface and will not settle properly. Finally the sedimentation results are very quick when we use ferrous sulphate and therefore we get best sludge volume. Being good oxidizing agents, the ferrous sulphate can remove Hydrogen sulphide, hydrogen, sulphate and its corresponding odour and tastes from water. To select the best coagulant in addition to above mentioned parameters, it should be considered parameters such as required coagulant dose, coagulant cost, and optimum pH after reaction for discharging into environment.

V. CONCLUSION

Based upon the experiments results in the study and limited to the conditions determined a prior, the following observations and conclusions could be drawn:

- Using coagulation and sedimentation improve the removal of the colloidal, suspended solids form the industrial wastewater.
- Alum and ferrous sulfate showed better turbidity removal than that of the lime and ferric chloride.
- Alum alone removed all the colloidal suspended solids at dose of 100 mg/L.Using the coagulation and precipitation improve the COD removal up to 45%.
- The relatively high coagulants dose and cost may limit the application of the study in the field and study for the treatment inside factories rather than the mixed wastewater is recommended.
- To select the best coagulant in addition to above mentioned parameters, it should be considered parameters such as required coagulant dose, coagulant cost, and optimum PH after reaction for discharging into environment.
- The efficiency of the coagulation of raw water is highly dependent on the control of PH and coagulant dose within an optimum range.
- Clarification process can be used in wastewater treatment and reduces the operational cost too.
- Combination A (Lime (20% Sol) + Ferrous Sulphate (10% Sol) + Polyelectrolyte(0.2% Sol)) gave the best results. It was also observed that Combination A formed maximum flocks between pH 9 and 10. These flocks settled in quick time when dosed with polyelectrolyte which is a highly viscous solution. On reducing pH below 9 results in decrease flocks size which did not settle sludge effectively.
- The sedimentation results are very quick when we use ferrous sulphate and therefore we get maximum sludge volume.
- The industrial effluents should be treated before to be drained into the natural water bodies so that it may not cause water and soil pollution and iron salts might be used for wastewater treatment on industrial scale.

REFERENCES

[1] Aygun, T. Yilmaz,” Improvement of Coagulation-Flocculation Process for Treatment of Detergent Wastewaters Using Coagulant Aids” ,International Journal of Chemical and Environmental Engineering ,December 2010, Volume 1, No.2.
[2] B. Meenakshipriya, Dr.K.Saravanan, R.Shanmugam,”Study of pH System in Common Effluent Treatment Plant”, morden applied science,volume 2,no.4,july 2008.
[3] M. Malakootian, A. Fatehizadeh ,”Color removal from water by coagulation/caustic soda and lime”, *Iran. J. Environ. Health. Sci. Eng., 2010, Vol. 7, No. 3, pp. 267-272*.
[4] Prashant Mehta, “Treating textile effluents by coagulation - flocculation method using different dosing compositions”, Advances in Applied Science Research, 2012, 3 (4):2514-2517.
[5] David J. Pernitsky and James K. Edzwald ,”Selection of alum and polyaluminum coagulants:principles and applications”, Journal of Water Supply: Research and Technology—AQUA | 55.2 | 2006.
[6] H. El Karamany, “Study for industrial wastewater treatment using some coagulants”, Fourteenth International Water Technology Conference, IWTC 14 2010, Cairo, Egypt.
[7] Kadhum M. Shabe Suhama E. Salah Mervit M. Janbi “Coagulation-Flocculation process to treat Pulp and Paper Mill Wastewater by Fenugreek Mucilage Coupled with Alum and Polyaluminum Chloride” Al-Khwarizmi Engineering Journal, Vol. 7, No. 3, PP 39 - 47 (2011).
[8] Somanth Pal, Pankaj Kumar Roy, Arunabha Majumder, Asis Mazumdar “Development of technological options for treatability study of chrome tannery effluent”, International journal of advanced scientific and technical research Issue 2 volume 6, December 2012.
[9] A. Koohestanian, M. Hosseini and Z. Abbasian, “The Separation Method for Removing of Colloidal Particles from Raw Water”, American-Eurasian J. Agric. & Environ. Sci., 4 (2): 266-273, 2008.
[10] Anil Choudhary and Deepak Ojha, “Effect of the Chemical Dosing in Treatability study for the Textile based Industrial WasteWater”, ASIAN J. EXP. BIOL. SCI. VOL 2(3) 2011.