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Some Studies on the Treatment of Industrial Waste Water – A Review

Dr. Kanjan Upadhyay
Professor
Chemical Engineering Department,
Ujjain Engineering College, Ujjain (M.P.)

Akhilesh Sharma
M. Tech Scholar
Chemical Engineering Department,
Ujjain Engineering College, Ujjain (M.P.)

Abstract:- **Different types of chemical are used to make surface and underground water fit for drinking purpose. The characteristic of water various from one geographical location into another that makes the treatment process complex and costly. Treatment with ferric chloride has gained important in the last decade. The present work done with the treatment of industrial waste water with ferric chloride and evaluate the feasibility of the treatment process. All the conventional treatment process development are being evaluated and economical operation are compare with ferric chloride treatment.**

Keyword:- Ferric Chloride, Turbidity, Coagulation, pH, T.S., Color.

INTRODUCTION

The availability of drinking water is gradually becoming difficult due to the pollution of surface and underground water. On the earth plenty of water is available but scarcity of drinking water is being observed throughout the word. Nearly 70% of the river are being polluted and not fit for drinking water without treatment. There are number of methods used for the treatment of drinking water such as chlorination treatment, with Alum treatment, with PAC etc. All the methods have got advantage and disadvantage. The conventional method of treatment undergoes limitation, due to varying seasonal condition and industrial discharge. The effectiveness of treatment method decrease due to this variation and makes the discharge on land and in river unsafe. One of the promising method that is gaining importance in the last decade in treatment chemicals the use of ferric chloride, one of the effective method of removing suspended as well as dissolved practical from water by coagulation and flocculation method. The chemical formula of ferric chloride is $FeCl_3$ (molecular weight 162.2 g/mole, density 2.90 g/cm^3). Ferric chloride is produced as a solution from the oxidation of ferrous chloride with chlorine and it has the unusual distinction of being one of the purest and most concentrated forms of iron commercially available for water treatment. Ferric chloride not only functions as a reactant but remove water impurities and functions as both a coagulant and a flocculent.

LITERATURE REVIEW

The necessity for safe drinking water is becoming more and more important in 21th century. Almost majority of the river are being polluted with different industrial and human activities. Therefor number of treatment methods are available to make the water safe for drinking purpose. Each and every methods has got its own limitation and benefits. The cost of treatment increases with the number of unit operations involved. More research work is carried out in this area to increase the effectiveness of the process and to identify and to evaluate other chemicals for the treatment of polluted water. Some of the research work carried out in this field are as follows:

In the year (2017), Mbaeze MC et al studied comparative assessment of performance of aluminium sulphate (alum) and ferrous sulphate as coagulants in water treatment. The outline for the study include the following parameters: pH, total suspended solids, dissolved oxygen, biochemical oxygen demand, turbidity, chloride, fluoride, phosphate and chemical oxygen demand. It was observed that pH, DO, BOD, fluoride, phosphate and COD mean percentage reduction efficiencies were higher for ferrous sulphate coagulant in comparison with alum.

In the year (2016), P.Mohsinkhan G et al studied comparative study of alum and ferric chloride for removal of turbidity from water. The outline for the study include removal of turbidity and containing colloidal particles. It was found that turbidity removal efficiency was within 86.7-98.9 % for alum and 91.8-98.32 % for ferric chloride. Turbidity removal efficiency was higher for ferric chloride compared to alum.

In the year (2016), A.A.Aghapour et al studied nitrate removal from water using alum and ferric chloride: a comparative study of alum and ferric chloride efficiency. The outline for the study include efficiency in removing nitrate in a conventional water treatment system. It was noted that ferric chloride was more effective than alum removing nitrate.

In the year (2016), M.Pirsaheb et al studied the performance of inorganic coagulants (poly aluminum chloride, ferrous sulfate, ferric chloride and aluminum sulfate) in removing the turbidity from aqueous solutions. The outline for the study include comparing the efficiency of coagulants in removing turbidity, color, pH etc. It was found that poly aluminum chloride with 5mg/l concentration is the best coagulant for removing turbidity (99-99.8%).

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In the year (2016), L.Postolachi et al studied effect of aluminium sulphate aging on coagulation process for the prut river water treatment. The outline for the study include removal of certain contaminants, turbidity and color. It was found that the using of optimal aging solution of coagulant improves the coagulation process and decrease the color of the sample (river water).

In the year (2016), A.Almasi et al studied evaluation of common coagulants and polymeric coagulant aid in the removal of suspended particles and colloidal turbidity of raw water of gavoshan dam. The outline for the study include turbidity removal with the help of ferric chloride, anionic polymer. It was found that Ferric chloride at 10 mg/l and anionic polymer at 1 mg /l concentration are the best coagulant and coagulant aid respectively with 82.61% and 87.57% turbidity removal efficiency.

In the year (2016), R.R.Ayangunna et al studied coagulation-flocculation treatment of industrial wastewater using tamarind seed powder. The outline for the study include turbidity and COD removal. It was observed that a dose of 400 mg/L decrease turbidity by 97.72% and COD by 39.55% respectively.

In the year (2016), Z.Daud et al studied treatment of biodiesel wastewater by coagulation flocculation process using polyaluminium chloride and polyelectrolyte anionic. The outline for the study include removal of suspended solids (SS), colour, COD and oil and grease. It was noted that removal of 97%, 95%, 75% and 97% for SS, colour, COD and O&G respectively, were achieved at dosage value; 300 mg/L.

In the year (2015), T.Jowa et al studied treatment of low turbidity water using polyaluminium chloride and recycled sludge. The outline for the study includes pH, conductivity, floc quality and most importantly turbidity. It was noted that PAC to treat low turbidity water is more efficient than alum in terms of turbidity reduction. The range of efficiency was 31.2-83% for PAC compared to 15-82% for alum.

In the year (2015), N. Zouhri et al studied effectiveness of treatment of water surface with ferric chloride and aluminium sulphate. The outline for the study include pH, turbidity, color etc. It was noted that reduction of the turbidity is greater by the use of ferric chloride in comparison with alum and this at lower doses. Alum shows a high reduction of turbidity of water at acidic pH.

In the year (2015), D.J.Naghan et al studied efficiency comparison of alum and ferric chloride coagulants in removal of dye and organic material from industrial wastewater. The outline for the study include COD, TSS and dye removal. It was noted that removal of COD, TSS and dye using alum were 36%, 19% and 68.8% while for ferric chloride were obtained 72%, 60% and 98% respectively. Ferric chloride has higher efficiency than alum.

In the year (2015) Dr.L.Nageswara Rao studied coagulation and flocculation characteristic of industrial wastewater by chitosan. The outline for the study include removal of turbidity, color, odor, toxicity and alkalinity by the use of alum, ferrous sulfate, ferric chloride and ferric chloro-sulfate. It was found that chitosan not only reduces the COD but also reduces the maximum percentage of turbidity of sample i.e. chitosan removes maximum color.

In the year (2015), Y.Gangadhar Reddy et al studied treatment of pharmaceutical waste water using coagulation method. The outline for the study include the analytical parameters COD, BOD, TOC, hardness and total solids (TS) using alum. It was found that removal rate of COD, TOC, BOD, TS observed to be 70%, 54%, 44%, 79 % respectively. Alum was found to be better for pharmaceutical wastewater treatment.

In the year (2015), B.Abderrezzaq et al studied comparative study between aluminum sulfate and ferric chloride in water treatment: turbidity removal. The outline for the study include the reduction of turbidity and dissolved solids with the help of aluminum sulfate and ferric chloride. It was found that aluminum sulfate combined with ferric chloride give a good result for turbidity removal.

In the year (2015), P.V.Pathak et al studied enhanced removal of turbidity in thermal power plant. The outline for the study include removal of turbidity with the help of alum and poly aluminum chloride. It was noted that the dosage of PAC required for river water treatment was less as compared to alum at all levels of turbidity.

In the year (2015), T.Yarahmadi et al studied comparison of water turbidity removal efficiencies of descurainia sophia seed extract and ferric chloride. The outline for the study include turbidity removal, efficiency of descurainia sophia seed extract, compared with ferric chloride. It was noted that ferric chloride remove 89.75% turbidity and descurainia sophia remove 43.13% turbidity.

In the year (2015), P.S.Dange et al upgraded conventional sewage treatment process by using mangifera indica. The outline for the study include removal of TSS, BOD and COD. It was observed that mangifera indica act as a natural coagulant to treat sewage water, the average TSS, BOD and COD of sewage reduces to 31.62%, 32.42% and 33.43 % respectively.

In the year (2015), F.M.Moghaddam et al studied treatment of highly turbid water by polyaluminum ferric chloride (PAFCL). The outline for the study include removal of turbidity, color and natural organic matter (NOM). It was found that polyaluminium ferric chloride has a very good efficiency for the removal of turbidity, color and organic matter in high turbid water.

In the year (2014), Ukiwe L.N. et al studied chemical and electrocoagulation techniques in coagulation-flocculation water and waste water treatment. The outline for the study

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include pH, coagulation dose, coagulant type, current density, applied voltage, water and wastewater type, type of electrode. It was observed that Electrocoagulation has been proposed as an alternative method to chemical coagulation because it is environmental friendly and cheap to operate.

In the year (2014), J.E.Amburgey et al studied coagulation-ceramic membrane filtration for U.S. surface water treatment. The outline for the study include particle removal, organics removal, and membrane fouling. It was noted that ferric chloride was more effective than alum.

In the year (2014), M.Fazeli et al worked on selecting the optimal coagulant, in turbidity removal and organic carbon of surface water using AHP (analytic hierarchy process). The outline for the study include comparing the performance of five coagulants including poly ferric sulfate, ferric chloride, alum, poly aluminum chloride, and poly aluminum ferrous chloride on turbidity and organic material removal. It was noted that PFS (poly ferric sulfate) performed best as coagulant from the five coagulant in terms of turbidity, color, COD etc. removal.

In the year (2014), Oria-Usifo E.E. et al worked on the use of moringa oleifera seed extracts as alternative natural material for water purification. The outline for the study include removal of turbidity, bacteria, and natural organic matter, Comparison between coagulant chemicals and Moringa oleifera (MO) seed extract. It was found that Protein powder had the highest turbidity removal efficiency with a percentage turbidity removal of 92.3% followed by de-oiled powder with a percentage turbidity removal of 83.25% and shell blended powder with a percentage turbidity removal of 75.68% at optimal dosage.

In the year (2014), N.F.Akmal et al studied wastewater treatment by using natural coagulant like Roselle seed. The parameter for the study include removal of turbidity. It was noted that with natural coagulant, efficiency removal of 99.1% turbidity in wastewater as compared to the aluminium sulphate as commercial coagulant.

In the year (2014), N.B.Prakash et al studied waste water treatment by coagulation and flocculation method by using various coagulants such as alum, ferric chloride and ferrous sulphate. The parameter for the study include pH, turbidity, color, TSS etc. It was found that Alum was found to be more efficient with removal 98.9% than ferric chloride and ferrous sulphate.

In the year (2013), A.K.Vuppaladadiyam et al studied comparative study on coagulation process for vellore municipal drinking water using various coagulants like alum, ferric chloride and moringa oleifera seed. The outline for the study includes effect of pH, turbidity, total dissolved solids, microbial removal efficiency, and organic carbon content. It was noted that alum works at pH 7.5 with 45mg/l dosage and ferric chloride works pH 7 with 25mg/l dosage. Ferric chloride better removal efficiency than alum. moringa oleifera seed does not worked effectively as coagulant.

In the year (2013), O.P.Sahu et al studied chemical treatment of industrial waste water using alum. The outline for the study includes pH, turbidity, colour, test, micro pollutants, odour, and water stabilization. It was found that Coagulation used ahead of gravity settling may be expected to yield suspended solids removals of about 90% as compared to alum about 35% without coagulation.

In the year (2013), A.Takdastan et al carried research work using powdered activated carbon as coagulant aid in the treatment of water of Koot Amir Water treatment plant. The parameter for the study include removal of Total Organic Carbon. It was noted that Poly aluminum chloride was more effective in TOC removal than ferric chloride.

In the year (2013), Dr.A.H.Wadie studied improve coagulation process to control the disinfection by-products in water treatment plant. The outline for the study include comparing three coagulants (alum, ferric chloride, and ferric sulfate), removal of total organic carbon removal of turbidity. It was found that removal of turbidity were observed (86%) for ferric chloride, (78%) for alum, and (65%) for ferric sulfate, removals of total organic carbon were observed (21-59 %) for ferric chloride, (14-50 %) for alum, and (18-48%) for ferric sulfate.

In the year (2013), A.K.Popuri et al studied color removal from dye effluent by using coagulation technique using Alum, Ferric chloride, Aluminium chloride. The outline for the study include color removal using coagulation process with the help of three coagulant like alum, ferric chloride, aluminium chloride. It was noted that removal of color by alum were (54%), aluminium chloride (99.49%) and ferric chloride (69.9%) respectively.

In the year (2013), N.Parmar et al studied treatability study of pharmaceutical wastewater by coagulation process. The parameter for the study include turbidity, COD, chloride, alkalinity, acidity, hardness and Total solids (TS) removal using ferric chloride, ferrous sulphate, aluminium chloride. It was observed that the ferrous sulphate coagulant gives the good results as compared to the ferric chloride and aluminium chloride coagulants.

In the year (2012), H.Farajnezhad et al studied coagulation treatment of wastewater in petroleum industry using poly aluminum chloride and ferric chloride. The outline for the study include removal of color, COD and TSS from petroleum wastewater. It was found that poly aluminum chloride gives better result as compare to ferric chloride.

In the year (2012), Parde et al studied the comparative evaluation of surface water treatment by using different coagulating agent like alum and PAC. The parameter for the study includes alum stock solution preparation, PAC stock solution preparation, Turbidity test, pH test. It was noted that PAC (Poly Aluminum Chloride) performed well in the river water treatment as compared to Alum.

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In the year (2012), P. Mehta studied treatment of textile effluents by coagulation-flocculation method using different dosing compositions. The outline for the study include parameters such as color, COD, Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and settled sludge volume removal with the help of different coagulants like Alum, Lime, Ferrous Sulphate, Ferric Chloride, and poly-electrolytes. It was noted that composition A (Lime (10% sol) + ferrous sulphate (5% sol) + polyelectrolyte (0.1% sol)) gives the best results of COD, TSS, hardness and TDS by 60% decrease, 50% decrease, 26% decrease and 32% increase respectively.

In the year (2012), M.Z. Abideen et al worked on optimizing the coagulation process in a drinking water treatment plant comparison between traditional and statistical experimental design jar tests. The parameter for the study include removal of turbidity with use of alum and polymer coagulant. It was noted that polymer coagulant is more efficient than alum.

In the year (2011), P. Kumar et al studied treatment of paper and pulp mill effluent by coagulation technique. The outline for the study includes removal of chemical oxygen demand (COD) and colour with the help of Poly aluminium chloride (PAC) and alum. It was found that COD and colour removal of 84 % and 92 % respectively were obtained using PAC as compared to 72 % and 84 % with alum.

In the year (2011), B.Saritha et al studied the efficiency of ferric chloride, aluminium sulphate and their combination for treatment of tannery effluent. The outline for the study include analysis of physico-chemical parameters (BOD, COD). It was noted that pH=8 is optimal for better efficiency of alum, ferric chloride and their combination (alum+ferric chloride) , (alum+ferric chloride) combination is more effective for reduction of concentration of pollutants.

In the year (2010), A. Baghvand et al studied optimizing coagulation process for low to high turbidity waters using aluminum and Iron salts. The parameter for the study include removal of turbidity, containing colloidal particles. It was observed that turbidity removal efficiency was higher for ferric chloride compared to aluminum sulfate at optimum conditions. The highest turbidity removal efficiency noted within 82.9-99.0% for alum and 92.9-99.4% for ferric chloride.

In the year (2010), H.E. Karamany carried out research work in the treatment of industrial wastewater treatment using some coagulants like alum and ferric chloride. The parameter for the study include turbidity removal and removal of colloidal suspended solids. It was noted that ferric chloride is more efficient than alum in the removal of turbidity and colloidal suspended solids.

In the year (2009), G.N. Bidhendi et al studied the performance characteristic of plantago ovata in elimination of water turbidity. The outline for the study include removal of turbidity, adjustment of pH etc. It was found that plantago ovata worked well in elimination of water turbidity using coagulation and flocculation processes. Plantago ovata coagulant aid can be used to reduce ferric chloride consumption.

In the year (2009), A. Maleki et al carried out research work composting plant leachate treatment by coagulation-flocculation process. The parameter for the study include removal of COD and removal of heavy metals with the help of alum and ferric chloride. It was noted that for the removal of COD ferric chloride is better than alum but in case of removal of heavy metals alum is better than ferric chloride.

In the year (2009), E. Angreni studied optimization of conventional drinking water treatment plant. The outline for the study include pH, turbidity, and hardness with the help of alum and ferric chloride. It was observed that efficiency with ferric chloride (99.6%) and with alum (89.7%) were achieved.

In the year (2008), N. D. Tzoupanos et al studied coagulation-flocculation processes in water and wastewater treatment: the application of new generation of chemical reagents. The outline for the study include removal of inorganic and organic matter, removal of metals and anions, removal of pathogen microorganisms. It was found that coagulation reagents exhibits several advantages, compared to the conventional and simple pre polymerized coagulants.

In the year (2008), A. Koohestanian et al studied the separation method for removing of colloidal particles from raw water using ferric chloride, alum. The parameter for the study includes pH, Turbidity, organic matters, viruses, colloids, bacteria and color. It was noted that Ferric chloride produced better results than alum.

In the year (2008), G. D. Lancine et al studied coagulation flocculation treatment of a tropical surface water with alum. The parameter of the study includes influence of alum dose, pH adjustment, dissolved organic matter (DOM), turbidity and aluminum residual. Percentage removal of 70% DOM and 98% turbidity noted.

In the year (2007), L. Rizzo et al studied coagulation/chlorination of surface water: a comparison between chitosan and metal salts. The outline for the study include removal of turbidity, natural organic matter (NOM) and as well as acute toxicity. It was noted that the chlorination step after coagulation increased toxicity too according to the coagulant type as follows: chitosan > ferric chloride > alum.

CONCLUSION

The current study was to evaluate the ability of industrial waste water treatment processes to reduce contamination in waste water. Although the studied method is not a specialized or ideal technology for the treatment of industrial waste water. This study has shown that coagulation and flocculation is a useful method as industrial waste water treatment. Based on the findings, pH is effective parameters in terms of coagulation and flocculation process and it can be observed that use of ferric chloride for the removal of COD, TSS and

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color of industrial waste water had higher efficiency than alum. The performance of different chemicals varies with industrial waste water characteristic. Therefor selection of treatment chemicals and its performance at acidic, neutral and alkaline condition are the major criteria to obtain optimum result using coagulation and flocculation technique.

REFERENCE:-

[1] Mbaeze MC, Agbazue VE and Orjioke NM Mbaeze (2017). Comparative assessment of performance of aluminium sulphate (alum) and ferrous sulphate as coagulants in water treatment. Mod Chem Appl 2017, 5:4 DOI: 10.4172/2329-6798.1000233.

[2] Pathan Mohsinkhan G, KolateSurajR, LondheSagar R, Mate Umesh A (2016). Comparative study of alum and ferric chloride for removal of turbidity from water. Vol. no.02 issue 03 march 2016. www.ijirse.com.

[3] Ali Ahmad Aghapour, Sepideh Nemati, Amir Mohammadi, Heshmatollah Nourmoradi, Sima Karimzadeh (2016). Nitrate removal from water using alum and ferric chloride: A comparative study of alum and ferric chloride efficiency. Environmental health engineering and management journal 2016, 3(2), 69–73.

[4] Meghdad Pirsaheb, Kiomars Sharafi, Amir Karami, Abdollah Dargahi, Alireza Ejraei. Abdollah Dargahi (2016). Evaluating the performance of inorganic coagulants (poly aluminum chloride, ferrous sulfate, ferric chloride and aluminum sulfate) in removing the turbidity from aqueous solutions. IJPT| June-2016 | Vol. 8 | Issue No.2 | 13168-13181.

[5] Larisa Postolachi, Vasile Rusu, Tudor Lupascu (2016). Effect of aluminium sulphate aging on coagulation process for the prut river water treatment. 2016, 11(1), 27-32. larisa.postolachi@gmail.com.

[6] Ali Almasi, Abdollah Dargahi, Zeinab Jafari Motlagh, Mojtaba Mahmoodi, Mitra Mohammadi, Sedigheh Rezaei, Hosna Janjani, Tahereh Amirian (2016). Evaluation of common coagulants and polymeric coagulant aid in the removal of suspended particles and colloidal turbidity of raw water of Gavoshan dam. ISSN: 0974-2115 www.jchps.com October - December 2016 JCPS Volume 9 Issue 4.

[7] Ronke Ruth Ayangunna, Saidat Olanipekun Giwa, Abdulwahab Giwa (2016). Coagulation-flocculation treatment of industrial wastewater using tamarind seed powder. International Journal of ChemTech Research CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN (Online):2455-9555 Vol.9, No.05 pp 771-780, 2016.

[8] Zawawi Daud, Nazlizan Nasir, Ab. Aziz Abdul Latiffl, Mohd Baharudin Ridzuan and Halizah Awang (2016). Treatment of biodiesel wastewater by coagulation flocculation process using polyaluminium chloride (PAC) and polyelectrolyte anionic. VOL. 11, NO. 20, OCTOBER 2016 ISSN 1819-6608 ARPN Journal of Engineering and Applied Sciences.

[9] Taurai Jowa and Liberty L Mguni (2015). Treatment of low turbidity water using poly-aluminium chloride (pac) and recycled sludge: case study chinhoyi. Zimbabwe Journal of Science & Technology pp 101-108 Vol.10 [2015] e-ISSN 2409-0360 Zimbabwej.sci.technol.

[10] N. Zouhri, M. El Amrani, M. Taky, M. Hafsi, A. Elmidaoui (2015). Effectiveness of treatment of water surface with ferric chloride and aluminium sulphate. Review of Catalysts, 2015, 2(1): 1-13.

[11] Davood Jalili Naghan, Mohammad Darvish Motevalli, Nezam Mirzaei, Allahbakhsh Javid, Hamid Reza Ghaffari, Mohammad Ahmadpour, Masoud Moradi, Kiomars Sharafi (2015). Efficiency comparison of alum and ferric chloride coagulants in removal of dye and organic material from industrial wastewater. Bulgarian Chemical Communications, Volume 47, Special Issue D (pp. 206 – 210) 2015.

[12] Dr L.Nageswara Rao (2015). Coagulation and flocculation of industrial wastewater by chitosan. International Journal of Engineering and Applied Sciences (IJEAS) ISSN: 2394-3661, Volume-2, Issue-7, July 2015.

[13] Yeddla. Gangadhar Reddy, Dr. T. Bala Narsaiah, B. Venkateswar Rao (2015). Treatment of pharmaceutical waste water using Coagulation method. ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 11, Issue 11 (November 2015), PP.61-67.

[14] Benalia Abderrezzaq, Derbal Kerroum (2015). Comparative study between aluminum sulfate and ferric chloride in water treatment: turbidity removal. JDOC Numéro 01 -2015 Workshop jeune chercheur –Mai 2015 –Université Constantine 3.
Benalia.abderrezzak@gmail.com;derbal_kerroum@yahoo.fr.

[15] Mr. P.V. Pathak1, Dr. S. T. Ingale, Dr. S. R.Thorat (2015). Enhanced removal of turbidity in thermal power plant. September 2015 | IJIRT | Volume 2 Issue 4 | ISSN: 2349-6002.

[16] Tooran Yarahmadi a, Mazyar Peyda a, Mehran Mohammadian Fazlia, Rezan Rezaeian a, Negin Soleimania (2015). Comparison of water turbidity removal efficiencies of descurainia sophia seed extract and ferric chloride. 2015 www.zums.ac.ir/jhehp. mazyarpeyda@zums.ac.ir.

[17] Mr Purushottam S. Dange Dr. Ravindra K Lad (2015). Upgrading conventional sewage treatment process by sing mangifera indica. IJSRD Vol. 3, Issue 02, 2015 ISSN (online): 2321-0613.

[18] Fazel Mohammadi-Moghaddama, Mokhtar Mahdavib, Yaghob Hajizadehc, Hmid Reza Tashauoeid, Hossain Ataeifare, Afshin Ebrahimif (2015). Treatment of highly turbid water by polyaluminum ferric chloride (PAFCL). Arch Hyg Sci 2015; 4(4): 208-216. Journal Homepage: http://jhygiene.muq.ac.ir.

[19] UkiweL.N, Ibeneme S.I, Duru C.E, Okolue B.N, Onyedika G.O. & Nweze C.A. (2014). Chemical and electrocoagulation techniques in coagulation-floccculationin water and wastewater treatment. IJRRAS 18 (3) March2014 www.arpapress.com/Volumes/Vol18Issue3/IJRRAS_18_3_09.pdf.

[20] James E. Amburgey, Amir Y. Alansari, Tanju Karanfil, Meric Selbes, Jaehong Kim, Seungjin Lee, and Yonggyun Park (2014). Coagulation-ceramic membrane filtration for u.s. surface water treatment. 2014.

[21] Mojtaba Fazeli, Mastaneh Safari, Tavakol Ghobaee (2014). Selecting the optimal coagulant in turbidity removal and organic carbon of surface water Using AHP. Bull. Env. Pharmacol. Life Sci., Vol 3 [6] May 2014: 78-88 ©2014.www.bepls.com.

[22] Nur Fathinatul Akmal binti Saharudin, Rajesh Nithyanandam (2014). Wastewater treatment by using natural coagulant. 2nd eureka 2014 Wastewater Treatment by using Natural Coagulant.

[23] N.B.Prakash, Vimala Sockan, P.Jayakaran (2014). Waste Water Treatment by Coagulation and Flocculation. IJESIT Volume 3, Issue 2, March 2014.

[24] Arun K. Vuppaladadiyam, Sowmya V., Pallavi Dasgupta (2013). Comparative study on coagulation process for vellore municipal drinking water using various coagulants. Euresian Publication c 2013eISSN 2249 0256.

[25] O.P.Sahu; P.K.Chaudhari (2013). Review on chemical treatment of industrial waste water. J. Appl. Sci. Environ. Manage. June 2013 Vol. 17 (2) 241-257. www.ajol.info and www.bioline.org.br/ja.

[26] Afshin Takdastan, Azadeh Eslami (2013). Using of powdered activated carbon as coagulant aid in total organic carbon

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 08, August-2018

removal in koot amir water treatment plant. Jundishapur J Health Sci 2013; 5(2):117-127.

[27] Dr. Alaa H. Wadie Al-Fatlawi(2013). Improve coagulation process to control the disinfection by-products in water treatment plant. ISCESD 2013 29-30 Dec, 2013.

[28] Ashok kumar popuri and bangaraiah pagala (2013). Color removal from dye effluent by using coagulation technique. Int J Pharm Bio Sci 2013 Oct; 4(4): (B) 1091 – 1099.

[29] Nitesh Parmar, Kanjan Upadhyay (2013). Treatability Study of Pharmaceutical Wastewater by Coagulation Process. International Journal of ChemTech Research CODEN (USA): IJCRGG ISSN: 0974-4290 Vol.5, No.5, pp 2278-2283, July-Sept 2013.

[30] Hamidreza Farajnezhad & Parvin Gharbani (2012). Coagulation treatment of wastewater in petroleum industry using poly aluminum chloride and ferric chloride. IJRRAS 13 (1) October 2012 www.arpapress.com/Volumes/Vol13Issue1/IJRRAS_13_1_25.pdf.

[31] R. S. Parde and V. C. Renge (2012). Comparative evaluation of surface water treatment by using different coagulating agents. E-ISSN 0976-3945 IJAET/Vol.III/ Issue IV/Oct.-Dec., 2012/86-88.

[32] Prashant Mehta (2012). Treating textile effluents by coagulation - flocculation method using different dosing compositions. 2012, 3 (4):2514-2517. www.pelagiaresearchlibrary.com.

[33] M. Zainal-Abideen, A. Aris, F. Yusof, Z. Abdul-Majid, A. Selamat and S. I. Omar (2012). Optimizing the coagulation process in a drinking watertreatment plant – comparison between traditional and statistical experimental design jar tests. IWA Publishing 2012 Water Science & Technology | 65.3 | 2012.

[34] Pradeep Kumar, Tjoon Tow Teng, Shri Chand, and Kailas L. Wasewar (2011). Treatment of Paper and Pulp Mill Effluent by Coagulation. International Scholarly and Scientific Research & Innovation 5(8) 2011.

[35] B.Saritha, A.Ambica, G.Sharmilaa, J.Chmundeeswari (2011). Study of Efficiency of Ferric Chloride, Aluminium Sulphate and Their Combination for Treatment of Tannery Effluent. IJETT Volume1 Issue3 June 2011.

[36] Akbar Baghvand, Ali Daryabeigi Zand, Nasser Mehrdadi and Abdolreza Karbassi (2010). Optimizing Coagulation Process for Low to High Turbidity Waters Using Aluminum and Iron Salts. American Journal of Environmental Sciences 6 (5): 442-448, 2010 ISSN 1553-345X© 2010 Science Publications.

[37] H. El Karamany, Study for industrial wastewater treatment using some coagulants (2010). Fourteenth International Water Technology Conference, IWTC 14 2010, Cairo, Egypt. dr_elkaramany@link.net.

[38] Gholamreza Nabi Bidhendi, Toktam Shahriari, Sh Shahriari (2009). Plantago Ovata Efficiency in Elimination of Water Turbidity. J. Water Resource and Protection, 2009, 2, 90-98 doi:10.4236/jwarp.2009.12013 Published Online August 2009 (http://www.SciRP.org/journal/jwarp/).

[39] Afshin Maleki, Mohammad Ali Zazouli, Hassan Izanloo and Reza Rezaee (2009). Composting Plant Leachate Treatment by Coagulation-Flocculation Process. American-Eurasian J. Agric. & Environ. Sci., 5 (5): 638-643, 2009 ISSN 1818-6769 © IDOSI Publications, 2009.

[40] Endah Angreni (2009). Review on optimization of conventional drinking water treatment plant. World applied sciences journal 7 (9): 1144-1151, 2009 issn 1818-4952 idosi publications, 2009.

[41] N. D. Tzoupanos and A. I. Zouboulis (2008). Coagulation-flocculation processes in water/wastewater treatment: the application of new generation of chemical reagents. 6th iasme/wseas international conference on heat transfer, thermal engineering and environment (hte'08) rhodes, greece, august 20-22, 2008.

[42] A. Koohestanian, M. Hosseini and Z. Abbasian, American-Eurasian J. Agric. & Environ (2008). The Separation Method for Removing of Colloidal Particles from Raw Water. Sci., 4 (2): 266-273, 2008 ISSN 1818-6769 © IDOSI Publications, 2008.

[43] Gone Droh Lanciné, Kamagate Bamory, Ligban Raymond, Seidel Jean-Luc, Batiot Christelle, Biemi Jean (2008). Coagulation-Flocculation Treatment of a Tropical Surface Water with Alum for Dissolved Organic Matter (DOM) Removal: Influence of Alum Dose and pH Adjustment. J. Int. Environmental Application & Science, Vol. 3 (4): 247-257 (2008).

[44] Luigi Rizzo, Annamaria Di Gennaro, Marialuisa Gallo, Vincenzo Belgiorno (2008). Coagulation/chlorination of surface water: A comparison between chitosan and metal salts. Separation and Purification Technology 62 (2008) 79–85. www.sciencedirect.com.

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