International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 11
November 2017

A Review on Effluent Treatment of Textile by Biological and Chemical Methods

M.Shireesha, Asst. Professor, Anurag Group of Institutions
P.Kartheek.Rao, Under graduate student, Anurag Group of Institutions
MD. Hyder Ali, Under graduate student, Anurag Group of Institutions
K.V Chaitanya,Under graduate student, Anurag Group of Institutions

ABSTRACT:

For manufacturing single cloth piece many gallons of water is used. Removal of dyes plays an important role in conservation of water bodies. Most of the industries depend on chemical treatment of effluents while they forget the use of biological waste (Banana, Orange, Mango waste etc.,) to treat the waste water released. Untreated water mostly contains dyes which have traces of Zinc, Chromium, Copper, cobalt etc.,. Presence of these metals can cause harm to Marine animals when released into water bodies untreated and can cause long run diseases to the humans consuming it. Process of Effluent treatment is classified into primary treatment (Screens and settling for removal of gritty material), Secondary treatment (Advanced Oxidation Method), Tertiary treatment(Removal of organic colour compounds by adsorption and dissolved organic substances by Orange peel, Garlic Peel, Banana Peel etc.,). Efficient and effective separation can be obtained by these methods mentioned. Our paper solely describes the biological and chemical methods for the treatment of effluent.

Key Words: Sedimentation, Electro-coagulation, Trickle bed filters, Algae-treatment, Ultra-Violet treatment, Membrane technology, Advance oxidation

Introduction:

Textile industry is one of the oldest industries and it has developed with time, but the complexity of the industry makes it quite different from all the industries. Textile industry is classified into two main streams. They are natural (cotton, jute, wool and silk) and synthetic fibres (acrylic, polyester, rayon etc.,) industry. Fibres are manufactured in five steps they are desizing, scouring, bleaching, mercerizing and dyeing processes[1]

- Desizing: This is a process of sizing of materials before weaving. Water insoluble material is chemically washed[6]
- Scouring: In this process, fibres are treated with alkali solution to breakdown the natural impurities [7]
- Bleaching: Sodium hypochlorite and hydrogen peroxide is added as a bleaching agent to the fibre to remove unwanted colour[8]
- Mercerizing: In this process cotton fibre is drenched with alkaline solution and acid solution to increase the dye ability to stick on the fibre and to increase the lustre. This is done before dyeing step only for cotton.[9]
- Dyeing: Desired dye is added to colour the fibre in Batch, Continuous or Semi-Continuous process. To increase the absorbency of the dye on the fibre metals, surfactants, sulphide and formaldehyde is added. Most common process used is Batch to dye the textile materials[42]

Textile industry gives out huge loads of effluents which contain fibres, dyes, salts, insecticides, pesticides, fungicides, solvents, inorganic salts and heavy metals. Effluent chemically is composed of polyphenols, sulphur, organic halogen, nitrogen radicals, sulfonated aromatic compounds and non-ionic surfactants [2].

PARAMETERS	COMPOSITES INDUSTRIES	PROCESSING INDUSTRIES	WOOLEN INDUSTRY
pH	5.5-11.0	7.0-8.5	7.0-11.0
SS, mg/l	300-500	300-500	160-380
BOD,mg/l	350-600	230-450	160-350
COD,mg/l	600-1400	470-900	220-700
Chloride,mg/l	700-1200	300-900	-
Sulfate,mg/l	300-700	200-1000	-
Phenol,mg/l	0.5-2.0	0.5-2.0	-
Oil and grease, mg/l	5-15	5-10	-
Na, mg/l	-	600-870	-

Table1: Combined Effluent characteristics from Textile industries[15]

Textile industry effluents when released untreated causes environmental pollution and health issues. The estimate of pollution is around 100kg COD/ton for 100-200$m^{3/}$ton of fabrics produced [3]. These waters disturb the marine life near the discharge of the effluent point. Presence of benzidine, a known carcinogen in the drinking water can cause cancer and mutagenic diseases [4].

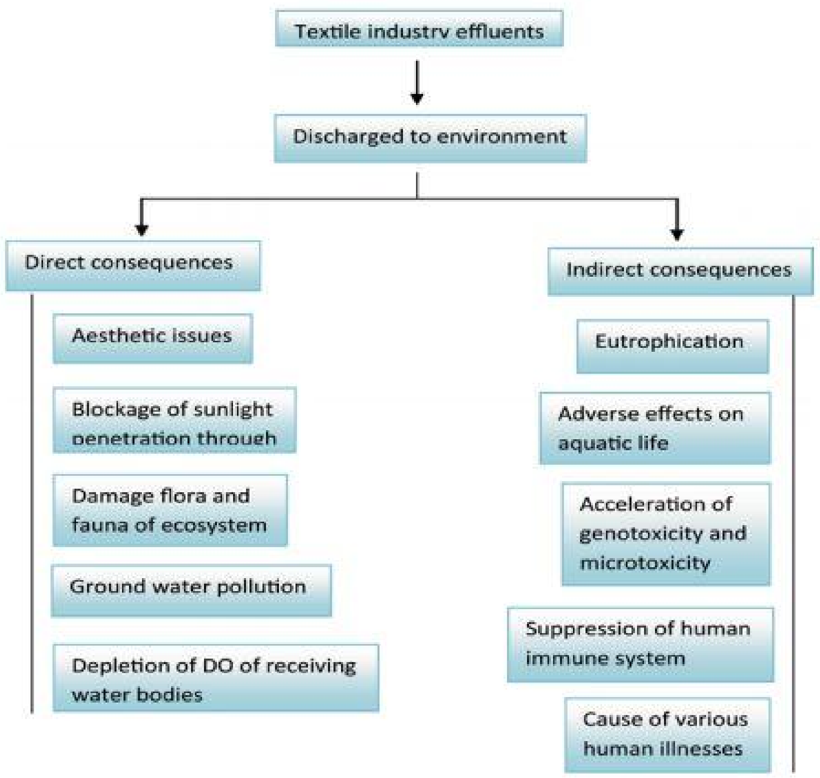


Fig 1: Consequences by the discharge of industrial effluents to the environment

The most important textile effluent observed through the naked eyes is dyes.Dyes are classified into Synthetic and Natural dyes. The most used dye is Azo dye and there are 2000 differently structured dyes are used in textile industry [10] and few structure are described below

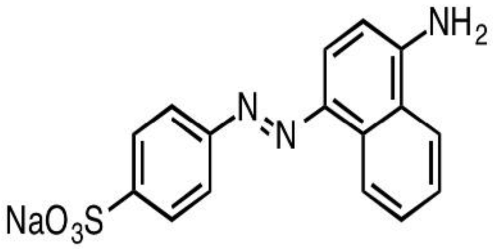


Fig 2: Direct Brown Azo dye

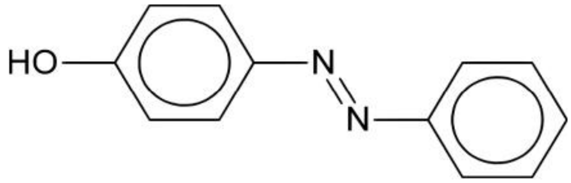


Fig3 : Orange Azo dye

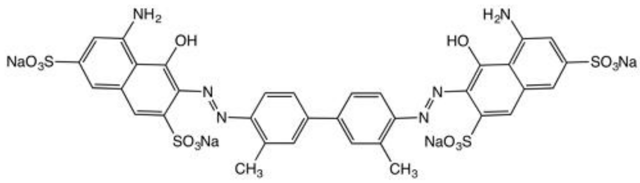


Fig 4:Tryptan Blue Azo dye

The second most used dye is Anthroquinine after Azo dyes[11].

S.No	Types of Dyes	Uses
1.	Dispersed Dyes	Polyester and Cellulose ester
2.	Azoic Dyes	Natural fibre cellulose and viscous fibre
3.	Direct Dyes	Cotton
4.	Sulphur Dyes	Cotton and staple fibres

Table2: Types of dyes and their usage over types of materials [5]

Textile Effluent treatment

To reduce the amounts of carcinogens and pollution causing agents from the textile effluent water, treatment is done in three steps which involve physical, chemical and biological steps. These steps are classified as primary, secondary and tertiary treatment.

Treatment	**Methods**
Primary Treatment	Fibre, Excessive oil and Grease
Secondary treatment	BOD, Oil remains and Color
Tertiary treatment	TDS, Residual color and odor

Table3: Classification of treatments and their methods

Primary treatment:

Excessive quantities of oil and grease, gritty materials and suspended solids are removed first [12]. Textile wastewater is screened with bar and fine screens to remove fibres, rags and fabrics using bars and fine screens [13].pH is changed to reduce the acidity of the effluent water. For ideal considerations of treating effluent water the Optimum pH range of 5-9 is maintained [12][14]. Post removal of coarse materials, suspended particles is removed by settling method like sedimentation, coagulation and flocculation. Sedimentation is not found to be effective because of its inefficiency of removal of suspended solids from the effluents and also it occupies large spaces[16].

In coagulation solids have charges around them which on adding chemicals forms colloids with another colloidal particle in the effluent. The chemicals used are Alum Sludge, Chitosan and combination of alum slude chitosan. These chemicals are called coagulants as they help coagulate the suspended particles[17].In Electrocoagulation, Electrical potential is supplied to the effluent by the help of electrodes. Iron and Aluminium electrodes are used as electrodes and this method is found to be effective[21]

Another physical process called flocculation where impeller blade design and addition of flocculantchemicals(Polymers Ex: Polyacrylamide) improves the amount of flocculation and the time required to achieve it. For the floc formation low shear axial flow is maintained as designed by Dynamix^{TM}Agitators [18]

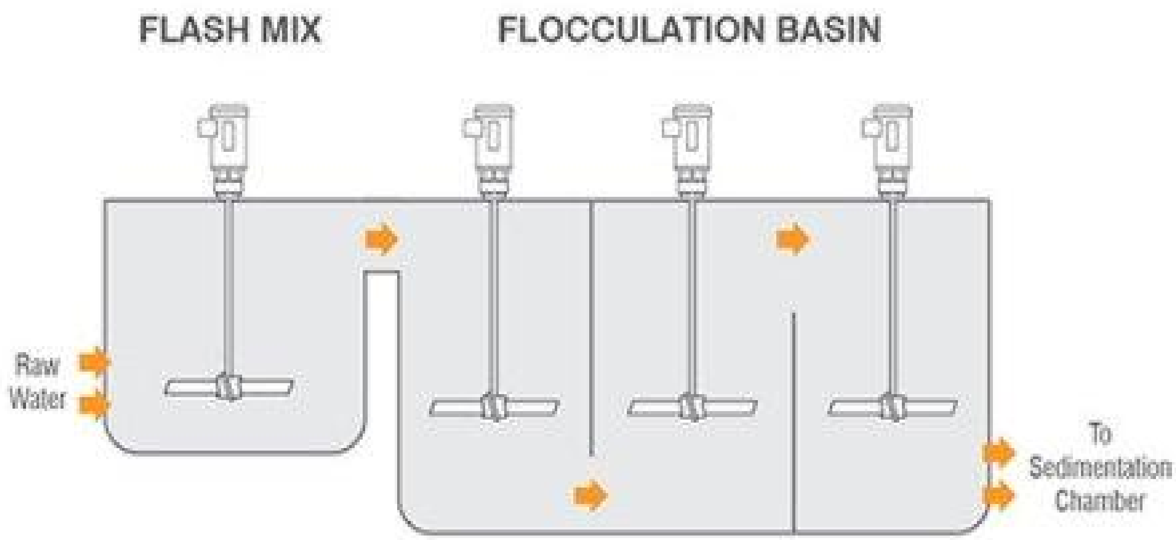


Fig: Basic flocculation tank diagram[18]

Secondary Treatment:

In this step oil remains, BOD and colour is removed. Treatment under this step is done in two ways, aerobic or anaerobic with the help of microorganisms[19]. In Anaerobic water treatment, effluent is hydrated, “Acidogenesis” or Acid Fermentation, Acetic acid, Carbon Dioxide and hydrogen formation by oxidation of reduced products of acid fermentation and Methane Fermentation is done. Each and every step in this process adds to give a food chain [20].

Most of the industries use aerated lagoons, the large holding tanks filled with effluents are aerated continuously for 2-6 days at a stretch and the formed sludge at the bottom of the tank is removed [22]. Aerobic treatment was found to be the effective one as it gives 75-98% while the anaerobic treatment only gives 51-96% of treatment efficiency. The anaerobic treatment outlet needs to be treated further until it reaches the discharge limits [23].

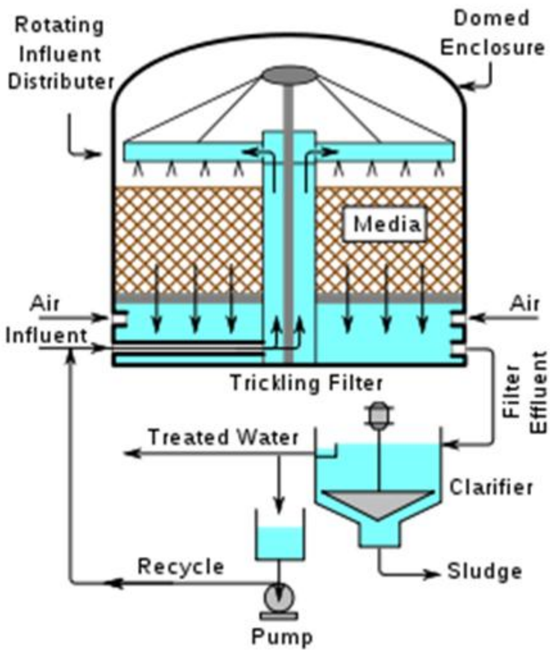


Fig5: Trickling Filter Design [24]

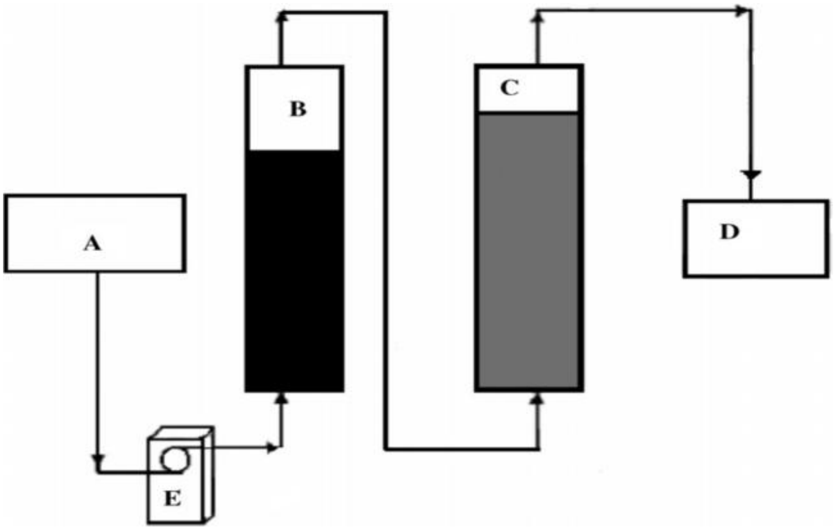
Trickling filter is of high importance in the waste water treatment technology. In this process, the waste water is sent through the tubes and is evenly spread over the filters which hold large surface area to the volume. The biological treatment process occurs when the microorganisms consume the waste water and organic matter present in the effluent stream thus releasing the carbon dioxide, water and energy [25]. In addition for the microbial growth the oxygen flow rate is maintained from the bottom. Thin slime of micro-organisms present on the walls of the filter slowly gets slipped down due to the increase in the film size. New slime grows at the wall and this process continues. In the outlet stream washed out slime and water is separated in settling tank[27].

The sludge obtained also needs to be disposed at the discharge limits. Before discharging the sludge it needs to be treated in aerobic or anaerobic methods. Aerobic method is done in the presence of the air which converts the sludge into biomass of carbon dioxide and water. Anaerobic bacteria and absence of the air constitutes anaerobic method of sludge treatment produces methane, Carbon dioxide and biomass [26].

Color in the water indicates the presence of dyes. Few dyes are biodegradable and the organism used to degrade them is algae. *Chlorella vulgaris, lyngbyalagerlerimi, Elkatothrixviridis, Osccillatoriarubescens, Volvox aureus and Nostoclincki* are some of the algae which are used to degrade, Decolorize amd remove Orange II, G-Red and basic fuchsin. Among which Nostoclinckialgae has 82% removal of methyl red colour [28]. Cellulose based waste like orange and banana peels tend to absorb the dyes from the effluent water which is aqueous solution [29].

Tertiary treatment:

After the primary and secondary treatment not all the impurities are removed from the wastewater so tertiary treatment is used, which removes Total Dissolved Solids (TDS), Residual color andodor [30]. In the Adsorption process the wastewater is passed through the absorbent activated charcoalalong with the color the process can remove the organic and mineral pollutants [31]. As a replacement of activated charcoal; banana peels[43], orange peels[44] or rice husk[44] are used to adsorb basic and acidic dyes by single usage or subsequent addition of biological materials for adsorption. The wastewater contains inorganic salts and some organic anionic components that are eliminated by passing the wastewater from cation and anion electrode they both attracts the OH^- and H^+ ions respectively. This process is called ion exchange process [32].



(A) treated wastewater, (B) cation exchange resin column, (C) anion-exchange resin column, (D) reusable water and (E) peristaltic pump.

Fig: Ion-exchange experimental set up [32].

In Membrane separation the wastewater passed from sand filtration which removes suspended solids and some amount of bacteria, virus, proteins and some sugars present in the wastewater are removed byultrafiltration. Still the wastewater contains the salts, lead, and some organic content which is removed completed by the process of Reverse Osmosis. [33]. The next process in the tertiary treatment is Electrodialysis in whichthe metals and non-metals present in the wastewater get attracted to the anion exchange membrane and cation exchange membrane [34].

The Advanced Oxidation Processes which is emerging now with many developments are undergoing. In this process the strong inorganic oxidant hydroxyl radical (OH) reacts with the wastewater in oxidation [35]. The conventional oxidant that doesn't oxidize the compound will be oxidized by the use of this hydroxyl radical. These are very unstable and highly reactive. Non-Biodegradable and organic pollutants can be eliminated from the wastewater [37]. This Advanced oxidation process is containing the Ozone(O_3), Hydrogen Peroxide(H_2O_2), Ultraviolet and their combinations [36].

In ozonation the ozone combined with the hydroxyl radical in alkali condition which results in oxidation of organiccompound by breaking the bonds of molecules in the organic compound. The ozone reacts in direct and indirect oxidation. This breaking of bonds cause smaller compound which reduces the residual color. Ozone decomposed in water it reacts in direct oxidation causing molecular ozone and indirect oxidation which forms hydroxyl radical. [38].

$$3O_3 + H_2O^{OH-} \longrightarrow 2OH^{\cdot} + 40_2$$

Many cases organic compound can't be oxidized into CO_2 and H_2O by conventional oxidation, According to Rein(2001). The intermediate product of the oxidation will be toxic or more toxic than the initial compound. By passing UV radiation this reaction can complete the oxidization. In the UV/O_3 process the formation ofhydroxyl radical is done by the activation of ozone molecules by Ultraviolet photon. [39]

$$0_3 + H_2O + hv \longrightarrow HO_2 + O_2$$

The oxidation done by the Hydrogen Peroxide(H_2O_2) alone ineffective at both acid and alkali values [40]. By accelerating hydrogen peroxide with UV radiation it gets photolyzed and reacts with the organic contaminants.

$$H_20_2 + hv \longrightarrow 2\ OH^-$$

More effective in acidic medium. The one of the combination in the AOP is UV/H_2O_2[39]. The above processes are used commercially but the remaining combination UV/TiO_2, Photo-Fenton reaction are done on lab and pilot scale

CONCLUSION:

There is a lot of consumption of water in the manufacturing of the textile from its raw form to the product form. It discharges large amount of polluted water, which should be treated before discharging it to the water bodies. As the technology is developing many new processes are to be used for the better treatment of the water to reach the discharge standards set by the State.

References:

[1] EPA (1997) Profile of the textile industry. Environmental Protection Agency, Washington.
[2] Shaul et al., 1991; Camp and Sturrock, 1990.
[3] A. Lopez*, G. Ricco*, R. Ciannarella*, A. Rozzi**, A. C. Di Pinto*** and R. Passino***, Textile wastewater reuse:ozonation of membrane concentrated secondary effluent WalSci Tech. Vol. 40. No.4-, pp. 99-10'.1999.
[4]Mutation Research/Genetic Toxicology and Environmental MutagenesisVolume 626, Issues 1–2, 10 January 2007, Pages 53-60.
[5] Rahman F (2016), The Treatment of Industrial Effluents for the Discharge of Textile Dyes Using by Techniques and Adsorbents. J Textile Sci Eng. 6: 242. doi:10.4172/2165-8064.1000242.
[6] http://www.dupont.com/products-and-services/industrial-biotechnology/industrial-enzymes bioactives/articles/what-is-desizing.html.
[7] http://textilelearner.blogspot.in/2013/03/an-overview-of-textile-scouring-process.html.
[8] https://en.wikipedia.org/wiki/Textile_bleaching.
[9] Mercerization, Encyclopedia Britannica, Inc, July 27, 2012.
[10] Vijaykumar MH, Vaishampayan PA, Shouche YS, Karegoudar TB (2007),Decolorization of naphthalene-containing sulfonated azo dyes by Kerstersia sp. strain VKY1. Enz Microbial Technol 40:204–211.
[11] George L. Baughman, Eric J. Weber, Transformation of dyes and related compounds in anoxic sediment: kinetics and productsEnviron. Sci. Technol., 1994, 28 (2), pp 267–276.
[12] Eswaramoorthi S, Dhanapal K, Chauhan D (2008), Advanced in Textile Waste Water Treatment: The Case for UV-Ozonation and Membrane Bioreactor for Common Effluent Treatment Plants in Tirupur, Tamil Nadu, India. Environment with People’s Involvement & Co-ordination in India. Coimbatore, India.
[13] Chipasa K (2001), Limits of Physicochemical Treatment of Wastewater in the Vegetable Oil Refining Industry. Polish Journal of Enviro Studies.
[14]Babu RB, Parande AK, Raghu S, Kumar PT (2007), Textile Technology-CottonTextile Processing: Waste Generation and Effluent Treatment. The Journal ofCotton Science 11: 141-153.
[15] COINDS. (1999–2000). No. 59. Kanpur: Central Pollution Control Board.
[16] Das S (2000) Textile effluent treatment -A Solution to the EnvironmentalPollution.
[17] Muhammad Bilal Asif, Nadeem Majeed, Sidra Iftekhar, Rasikh Habib, Sadia Fida&ShamasTabraiz (2015), Chemically enhanced primary treatment of textile effluent using alum sludge and chitosan, Desalination and Water Treatment.
[18] Brian James, Dynamixtm, http://www.dynamixinc.com/waste-treatment-part-2.
[19] K. Sarayu& S. Sandhya,Current Technologies for Biological Treatmentof Textile Wastewater–A Review, ApplBiochemBiotechnol (2012) 167:645–661.
[20] J.G.vanAndelA.M.Breure, Anaerobic waste water treatmentVolume 2, Issue 1, January–february 1984, Pages 16-20.
[21] MehmetKobyaOrhan, TanerCanMahmutBayramoglu, Treatment of textile wastewaters by electrocoagulation using iron and aluminum electrodes ,Volume 100, Issues 1–3, 27 June 2003, Pages 163-178.
[22]Ghaly AE, Ananthashankar R, Alhattab M, Ramakrishnan VV (2014) Production, Characterization and Treatment of Textile Effluents: A Critical Review. J ChemEng Process Technol 5: 182.
[23] F.Y. Cakira , M.K. Stenstromb, Greenhouse gas production: A comparison between aerobic and anaerobic wastewater treatment technology Water Research 39 (2005) 4197–4203.
[24] https://en.wikipedia.org/wiki/Trickling_filter.
[25] https://www.youtube.com/watch?v=Q0BLswO6xhk , Brunswick Sewer District.

[26] Mittal A (2011), Biological Wastewater Treatment.
[27] http://nptel.ac.in/courses/105104102/Lecture%2028.html.
[28] Mostafa M.El-SheekhaM.M.GhariebbG.W.Abou-El-Souodb, Biodegradation of dyes by some green algae and cyanobacteriaVolume 63, Issue 6, September 2009, Pages 699-704.
[29] GurusamyAnnadurai,Ruey-Shin JuangB,Use of cellulose-based wastes for adsorption of dyes from aqueous solutions, Duu-Jong Lee Journal of Hazardous Materials B92 (2002) 263–274.
[30] GranchBerheTseghai, https://www.slideshare.net/ GranchBerheTseghai/textile-effluent-treatment.
[31] Himanshu Patel, R.T. Vashi, Treatment of Textile Wastewater by Adsorption and Coagulation, 2010, **7(4),** 1468-1476.
[32] S. Raghu, C. Ahmed Basha* Journal of Hazardous Materials 149 (2007) 324–330.
[33] G. Ciardelli *, L. Corsi, M. Marcucci, Resources, Conservation and Recycling 31 (2000) 189–197.
[34] M. Chandramowleeswaran, K. Palanivelu* Desalination 201 (2006) 164–174.
[35] FagbenroOluwakemi Kehinde1, Hamidi Abdul Aziz[2]**,** International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Issue 8, August 2014.
[36] Adel Al-Kdasi1Azni Idris[1], Katayon Saed[2]*, ChuahTeong Guan[1], Global Nest: The Int. J. Vol 6, No 3, pp 222-230, (2004).
[37] Rizzo, L., Bioassays as a tool for evaluating advanced oxidation processes in water and wastewater treatment. Water research, **45**(15), p:4311-4340, 2011.
[38] Balasubramanyan, Shriram& S, Kanmani. (2014). Ozonation of Textile Dyeing Wastewater - A Review.Journal of Institue of Public Health Engineers.2014-15. 2014.
[39] Gerald Ruppert and Rupert Bauer [1], *Chemosphere,* Vol. 28, No. 8, pp. 1447-1454, 1994.
[40] Olcay T., Isik K., Gülen E. and Derin O. (1996), Color removal from textile wastewaters, WaterScience and Technology**34**, 9-11.
[41] Crittenden J.C., Hu S., Hand D.W. and Green S.A. (1999), A Kinetic Model for H2O2 /UV Process in aCompletely Mixed Batch Reactor, *Water Research*, **33**, 2315-2328.
[42] Perkins, Warren S.A Review of Textile Dyeing Processes Source: Textile Chemist &Colorist .Aug91, Vol. 23Issue 8, p23-27.
[43] Annadurai G, Juang RS, Lee DJ (2002) Use of cellulose-based wastes for adsorption of dyes from aqueous solutions. J Hazard Mater B92:263–274
[44] Rajeswari S, Namasivayam C, Kadirvelu K (2001) Orange peel as an adsorbent in the removal of Acid violet 17 acid dye from aqueous solutions. Waste Management 21:105–110
[45] Malik PK (2003) Use of activated carbons prepared from sawdust and rice-husk for adsorption of acidic dyes: a case study of acid yellow 36. Dyes Pigment 56:243–250