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# ASSESSMENT OF ANALYTICAL STUDY FOR HEAVY METALS IN TEXTILE EFFLUENTS

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## ABSTRACT

In the present investigation, the study was undertaken to evaluate the features of textile effluent *i.e.* most of the physico-chemical characteristics and heavy metals were investigated. The results show that, higher levels of pollutants emitted into the environment than of the allowable standard. Assessed characteristic values are negatively differed but metal concentrations except sodium are positively diverted from standard limits of wastewater discharge set by BIS. In view of those characteristics, the textile industry effluents should be treated by setting eco-friendly effluent treatment plant (ETP) before directly discharging into the water bodies of textile industries to curtail pollution load.

**Keywords:** Analysis, Industrial Pollution, Wastewater, Textile Industries.

## INTRODUCTION

The word "textile" comes from the Latin word "texere," which means "to weave." This refers to weaving, whether by hand and by machine. Animal and plant natural fibres are used as sources. One of the achievements, because of the developments, is the production of fibres utilising chemicals (Norshila Abu Bakar et al., 2020). These industries are differentiated using fibres, which are obtained from plants such as hemp, cotton, lycell, rayon, linen, and other sources. Animals provide protein fibres such as wool, silk, cashmere, and angora. Nylon and polyester, for example, are artificially synthesised fibres (Parshetti, et al., 2006). Because dyeing and wet procedures are used in the production process, and these processes are followed by sub processes like yarn and tread formation, this has an impact.

**History of textile industry in India:** The evidence of ancient and medieval sculpture and literature has indicated textile industry in the Harappa civilization. In Vedic culture as well, the references to weaving and spinning have been mentioned. Textiles were traded throughout the early ages. India was generating around 25% of its output in 1750, and a big export of textiles to European and Asian countries was a vital source of revenue. The largest manufacturing industry during the Mughal was cotton textiles in the 16$^{th}$ to 18$^{th}$ centuries, about 95% of which were British from Asia. And eventually, through technical and marketing advances due to colonization, has replaced traditional methods.

**Recent developments of textile industry:** India is having a linkage with its culture, traditions and agriculture for spread of products for domestic and for economic export. The textile is one of the largest industries in world; total export in 2017-18 was about 12.4% with 5% share in global trade in textile and apparel. Having a largest strength and manufacturing capacity across India. Traditional sector is with handloom, handicraft and small-scale power-loom units and the mill sector having about 3400 mills with

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installing capacity of 49 million spindles and 841000 rotors. This is providing largest source of employment for millions of people. The industry is contributing about,2% GDP of India with 7% of output in value terms and 15% of export earnings and directly employing about 46 million of people. [annual report of ministry of textile2017-18].The government of India liberalized its investment policy for the textile industry for the economic reform. the Government of India uneiled its National Textile policy 2000. This policy is encouraging Indian textiles to set large integrated industries of textile and to have a joint venture with firm at international textile centres. The goal to reach at U.S $230 billion by 2020.In Maharashtra about 3,828 thousand hectares area is under the cultivation for cotton and it worth of Rs. 17,170 cr. from 1991 to 2016, covering about 958 projects under sector of textile. Major 11 textile hubs are in Maharashtra, fixed capital of USD 2,418 million with 7999 employments. (Report of Maharashtra textile ecosystem).The textile industry is playing a considerable role in the developing countries economy and this sector is one of the start-up for industrialization process, as the speedup of industrialization with population of the world and parallel reduction of water resource as the production is responsible for about 20% of global water pollution from dyeing and finishing products and 10% of global carbon emission, the increase of environmental problem, the related laws made necessary to develop and use the environment friendly sources and reduce the pollution.

Environmental impacts by textile sector: The effluent releasing varies hazardous components according to the types of chemicals used and manufacturing process in the industry. It consists of huge amount of substances such as sulphur, vat dye, nitrates, chromium, naphthol, acetic acids, and heavy meals like lead, arsenic, cadmium, cobalt, nickel, copper which cause damage to water. The presence of colour causes wastewater to become turbid (Parshetti et. al., 2011). The manufacturing process like desizing which causes high BOD, bleaching causes alkaline nature of effluent due to use of chemicals such as hypochlorite, chlorine, caustic soda, hydrogen peroxide, acids, which consumes about 38% of water (Bledzki et al., 1999), Mercerizing process releases caustic soda, dyeing process release dye stuff, reducing agents acetic acid, sulphide like pollutants, Printing process causes dye, acids, metallic salts, which utilised about 8% of water. It results high amount of water from these processes this interferes with oxygen transfer mechanism causing effect on process of self-purification process of water, and as this effluent enriched with textile waste caused soil pores blocking causes loss of productivity. (Chandra et. al., 2009). Problem of the colour in aquatic life is affecting the availability of the light to aquatic flora. (Mansour et. al., 2007) as presence of acidic and basic compounds are degrading the quality. Higher the concentration of the salts affects the soil as it makes soil not to be used for the agricultural activity. The organic compounds result to decreasing of dissolved oxygen (Saxena et. al., 2017). Metals one of the necessary element of dyes for imparting colour the release of such heavy metals(copper, zinc, chromium, lead, cobalt, manganese) causes damage to environment and human health (Hameed and El-Khaiary, 2008; Pang and Abdullah, 2013). As the first destination of the waste leftover by any industry is the environment as it over ten decades for the industrial revolution in textile sector so that to realization the pollution by textile wastes shows a significant effect on environmental health of flora and the general health of the resident of the area or the peoples these actives should lead for legal prohibition to treat hazardous waste from industry.

The Discharge is causing contamination of the water bodies, which shows reduction in the oxygen level of water and the quality of the water body there is the considerable increase from the last decade due to the increase of apparel market, which is driven by the fashion loving peoples and young generation which is leading to the consumption of the excessive use of dye for beautiful colour to fashion. This is causing numerous uses of hazardous chemicals and other substances to release directly in the environment. Approximately it has been estimated as these industries are generating over million cubic meters of wastewater. The parameter set according to release of effluent is not followed by the industries. For removal of such impurity generating from the textile industry many physico-chemical integrated treatments are present which are showing effective removal dyes but at pilot scale Shakiba Samsami (2020)each technology is showing many advantages but there are many of the drawbacks with technological used is having its limitation. Many technologies are cost efficient has been shown effectively simple, reliable at lab scale or at pilot scale: though they are not implemented at industrial scale Compulsion of the treatment process should be made and then only releasing of effluent with standard limit should be mandatory to prevent these hazards, as the requirement of the water by machine used for dyeing should made as to consume less water. As the dyes which are easy to degrade can be used this causes no trouble to environment. One of the most important and easy technique is reusing the water.

**IMPACT OF YARN FORMATION**

**Ginning Industry:** the process of separation of fibres from the seed leads to generation of cotton dust and machine noise are 89 to 106dB (Khatik, Shinde & Thakare, 2013). The workers are exposed to high cotton dust which leads to respiratory and occupational lungs hazards (Dube, Ingale & Ingle, 2012)with the heavy noise of machine which causes hearing loss (Bedi, 2006).

**Spinning Industry:** the formation of yarn from the raw material using heavy machinery with the high noise which shows impacts on workers as hearing loss, (Dube et al.,2012;

**Weaving industry:** process of fibre formation one of the nosiest process due to the heavy machines for weaving and the dust causing nasopharyngeal cancer, cough, bronchial asthma. (Anjum, 2009)

**Remedies for ginning, spinning and weaving:** as humidity the working areas which will help to control the cotton dust. And should encourage the workers to use the safety devices, updating of the machines should be done properly. (Hasanuzzaman, et. al., 2016).

The following are some of the effluent protection standards:

**IS:2490-(BIS,1981)**

Tolerance limit for effluents discharged into inland surface water: Part I of the schedule outlines general discharge effluent limitations to receiving bodies. (Indian Ministry of Environment, Forest and Environment Change, Environmental Protection Rules,1986). Schedule VI of this legislation contains information on the discharge of pollutants into the environment. I have also included dye and cotton textile industries in the programme. Effluent discharge to receiving bodies is also covered by Schedule I.

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## IMPACT OF YARN FORMATION GOVERNMENT INITIATIVES

Development and automation of Indian textile industry makes it competitive in global market but has detrimental effect on environment and human life. Automation and modernization increased the speed of production that results in consuming more and more resources and consequently pollutes the environment. Such as fibre production leads to emission of gases those are accused of global warming (viz. $CO_2$ and $NO_2$) as well as acid rain ($SO_2$ and NOx). While chemical processing of textile produces toxic effluent along with gaseous emissions that pollute land, water, air and leads to severe health hazards. On the other hand, mechanical processing of textile forces the worker to work in the noisiest environment that remains full of dirt and dust makes the workers to suffer from several diseases (viz. hearing and respiratory impairment, occupational lungs disorder etc). Although the effect of textile mechanical processing is limited to the work room, fibre formation and chemical processing has vast negative impact on outside world that pollutes land, water, air and emits hazardous by-product which indirectly promotes acid rain and global warming. As Indian textile industry are still using the old technologies in this developed era, machineries and its instruments are still outdated. Several schemes are allotted by government of India such as National textile policy (NTP) 2000, which accomplish. To enable the textile sector to achieve and maintain a preeminent global position in manufacturing by the year 2000 and garment exports, as well as a technology upgradation fund scheme to help with the installation of cutting-edge technology.

Chemical processing of textile industry:

1. **Preparatory operation:** the fabric is prepared for further process their impurities are removed as these impurities makes the fabric hydrophobic in nature. These are the impurities which are removed by:

   **Singeing:** is burning of fibre from both sides as removal of impurity is done.

   **Desizing:** starch from the fabric is removed, souring: oil, wax, residual are removed by chemical treatment.

   **Bleaching:** this is used to make the fibre perfect white.

   **Mercerizing:** the concentrated and cold solution of sodium hydroxide is to remove impurity. These all depends on the type of fibre and the constituent of fabric.

**2. Textile Dyeing:**

**Vat Dyes:** these dyes are water insoluble, so they are converted to water soluble with caustic soda and sodium hydro sulphite than these are applied on the fabric, these are widely used for cellulose, protein and nylon fibres, these produces deep shades.

**Azoic/Napthol Dyes:** these dyes are the insoluble dyes used for cellulose fibres, as they are formed by reacting the fibre with amine with naphthol's, this class is known as Azo dyes. This class give black shade to the fibre.

**Direct Dyes:** these are used for the cellulose fibre as they are derived from Benzedrine salts. These are water soluble and least expensive, so there is not any use of fixing agent for direct dyes.

**Sulfur dyes:** applied by exhaust dyeing method and is the water insoluble and cannot be used directly, dyes and are derived from formulating sulphur containing compounds, and are used by reducing them to sodium sulphite and sodium hydroxide.

**Reactive Dyes:** these are anionic in nature. And is water soluble which react with the fibre and form covalent bond with the fibre, they react with cellulose in presence of sodium carbonate.

**Disperse Dyes:** used to dye nylon, polyester material, these dyes are non-ionic aromatic compounds and water insoluble.

**Basic Dyes:** these dyes are water soluble contains cationic group used to dye acrylic material, used for wools and silk and nylon.

**Acid dyes:** these dyes are water soluble and are in the form of sodium salt of sulphonic acid which is having good kinship to dye wools and silk fibres.

The source of hazards are from the discharge coming out from such process of chemical dyeing as described above; these chemical which are unfix are in effluent which are discharged with huge amount of water, as these are directly or indirectly transferred to river where water pollution is taking place as well as causing the air pollution in the surrounding as during drying the effluent is evaporating (Rathore,2012) the constituent which are to the air of through effluent like ammonia, sulphides (EPA,2001), the bleaching agent sodium hypochlorite which is causing emission of chlorine gas. (Das, 2000).

**3. Remedies:** as before releasing the effluent in the environment it must be neutralized by various method as the pollution indicating physic chemical parameters such as pH, colour COD, BOD, TDS, SS and heavy metals. (Patel, et al. 2013; Imtiazuddin, et al., 2012;)

## MATERIAL AND METHODS

The sample is collected manually from inlet and outlet of textile effluent treatment plant. Sample collection was done in sterilized bottle using grab sampling technique as the sampling is done with complete care as to avoid the contamination and labelled as inlet and outlet. The effluents samples were collected in cleaned poly-propylene bottles pre-washed with 20% $HNO_3$ acid and rinsed repeatedly with deionized water from the effluent outlets just before the treatment plant for individual textile and dying industries for metals examination,65% concentrated ultra-pure $HNO_3$ acid was added to each sample by dropper after immediately collection of effluent samples to bring the pH blow 2 to minimize precipitation and adsorption onto container walls (APHA, 1998). 100 ml well-mixed and acid-preserved sample was transferred into clean beaker and 5 ml 65%concentrated $HNO_3$ acid was added and covered with a clean watch glass. The beaker was heated (120-150º C) slowly on a sand bath hotplate in a fume chamber and evaporating until the sample is reduced to about 10 ml. The suspension was kept for cooling at room temperature and later added 5 ml 65% concentrated $HNO_3$ acid and 10 ml 70% concentrated $HClO_4$ acid. Suspensions were heated gently at 200˚C and melt away to about 10 ml. After cooling at room temperature, the suspensions were diluted to 100 ml in a100 ml volumetric flask with deionized water. Then the solution was filtered using Whatman No. 41 into plastic bottle and kept the solution in the refrigerator until analysis. The digested effluent samples were analysed by Flame Atomic Absorption Spectrophotometer (Model: AA-6800,Shimadzu) to determine calcium (Ca),magnesium (Mg), copper (Cu), zinc (Zn),nickel (Ni), lead (Pb) and cadmium (Cd). Sodium (Na) was determined by FlamePhotometer (Model: PFP7, Jenway). Throughout the whole process of sample preparation and analysis, special care was taken to minimize impurities from air, glassware and reagents. All glassware were washed with deionized water before using in this study. All reagents used during analysis were prepared from analytical reagentor higher-grade chemicals. All instruments were calibrated with standard solutions in accordance. Ghaly et al., 2014; Kale, 2016; Malik and Abdul 2013, Parshetti, et al. 2006; Patell and Vashi, 2015; Rathore, 2012 and Thorat, 2002.

## RESULT AND DISCUSSION

As per the result the parameter is showing the need to be treated before discharge. As the Primary process is not able to remove the impurity so complete tertiary treatment is required.

**Temperature:** as per the standard limit according to BIS is about 40degree Celsius and as per the effluent collected have shown 48 mg/l for inlet and 46 mg/l outlet as to treat effluent with chemical and biological technology the temperature must be controlled as per requirement as the rise of temperature results crop growth reduction with decrease of dissolved oxygen (Gaikwad et al., 2014 Thorat and Chavan, 2004).

**Electrical Conductivity:** it is measured though conductivity meter as per BIS Standards it should be 1400µS/cm. Though it is used to measure the salinity of effluent, it depends on mobility of ions, temperature. Higher the conductivity rates the life forms is affected by dehydration.

**pH:** the pH is measured by pH meter, as the BIS standard limit for pH is 5.5 - 9.0. and the effluent has shown as 7.5-8.6, this observed reading showed alkaline affinity, due to presence of heavy metals with increased pH as shown in Table no. 1 which determines the nutrient availability with its solubility, so it is a significant one for treatment.

**Colour:** Due to presence of colour to the effluent it alters the photosynthesis activity due to colouration is dark it is affecting other parameters likewise temperature DO and BOD. etc. dyes, colour producing compound and metals presence is showing colour to the effluent as shown in Table no. 1. (Malik et. al, 2013)

**Turbidity:** the observed value for sample is19 NTU for inlet and 16 NTU outlet, the standard for as it affects the aquatic life as it does not allow the sunlight to penetrate due to suspended impurities are present in the effluent which causes decoration of water.

Dissolved oxygen: According to Standard limit is dissolved oxygen is evaluated by wrinkle's method which resulted nil for inlet and 0.5 mg/l outlet as the increase in oxygen level leads to overgrowth of bacteria and other microbes, as if untreated effluent dumped in the water which reduces the dissolved oxygen rate of water bodies as shown in Table no. 1.

**Biological oxygen demand:** this shows the oxygen utilized by the microorganisms, as the BOD is higher so it can be said as water contains more decomposable substances results higher amount of oxygen demand. Sample BOD observation is910mg/l inlet and 368mg/l outlet and according to standard of BIS is 100mg/l. as higher the observed value showed higher polluted effluent as shown in Table no. 1.

**Chemical oxygen demand:** it calculates the non-biodegradable organic load present in the effluent according to BIS standard it should be 250mg/l. higher the concentration of COD it shows more hazardous effects on the aquatic life (Varma and Sharma, 2011).It caused depletion of dissolved oxygen on the surface of water rapidly. As increasing COD level as compared to BOD also indicates significant level of toxic and due to impurities of heavy metals in effluent as shown in Table no. 1. (Ingale and Thorat 2021).

**Total Suspended solids and Total Dissolved Solids:** It is the estimation of organic and inorganic constituents present in the water. as the TSS and TDS are higher due to the dyes present in the effluent of textile as it reduces the clearness of water as it reduces the sunlight penetration which reduces the dissolved oxygen as the temperature also increases due to the suspended particles which trap the sun rays and heat the water. (Kawser 2011) the prescribed limit of BIS for Total dissolved Solids are 2100 mg/l, and the Total suspended Solids limit is 100mg/l as shown in Table no. 1

**Chlorides (Cl):** during the process of bleaching, washing of fibres and use of chemical like hypo-choric acid, hydrochloric acid and in disinfection process and it is also used as the fixing agent for dye as it is causing the increase of chlorides in wastewater as it shows effect on growth of plants is reduced, it influence conductivity, TSS, TDS and alkalinity and indirectly they are added to the environment and disturbs the food chain and as these chlorides are used as disinfectant as they kill the microbes easily as shown in Table no. 1. (Varma and Sharma, 2011).

**Heavy Metals:** these are present in the dying agents as they are used during the process of finishing as an oxidizing agent. (Ingale and Thorat (2021). Some are used as the micronutrients in plants as zinc, copper and nickle but the excessive presence of the metals caused toxicity. Metals arise from metal complex dyes, dye stripping agents, oxidizing agents and finishers in textile effluents (Gaikwad S.R. Thorat S. R. and T.P. Chavan 2004). Pb and Cd concentrations were found below finding limits in this investigation. The range of Cuintensity was assessed from 0.012 to0.02 mg/L with a mean of 0.016 mg/l. Cu is an essential substance to human sustenance as a component of metallo-enzymes in which it acts as an electron donor or acceptor. However, in high concentrations, it can cause anaemia, liver and kidney damage, stomach and intentional irritation(Thorat and Wagh, 2000). Cu is toxic to aquatic plants at concentrations below 1mg/l, whereas a concentration close to this level can be toxic to some fish. The exact Zn concentration was observed in the range of 0.091 to 0.141 mg/l. Zn concentration in effluent improves due to use of chemicals impurities and process of viscous rayon fibres in textile industries. High concentration of Zn in water is extremely dangerous to aquatic life throughout early life stages. Ni concentration in textile effluent experiments varied from 0.006 to 0.009 mg/l. The most destructive health impacts from disclosure to Ni contain lung fibrosis, cardiovascular and kidney diseases and cancer of the respiratory tract. The evaluated concentrations of Cu, Zn and Ni are lower than the permissible limit of wastewater discharge specifications according to BIS standards as shown in Table no. 2. The mean applications of Cu and Zn in textile effluents in the present examination were lower than stated by Ingle et al. 2005, Thorat 2002, Sayed et al., 2006 in Maharashtra Ni= 0.67 mg/l.

**Table 1: Physico Chemical and Heavy Metals Characterization of Textile Industrial Effluent.**

| Sr. No. | Parameters Characteristics | Sample | Methodology | Inlet values | Outlet Values | BIS limit |
|---|---|---|---|---|---|---|
| 1 | Physical | pH | pH Meter | 8.4 | 7.6 | 5.5-9.0 |
| | | Colour (ADMI) | Appearance | Light purple | Dark yellow | |
| | | Temperature | Thermometer | 48 | 46 | >40 |
| | | Electrical Conductivity | Conductivity meter | 3085 | 2837 | 1400 |
| 2 | Chemical | Turbidity (NTU) | Nephelometer | 19 | 16 | |
| | | Alkalinity | Titration | 2330 | 1065 | |
| | | Chloride | Titration | 7040 | 2230 | 600 |
| | | Total Suspended Solids | TSS dried at 103-105ºC | 125/ | 50 | 100 |
| | | Total Dissolved Solids (mg/l) | TDS dried at 180ºC | 9220 | 8330 | 2100 |
| | | Chloride | Standard Titration Method | 626 | 756 | 600 |
| | | Sulphate | UV spectrophoto-meter | 2380 | 1940 | |
| | | Nitrate | UV/Visible spectrophoto-meter | | 138 | 0.1 |
| 3 | Organic | Dissolved Oxygen | | Nil | 0.5 | |
| | | Chemical Oxygen Demand | Standard Method | 3788 | 836 | 250 |
| | | Biological Oxygen Demand | BOD5 Track Method | 910 | 368 | 100 |

**Table 2: Assessment of Heavy Metals Characterization in Textile Effluent.**

| Sr. No. | Characteristics | Metal Value |
|---|---|---|
| 1. | Na (mg/l) | 4,659.890±230.902 |
| 2. | Zn (mg/l) | 0.141±0.0066 |
| 3. | Ni (mg/l) | 0.006±0.0015 |
| 4. | Pb (mg/l) | BDL |
| 5. | Cu (mg/l) | 0.012±0.0002 |
| 6. | Cd (mg/l) | BDL |

BDL-Below detection limit

## CONCLUSION

In terms of pH, hardness, electrical conductivity, biochemical oxygen demand, chemical oxygen demand, and heavy metals, wastewaters show significant deviations from BIS requirements. The highly polluted effluents have an adverse effect on water quality, resulting in substantial environmental and health issues. Our research reveals that the quantified Physico-chemical parameters such as temperature, colour, pH, dissolved oxygen, electrical conductivity, biological oxygen demand, chemical oxygen demand, total solids, total alkalinity, total hardness and Na were found higher than the standard recommendations. Pb and Cd concentrations were found below detection limit, but calcium, magnisium, zinc, nikel and copper concentrations were measured lower than the standard procedures. It is recommended that the effluents of textile industries must be treated well by treatment processes prior to their disposal into the adjacent water bodies to decrease the pollution load and avoid harmful pollution impact. The use of detergents (octylphenol ethoxylates, alkyl phenol ethoxylates and octylphenol), softeners, addition throughout souring and desizing and the residual dye is also the contributing to larger increase in intensity of chemical oxygen demand.

## REFERENCES


1. **Aafreen Syed, Kulkarni Mukesh, Narkhede S., Chavan A., Karpate H., and S. R. Thora**t: (2006) "Accumulation of heavy metals in lichens growing in Padmalya forest of Jalgaonin North Maharashtra Region." *Bull. Agriculture Science.* Vol. 5 Pp 41-45. ISSN: 0973-4023.

2. **APHA** (1998). Standard methods for theexamination of water and wastewater, 20th edition. American Public Health Association, WashingtonDC, USA.

3. **Bledzki A, Gassan J** (1999) Composite Reinforces with Cellulose Based Fibres. Progress in polymer science 24: 221-274.

4. **Chandra, R., Bharagava, RN., Yadav, S., and Mohan, D.** 2009. Accumulation and distribution of toxic metals in wheat (*Triticum aestivum* L.) and Indian mustard (*Brassica campestris* L.) irrigated with distillery and tannery effluents. *Journal of Hazardous Materials*. 162: 1514–1521.

6. **EPA**. (2001, August 13). Integrated risk information system (IRIS). National Centre for Environmental Assessment, Office of Research and Development, Washington DC, USA. Retrieved from http: // www. epa. Gov / iris / recent_2001. htm

7. **Gaikwad S.R. Thorat S. R. and T.P. Chavan** (2004) Phytoplankton and zooplankton diversity with respect to pollution starts of river Tapi in North Maharashtra Region *J. of Current sciences*. 5 (2): Pp.749-754. ISSN: 0972-6101.

8. **Ghaly AE, Ananthashankar R, Alhattab M, Ramakrishnan VV** (2014) Production, Characterization and Treatment of Textile Effluents: A Critical Review. *J Chem Eng Process Technol* 5: 182. doi: 10.4172/2157-7048.1000182 .

9. **Halimoon N and Yin R G S** 2010 Removal of heavy metals from textile wastewater using zeolite. *Environment Asia* 3(1) 124–130.

10. **Ingle K.N., Sonawane A.C., Bafna Y.D. and Thorat S. R.** (2005): "A study of physicochemical characteristics of Padmalya and Girna lake water in Jalgaon Maharashtra. *Bull. Env. Sci.* Vol. 23rd 2nd Issue Pp 39-41. ISSN: 0971-1732.

11. **Kadolph, S. J.** (2007). Textiles (10th Ed.). Upper Saddle River, NJ: Prentice Hall. Das, S. (2000). Senior Manager - Technical, Some issues of ecological hazards in textile industry, Global Brands Li & Fung (pp. 1–10). India: Private Limited.

12. **Kale V S** 2016. Consequence of temperature, pH, turbidity and dissolved oxygen water quality

parameters. *International Advanced Research Journal in Science, Engineering and Technology* 3(8) 186–190

13. **Malik and Abdul Khan, Sana.** (2013). Environmental and Health Effects of Textile Industry Wastewater. Environmental Deterioration and Human Health: Natural and Anthropogenic Determinants. 55-71. 10.1007/978-94-007-7890-0_4.
14. **Malloy, T. and Grubb, M.** (2008). MSD S– Nylon6. Retrieved from http: // skipper. physics. sunysb. Edu / HBD / MSDS / Nylon MSDS. pdf.
15. **Mandal H K** 2014 Effect of temperature on electrical conductivity of blended cement pastes. *Recent Research in Science and Technology*. 6(1) 171–175.
16. **Meride Y and Ayenew B.** 2016 Drinking water quality assessment and its effects on residents' health in Wondo genet campus, *Ethiopia Environmental Systems Research* 5 (1) 1–7.
17. **Norshila Abu Bakar, N. Othman, Z. M. Yunus, Zawawi Daud, Nur Salsabila Norisman and Muhammad Haziq Hisham.** Physico-Chemical Water Quality Parameters Analysis on Textile IOP Conf. Series: *Earth and Environmental Science*. 498 (2020) 012077doi:10.1088/1755-1315/498/ 1/ 012077.
18. **Parshetti, G., Kalme, S., Saratale, G., and Govindwar, S.** 2006. Biodegradation of malachite green by Kocuria rosea MTCC 1532. Acta Chimica Slovenica4: 492–498.
19. **Patel H and Vashi R T** 2015 Characterization and column adsorptive treatment for COD and color removal using activated neem leaf powder from textile wastewater. *Journal of Urbanand Environmental Engineering*. 9(1) 45–53.
20. **Patel, S., Rajor, A., Jain, B. P., & Patel, P.** (2013). Performance evaluation of effluent treatment plant of textile wet processing industry: A case study of narol textile cluster, Ahmedabad, Gujarat. *Performance Evaluation*. 2(4).
21. **Rakshanda M. Ingale and Sanjaykumar R. Thorat** (2021): Effect of bacterial strains on reduction of physico chemical characteristics in textile industrial effluent treatment system. *Aayushi International Interdisciplinary Research Journa*l (AIIRJ), Vol. 8(1). Pp. 14-18. ISSN: 2349-638x Impact Factor 7.149.
22. **Rathore, J.** (2012). Studies on pollution load induced by dyeing and printing units in River Bandi at Pali, Rajasthan, *India. International Journal of Environmental Sciences*, 3(1), 735–742.
23. **Shakiba Samsamia, Maryam Mohamadia, Mohammad-Hossein Sarrafzadeha, Eldon R. Reneb, Meysam Firoozbahr** (2020) Process Safety and Environmental Protection: Recent advances in the treatment of dye-containing wastewater from textile industries: Overview and perspectives.
24. **Thorat S. R.** (2002):"Surface and ground water quality of M.I.D.C. Chikalthana area at Aurangabad." **Bull. Envi. Sci.**, Vol. XIX., Pp 15 – 16. ISSN: 0971-1732.
25. **Thorat S. R. and Wagh, S.B.** (2000) "Physico-chemical analysis of tannery waste". *J. Industrial Control***.** 16, Pp. 107-109. ISSN: 0960-0342.
26. **Uwidia I E and Ejeomo C**. 2013 Characterisation of textile wastewater discharges in Nigeria and its pollution implications. *Global Journal of Research in Engineering General Engineering*. 13(4) 0–4.
27. **Varma L, Sharma J.** Analysis of physical and chemical parameters of textile wastewater. *Journal of International Academy of Physical Sciences* 2011;15(2):269-76.