Impacts of Textile Industry Effluents on Surface Water Quality: A Study on Hinganghat in Wardha District of Maharashtra

N. V. Gandhare[1], P. S. Jogi[2], N. C. Kongre[3], V. P. Meshram[4] and Jay Tanna[5]

[1]Nabira Mahavidhyalay, Katol, Nagpur
[2]Janata Mahavidyalaya, Chandrapur
[3]J.N. Arts, Comm. Science College, Wadi, Nagpur
[4]Dharampeth M.P.Deo Science College, Nagpur
[5]Department of Chemistry, R.T.M. Nagpur University, Nagpur
nilkanth81@gmail.com

Abstract:

The present investigation was conducted to study the impacts of textile effluents on surface water around the discharge area located at Hinganghat District Wardha (Maharashtra) India. The water samples were collected from nine different locations mainly from River after textile water discharge, Textile water discharged to nala and textile water discharge through nala to River at Hinganghat for various physico-chemical.and chemical quality parameters includes pH, alkalinity, acidity, EC, TDS, BOD, DO, Ca^{2+}, Mg^{2+}, Na^{+},K^{+-},NO_3^{-}, HCO_3^{-},SO_4^{2-},Cl^{-}.Most of these parameters, as found in this study, suggested the collected water is unsuitable for drinking, domestic and irrigation purposes. Studies on Physico-chemical and biological factors to evaluate the water quality, of river water and utility of river water for drinking, industries and irrigation purpose and shall be helpful in preparation of Environmental management plan to control the pollution and restore the river water quality for its designated best use.

Key words: Physcico-chemical, Effluents, Hinganghat, Textile water, etc.

Introduction:

Today water resources have been most exploited due to increasing population, industrialization, urbanization, increasing living standards and broad spheres of human activities. Good quality water is in adequate even for the normal living and is getting polluted due to industrial discharges including those of paper, textiles, rayon, fertilizers, pesticides, detergents, synthetic drugs, antibiotics, oil refineries and photo films (Oghenerobor et.al, 2014). Consequently water resources of highly industrialized cities in India (such as Bombay, Pune, Kanpur, Madras, Durgapur, Calcutta, Delhi etc.) have been heavily polluted. Thus efforts are mainly concentrated to enact laws to check these practices to control water pollution.

The textile industry from its beginning has been hampered by the large volumes of water required for the manufacture and dyeing of cloth. More recently water consumption and waste generation have become considerable concerns for textile manufacturers. Textile industry waste water is characterized primarily by measurements of BOD, COD, colour, heavy metals; total dissolved and suspended solids (Md.Khalid et.al, 2014). BOD or biochemical oxygen demand is the measure of the oxygen consuming capabilities of organic matter. Water with high BOD indicates the presence of decomposing organic matter and subsequent high bacterial counts that degrade its quality and potential uses. COD or chemical oxygen demand, measures the potential overall oxygen requirements of the waste water sample, including oxidizable components not determined in BOD analysis. Color is defined as either true or apparent color. True color is the color of water from which all turbidity has been removed. Apparent color includes any color that is due to suspended solids in the water sample.

Environmental problems of the textiles industry are mainly caused by discharges of waste water. Textile processing employs a variety of chemicals, depending on the nature of the raw material and product some of these chemicals are different enzymes, detergents, dyes, acids, sodas and salts. Industrial process generates waste water containing heavy metal contaminants. Since most of heavy metals are non-degradable into non-toxic end products, their concentrations must be reduced to acceptable levels before discharging them into environment. Otherwise these could pose threats to public health and / or affect the aesthetic quality of potable water. According to world Health organization (WHO) the metals of most immediate concern are chromium, zinc, iron, mercury and lead. Textile waste water contains substantial pollution loads in terms of COD, BOD, TSS, TDS and heavy metals (Vinod Kumar et.al, 2012).

Cotton textile waste waters has a high content of polluting compounds, the sources of which are the natural impurities extracted from the cotton fiber, the processing chemicals and the dyes. The discharge of this waste water to the environment causes aesthetic problems due to the residual colour (from the dyestuff used) and also damages the quality of the receiving water. The colour impedes light penetration and the dyes and /or their derivatives can prove toxic to aquatic life. Azo-reactive dyes are among the most common ones to dye cotton now days. They are non-biodegradable by conventional activated sludge treatment methods and they require intense physical / chemical methods in order to be removed from the waste water. The discharge of dyeing effluents into environments without appropriate treatment is currently a major problem in the textile industry. These effluents pose deep problems mainly in terms of colour, COD, toxicity and salinity. The textile dying industry requires large amounts of water (100-150 L), mineral salts (about 0.6 – 0.8 kg) and reactive dyes (30-60g) per Kg cotton. It results in to large waste water streams containing complex contaminants (N.P.Mohabansi et.al, 2011).

Dyes actually limit aquatic plant growth by reducing light transmittance. It is estimated that 20-30% of the used initially dyes are not fixed on the textile fibers and finally remain in the effluents of the dyeing baths. Cotton represents approximately half of all textiles worldwide and nearly all cottons are today dyed by reactive dyes. Hinganghat is located at 20.57^{0} N 78.830. It has an average elevation of 215 metres (705 feet.) above MSL. Before independence Hinganghat was in center of India, but after partition of India and Pakistan the Nagpur is called as center of India. Hinganghat's river is also well known as 'Vena River', a tributary of Wardha River which joins to Pranhita River, which ultimately flows into the Godavari River. There is textile cotton industry which is well known as Mohata Mill situated near Subhashchowk of Hinganghat about four kilometer away from the Hinganghat's Vena river. It is about twenty-one miles south east of the city of

Wardha. The town is located on the banks of Vena River, a tributary of Wardha River which joins to Pranhita River, which ultimately flows into the Godavari River. Hinganghat has been, in the past, a center of the Indian cotton trade, as it is located in the fertile WardhaValley.Water from River and nala are being used for irrigation purpose and textile (cotton) water discharged into these sources is likely to affect the characteristic of water and in turn the crop pattern with respect to its quality and quantity.

The present work thus aims at carrying out studies on one river of Hinganghat (Vena River) located at Hinganghat, district Wardha, state Maharashtra. The River water is used for drinking purpose, irrigation purpose. Present study refers to the impact of the textile cotton industry waste water (Hinganghat) on River water. Studies on physico-chemical and biological factors to evaluate the water quality, of river water and utility of river water for drinking, industries and irrigation purpose and shall be helpful in preparation of Environmental management plan to control the pollution and restore the river water quality for its designated best use.

Material and Methods:

In this investigation water samples have been collected in polythene bottles with necessary precaution. Water samples were collected from nine (9) different locations to a depth of 10cm to 15 cm below from the surface water level. Water was collected in sampling bottle nearly one liter. The first sample (S1) was taken from the nearest point from discharge point and eventually the last sample (S9) was collected from most distant point from the discharge point. The sampling was done in 15 November 2014. Collected samples were brought to the laboratory and were analyzed for various physic-chemical properties viz. temperature, turbidty, total dissolved solid(TDS),pH, electrical conductivity (EC), dissolve oxygen (DO), BOD (Biochemical oxygen demand), (Cl^-) etc.

A thermometer having a quick response with 0.1^{0}C division, checked against a precision thermometer. Water pH was determined by glass electrode using pH meter. pH meter was calibrated by buffer solution borax and KHP. Electrode was dipped in water sample and pH was noted. Determination of parameters like odour, colour, temperature, density, surface tension, viscosity, alkalinity, acidity, chloride, hardness, total dissolved solid (TDS),total suspended solids (TSS), DO, sodium ,potassium, and NO_3^- were carried out in the laboratory. Chloride is determined in a natural or slightly alkaline solution by titration with standard silver nitrate, using potassium chromate as an indicator. Silver chloride is quantitatively precipitated before red silver chromate is formed. Sulfate ions are precipitated as $BaSO_4$ in acidic media (HCl) with barium chloride. The absorption of light by this suspension is measured by spectrophotometer at 420nm or scattering of light by Nephelometer. The organic matter gets oxidized completely by $K_2Cr_2O_7$ in the presence of H_2SO_4 to produce CO_2 + H_2O. The excess of $K_2Cr_2O_7$ remaining after the reaction is titrated with $Fe(NH_4)_2(SO_4)_2$. The dichromate consumed gives the O_2 required for oxidation of the organic matter. Electrical conductance was carried out using pH-meter and conductivity meter respectively. Sodium (Na) and Potassium (K) were determined by using flame photometer. Sulphate ion concentration (SO_4^{2-}) was determined by using Systronic-108 and 166 spectrophotometer. The chemicals used method while were AR grade. Double distilled water is used for the preparation of solutions and reagents. All equipment like pH, conductivity meter and spectrophotometer were checked and calibrated according to manufacturer's specifications.

Result and Discussion:

The physic-chemical analysis data of samples of Hinganghat textile area are shown in table. From results it is evident that, the values of Electrical conductivity (EC) of the water samples ranged from 668 µS/cm to 862 µS/cm with an average value of 777 µS/cm. The highest value of EC was found in sample 862 µS/cm and lowest value of Electrical conductivity was found in sample 668 µS/cm.Usually, lower values of EC indicate the presence of lower content of dissolved salts in water, whereas higher values of EC indicate the higher content of dissolved salts in water. Total dissolved solid(TDS) in water mainly composed of various salts like chloride, phosphates and manganese, and other particles. The Total dissolved solid in the collected water samples varied from 2110mg/l to 2431mg/l. The average value of TDS was 2313mg/l. Water having higher TDS is unpalatable and potentially harmful for health. Dissolved Oxygen (DO) is not only an important parameter for determine the quality of water but also it helps us to understand the natural self-purification ability of water as well as the impacts of urbanization and industrialization on water. For fisheries, the range of optimum values of Dissolved Oxygen (DO) is 4 to 6mg/l, below that most of aquatic organisms could not survive. The lower values of DO of water may be due to inclusion of high organic and inorganic load in the present water body which leads to oxygen depletion. The average value of Dissolve oxygen was 3.18mg/l. Biological Oxygen Demand is used to measure the effects of organic pollutant on water quality and biodiversity, by measuring the quality of oxygen used by microorganism(aerobic bacteria).In the water, Biological Oxygen Demand values ranged from 8.10mg/l to 8.82mg/l.The average value of Biological Oxygen Demand was 8.33mg/l.

pH is an important ecological factor, which indicate hydrogen activity in water and express universally the intensity of the acid and alkaline condition of the water. The pH values ranged from 5.33 to 5.96.This means that the use of surface water around the industry is unsuitable for drinking purpose. The reason of low pH of water may be the over existence of acidic industrial effluents. pH of water can also lowered by organic acid for decaying vegetation and organic waste, or the dissolution of sulfide minerals. For aquaculture, the permissible limits of Sodium (Na^+) are 2mg/l to 100mg/l and the permissible limits of potassium is 1mg/l to 10mg/l. The sodium values and potassium values ranged from 15.34mg/l to 28.23mg/l 9.34 mg/l to 16.84 mg/l respectively. The highest sodium value and potassium value found to be 28.23mg/l and 16.84 mg/l respectively.

For fisheries, the recommended values of Calcium and Magnesium concentration in water are 5-10mg/l. For drinking water, the permissible limit of Calcium is 75mg/l; here the limit is 30-35mg/l for Magnesium. The concentration of Magnesium and Calcium ranged from 40.12mg/l to 60.23 mg/l and 23.15 mg/l to 38.33 mg/l respectively. The highest Calcium and Magnesium value found to be 60.23 mg/l and 38.33 mg/l respectively. The concentration of Chloride (Cl^-) serves as an indicator of pollution occurred by sewage and industrial effluents.Though excessive Chorine in drinking water is not particularly harmful. Excess Chlorine (more than 250mg/l) makes water salty. People who drink Chlorine rich water are often subject to laxative effects. In the present investigation, the concentration of Chlorine ranged from 62.33mg/l to 96.52 mg/l. Highest concentration of chloride found to be in water was 96.52 mg/l. For aquaculture, the recommended limit values of Bicarbonate (HCO_3^-) concentration in water is from 50mg/l to 300mg/l and values in the reservoir were within this limits, which indicate that this water is suitable for fisheries in terms of Bicarbonate (HCO_3^-) concentration. The concentration of Bicarbonate ranged from 204.81mg/l

to 345.22 mg/l. When sulphate (SO_4^{2-}) concentration in water become around 1000mg/l, it create laxative effects and causes gastro-intestinal irritation. In the present study, the concentration of Sulphate was found to be in the range from19.11mg/l to 27.49mg/l.

Table. 1-Physico-chemical parameters of the samples.

Sample No.	EC(µS/cm)	TDS(mg/l)	DO(mg/l)	BOD(mg/l)
S1	771	2335	3.30	8.12
S2	862	2422	1.65	8.12
S3	668	2110	4.23	8.10
S4	721	2244	4.52	8.23
S5	860	2425	1.83	8.25
S6	796	2253	3.82	8.55
S7	730	2279	4.23	8.45
S8	772	2322	3.22	8.82
S9	820	2431	1.89	8.33
Min-Max	668 - 862	2110-2431	1.65 - 4.52	8.10 -8.82
Mean	777	2313	3.18	8.33

Table. 2- Chemical constituents of the water samples.

Sample No.	pH	Cl^- (mg/l)	NO_3^- (mg/l)	SO_4^{2-} (mg/l)	HCO_3^- (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	Na^+ (mg/l)	K^+ (mg/l)
S1	5.94	81.85	35.33	23.39	310.44	41.23	27.55	23.12	12.35
S2	5.33	91.38	35.83	26.67	345.22	60.23	38.33	28.23	15.33
S3	5.74	62.33	30.52	19.11	225.23	36.34	23.15	15.34	9.34
S4	5.45	70.29	40.55	27.40	250.27	40.16	28.16	17.48	12.03
S5	5.83	96.52	32.23	26.56	321.12	52.60	34.89	27.07	16.84
S6	5.71	70.28	40.89	22.45	204.81	41.80	30.10	19.77	11.98
S7	5.47	71.29	40.58	27.49	250.20	40.12	28.18	17.45	12.10
S8	5.96	82.34	37.56	23.67	310.45	42.88	26.73	19.56	12.67
S9	5.64	91.21	35.55	25.54	315.65	54.54	35.09	24.65	16.12
Min-Max	5.33 - 5.96	62.33 - 96.52	30.52-40.89	19.11-27.49	204.81-345.22	40.12-60.23	23.15-38.33	15.34-28.23	9.34-16.84
Mean	5.67	61.18	36.56	24.69	281.52	45.54	30.24	23.58	13.19

Conclusion:

Water pollution is one of the most important issues facing the country. The harmful effects of textile water pollution are manifold. The textile cotton industry polluted water can cause disease such as cholera, typhoid and many other enteric infections. It is a problem for almost every industry to treat and dispose off the waste produced. The industry may be agro-based like sugar, distillery, Textile, pulp and paper mills etc. The main problem arising is that of organic substances dissolved in the process and the vast quantities of the water used. To conserve the limited water resources for the limited water supplies as well as for developing industries considerable work is being done on the characterization and treatment of waste from the textile cotton mills.

During sampling it was found that nala's sites were much more polluted, Municipality of Hinganghat should take care about the nala and river's surrounding. It can be concluded from analysis that these nine sites are not good for drinking. From the above result and discussion it is concluded that the values of EC, TDS, BOD, Na^+, Cl^-, HCO_3^-,SO_4^{2-} were found higher than the standard level in the water samples in Hinganghat around textile mill area. So, the water around the experimental area should not be used for recreation, drinking, domestic and industrial purposes.

Acknowledgement:

Authors are deeply thankful to the Principal, NabiraMahvidyalaya, Katol; RTM Nagpur University Nagpur for providing necessary laboratory and instrumental facilities.

References:

1. **Oghenerobor Benjamin Akpor, Gladys Onolunose Ohiobor, Tomilola Debby Olaolu.(2014):** Heavy metal pollutants in wastewater effluents: Sources and remediation, Advances in Bioscience and Bioengineering.,2(4):pp 37-43.

2. **Md. KhalidHasan, Mahin Miah (2014):**Impacts of Textile Dyeing Industries Effluents on Surface Water Quality: A Study on Araihazar Thana in Narayanganj District of Bangladesh,Journal of Environment and Human.,1(3): pp 2373-8332.

3. **VinodKumar, A.K.Chopra and R.K. Chauhan (2012):** Effects of Textile Effluents Disposal on water quality of Sub Canal of Upper Ganga Canal at Haridwar (Uttarakhand), India, Journal of Chemical and Pharmaceutical.,4(9):pp4206- 4211.

4. **N.P. Mohabansi, P.V. Tekade and S.V. Bawankar (2011):**Physico-chemical Parameters of Textile Mill Effluent, Hinganghat Dist Wardha (M.S), Current World Environment., 6(1):pp 165-168.

5. **World Health organization (1984)**, Geneva, Guidelines for drinking water quality.

6. **SDPI (1995):** Environmental examination of the textile industry in Pakistan.

7. **Indian standard IS (1974)**: 2296, New Delhi

8. **Wilcox (1965)**, L.V. Effects of Industrial wastes on water for Irrigation use, ASTM Tech Pub., No. 273 pp 58