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RESEARCH ARTICLE

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PHYSICO-CHEMICAL ANALYSIS AND ASSESSMENT OF DOMESTIC WATER SUPPLIED BY TIGHRA RESERVOIR, GWALIOR: A CASE STUDY

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ABSTRACT

Water pollution and its effective treatment is one of the major matters of interest for various environmental agencies. Water resources are in depredation of its quality due to Industrializations, rapid urbanization and modern agriculture practices. In this paper, an attempt has been made to study the characteristics of total nine physico-chemical parameters of raw water and treated water at the Motijheel treatment plant, Gwalior for a period of four months (January-April, 2015). In doing so various parameters like Total Dissolved Solids, Total Hardness, pH, Electrical Conductivity, Turbidity, Calcium, Magnesium, Dissolved Oxygen, Total Alkalinity, and Chloride were monitored to ascertain the drinking water quality. It has been found that three parameters, namely Turbidity, Dissolved Oxygen and Residual Chlorine have significant impact on water quality. Results of water analysis showed that the surface water chemistry is firmly influenced by anthropogenic activities and hydrologic processes. High turbidity of samples exhibits poor quality of water. It may be due to more runoff of surface water during monsoon. Which cross the standard limits in water samples but after treatment in Motijheel, Gwalior treatment plant it maintain the permissible limits. In general it has been found that all the parameters for treated water are within the range of standards values prescribed by various agencies.

Keywords: Water Treatment, Turbidity, Dissolved Oxygen, Residual Chlorine, drinking water.

1.0 INTRODUCTION

Water is a very important resource which is critical for survival of all species including human beings. Due to industrialization and other human population density related factors water quality is affected by pollution. Water pollution is generally localized and confined, affecting fresh water more severely. It is well known fact that potable safe water is absolutely essential for healthy living. The water borne disease out breaks associated with the distribution system failures has been increased over the years [1].

In India, Central board for the prevention and control of water pollution (1979) has classified the water on the basis of values of COD, BOD, total Coliform count, pH, free ammonia, electrical conductivity, sodium absorption ration, etc. Various surface water quality, monitoring programs are initiated by Central board for the prevention and control of water pollution in different parts of country to provide a reliable estimation of attempt to perform full analysis of water for a large number of physico-chemical parameters [2]. Therefore, these programs usually yield large data matrices. Numerous researches have been done on estimation of different physic-chemical parameters for safe drinking and domestic water in the past [3,4]. Safe drinking water parameters and their limits, as directed by WHO and Central board for the prevention and control of water pollution are used in water analysis [5,6]. Gwalior is well known district of chambal region of Madhya Pradesh, India with a geographical area over 780 Km^2. As of 2011, it was estimated to have a population of 1,901,981 (District census of India, 2011) [7]. The western area of the district is covered with hillocks. The soil of Gwalior is mainly consists of massive rocks transverse by quartz sand stone, limestone and slate. Gwalior soils are classified as alfisol (red soil) and vertisol (black soil) are classified as kabar and mar. Red soil covers the northern part of region. Tighra Dam, situated near Gwalior is the main source of water supply to Gwalior city and partially augmented by ground water. The total treated water availability, including supplies from the two WTPs and groundwater supplies, is about 155 MLD (37.5MGD), which theoretically translates into the per capita availability of around 160 lpcd considering no losses and equitable distribution. Theoretically, this supply is sufficient for the Gwalior city when compared to CPHEEO's norms for per capita supply of 135 lpcd. Water from the Tighra dam is supplied to Motijheel (Old and New) water treatment plants. These plants receive 67.2 MLD (14.8 MGD) and 68.7 MLD (15.1 MGD) of water from dam [8]. After treatment, the water is supplied to various areas, through supply of PSC pipes for supply water. The objective of this work is to analyze physical and chemical properties of drinking water supplied by tighra reservoir in Gwalior city according to APHA, 1998, standards and recommendation on end use of water based on average level of different parameters found after physical and chemical analysis.

2.0 MATERIALS AND METHODS

At 68.19 MLD, New Motijheel water treatment plant, two sampling stations have been selected namely raw water (before treatment of water) and secondly supply water (after treatment of water before supplying to municipal use) for the present study. Physico-chemical analyses of both of the sampling stations have been done for 4 months from January, 2015 to April, 2015. Monthly 06 water samples were collected from both sampling stations separately in sizes (1-1.5 liters) in plastic bottles during morning hours between 7:00 A.M. to 10:00 A.M. at a depth of 10-15 cm with precautions.DO was fixed at the spot while taking the samples for DO determination in 300 ml capacity BOD glass bottles. Water samples was brought to laboratory and analyzed soon after on the same day and data was recorded. The water samples were analyzed as per standard methods (APHA, 1998 and Diatloff, E. and Rengel, Z. 2001) [9,10]. Total of 10 parameters were analyzed;Measurement of pH,Electrical Conductivity,Turbidity, Nephelometric Method,Total Hardness, Total Dissolved Solids (TDS),Magnesium,Calcium, Dissolved Oxygen (DO)Azide Winkler's Iodometric Methods,otal Alkalinity,[9] and Chloride [10]. The entire chemicals used in this work were of analytical grade and were purchased from Merk (India). They were used as obtained, no further purification was done. A wide range of instruments was used in this work as given in APHA standard. Spectrophotometer UV-VIS, model number UV-1700(E) 23OCE are used for the estimation of nitrate, chloride and iron.

3.0 RESULT AND DISCUSSION

The results of the studies at 68.19 MLD, New Motijheel water treatment plant for various characteristics have been compared of raw water and Supply water at different months (Jan.-April, 2015).The physico-chemical characteristics of this study are presented in Tables on monthly basis.

3.1variation of pH (Potentiahydrogenii)

As pH is a very important parameter, its variation in the water treatment plant at different months is shown in fig 3.1.

From the study of variation of pH, it is noted that the pH of raw water varies from 7.5 to 8.14 with an average value of 7.88 while in supply water the pH is varies from 6.87 to 8.01 with an average value of 7.75. In Raw water the pH is high due to the anthropogenic sources as well as natural geological processes that increase alkalinity too. In natural water, the pH also changes durational and seasonally due to variation in photosynthetic activity. However, pH has no direct adverse effects on human health, but, sour taste is produced, if value is below 4 will and value above 8.5 an alkaline taste and also starts corrosion in pipes [11].

The pH values for both Raw and Supply water were predominantly alkaline. The samples of July in Supply water show acidic behavior, but after treatment of water the pH in Supply water is in permissible limits of the BIS.

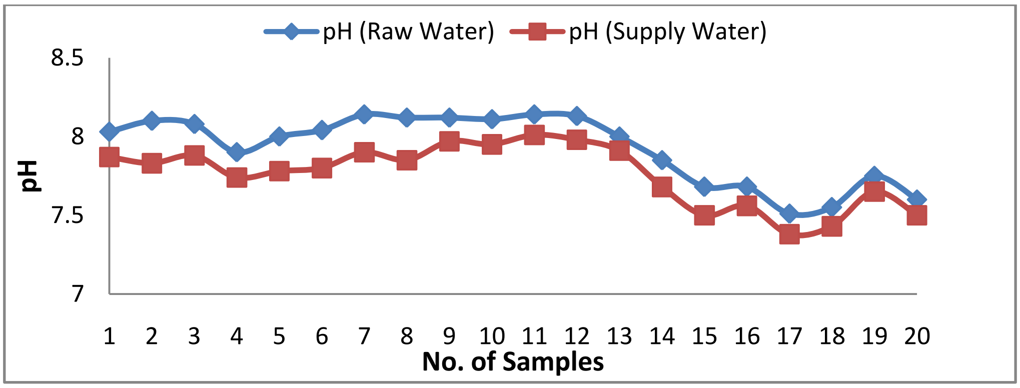

Fig.3.1: Monthly pH variation in water from Jan.-April, 2015.

3.2 Measurement of Electrical Conductivity (EC) The variation in EC in the water treatment plant at different months is shown in fig3.2.

Electrical Conductivity is the measure of capacity of a substance or solution to conduct electric current. High conductivity means more mobility and interaction of ions. Consequently, a sudden rise in conductivity in the water will indicate addition of some pollutants to it. The variation of EC varies from 160 to 285 µS/cm in both raw water and Supply water with an average value of 234.27 µS/cm(fig. 3.2). The maximum 290 µS/cm EC in raw water in the month of April and the minimum 160 µS/cm in the month of Jan due to the change in temperature. Conductivity is highly dependent upon temperature and therefore is reported normally at 25°C to maintain the comparability of the data from various sources. There is not much change in EC of supply water after the treatment.

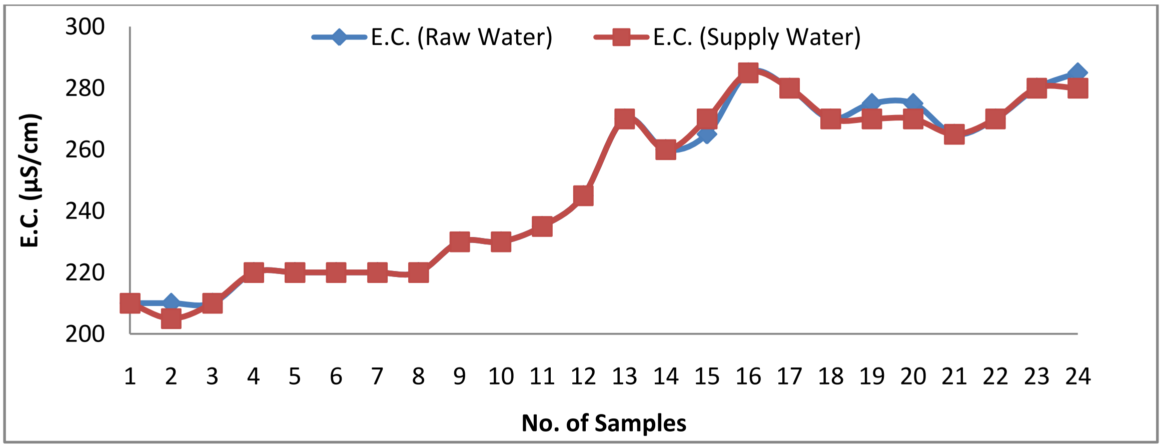

Fig 3.2: Monthly Electrical Conductivity variation in water from Jan.-April, 2015.

3.3 Measurement of Turbidity

The variation in Turbidity in the water treatment plant at different months is shown in fig 3.3.

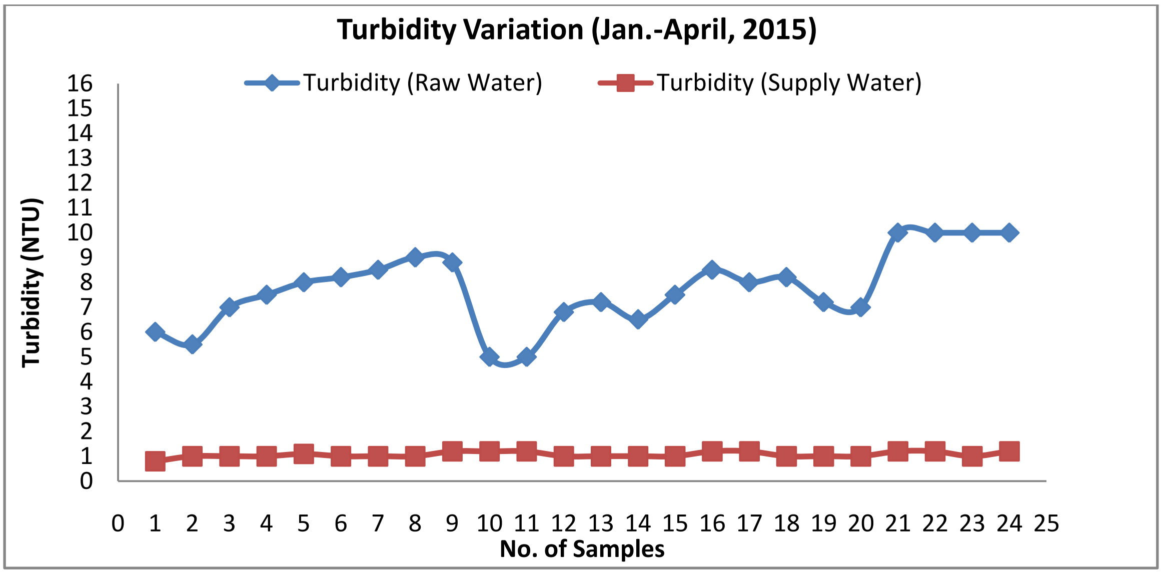

Fig 3.3: Monthly Turbidity variation in water from Jan.-April, 2015.

The turbidity of raw water varies from 3 to 1000 NTU with an average of 106.1 NTU while in the supply water turbidity varies from 0.5 to 4 with an average of 1.19 NTU. It is more than the permissible limits in the raw water due to the rain water. The maximum 1000 NTU turbidity in raw water is in the month of last June due to the heavy runoff of rain water but after treatment the turbidity in supply water is in permissible limits of the BIS.

The determination of turbidity is an important objective in raw water and supply water. Turbidity removed by coagulation, filtration etc, in drinking water treatment plants. A reduction in turbidity is associated with a reduction in suspended matter and microbial growth [12].

3.4 Determination of Total Dissolved Solids

The variation in Total Dissolved Solids in the water at different months is shown in fig. 3.4.

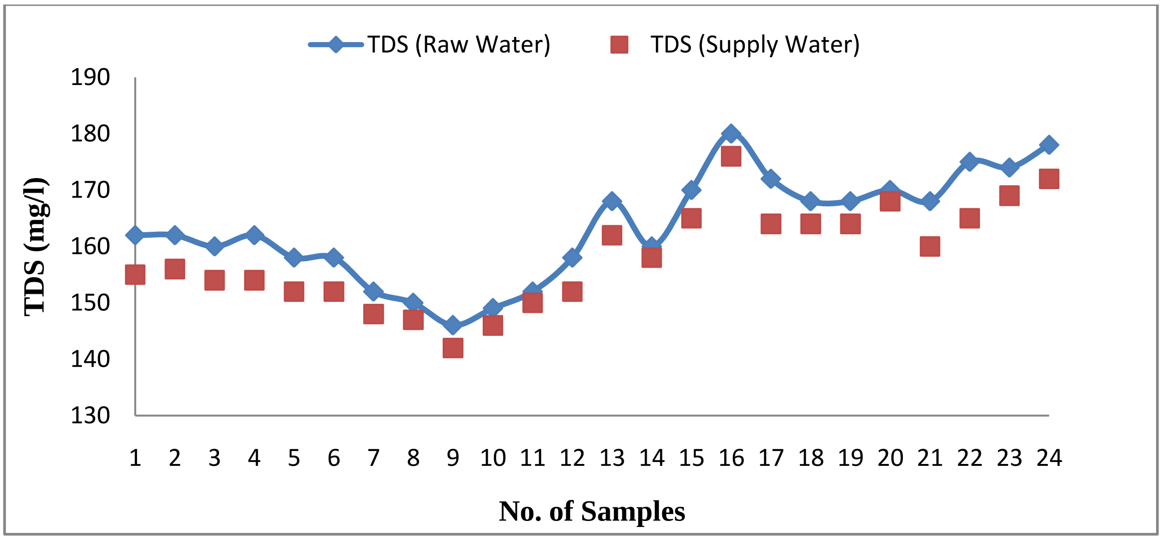

Fig 3.4: Monthly Total Dissolved Solids variation in water from Jan.-April, 2015.

The Total Dissolved Solid of raw water varies from 105 to 180 mg/l with an average of 149.5 mg/l while in the supply water total dissolved solids varies from 98 to 176 mg/l with an average of 143.5 mg/l. The concentration of dissolved solids is an important parameter in drinking water and other water quality standards. They give a particular taste to the water at higher concentration and also reduce its palatability. However, in case of drinking water the individual concentration of different substances are more important rather than the total dissolved solids [13].

3.5 Determination of Total Hardness

The variation in Total Hardness in the water at different months is shown in Fig. 3.5.

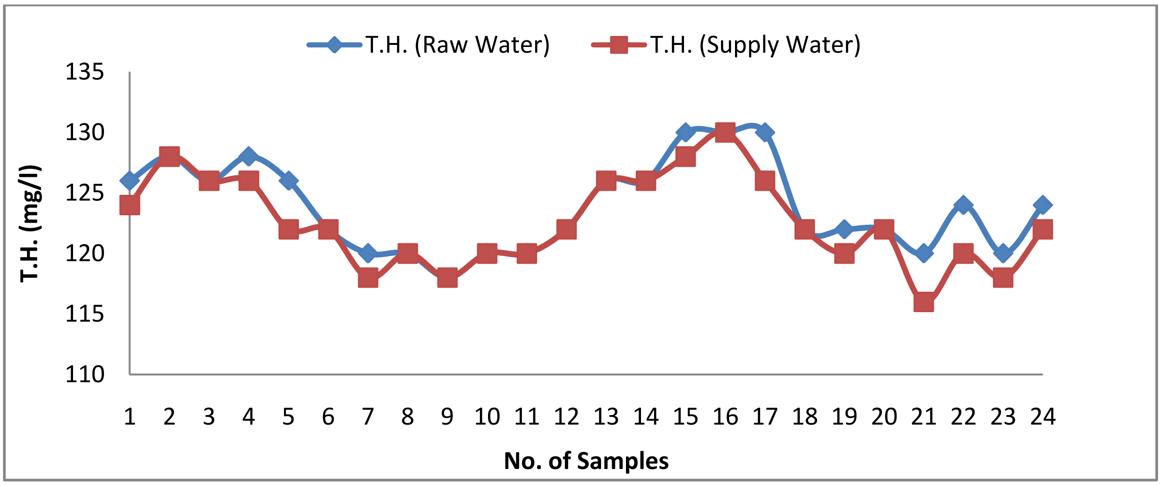

Fig 3.5: Monthly Total Hardness variation in water from Jan.-April, 2015.

Hardness is the property of water vents the lather formation with soap and increase the boiling point of water. Hardness is mainly caused by, chloride,bicarbonates,carbonates, sulphates, silicates,nitrates etc. Hardness has no known effects on health; however, some evidence has been given to indicate its role in heart disease [14]. The Total Hardness of raw water varies from 76 to 130 mg/l with an average of 108 mg/l while in the supply water total hardness varies from 76 to 130 mg/l with an average of 106.8 mg/l. The hard water is also not suitable for domestic use in washing, cleaning and laundering. The maximum hardness in raw water is in the month of last March then lower down in later and minimum in April. There is not much change in hardness of supply water after the treatment; it is within permissible limits of the BIS.

3.6 Determination of Calcium

The variation in Calcium in the water at different months is shown in Fig 3.6.

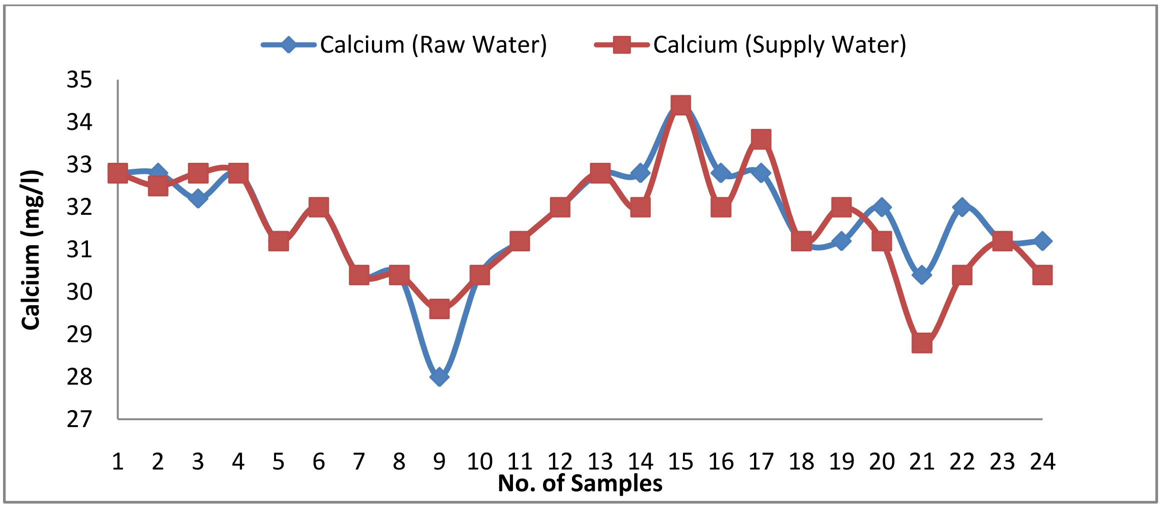

Fig. 3.6: Monthly Calcium variation in water from Jan.-April, 2015.

The quantities in natural waters generally vary from 10 to 100 mg/l depending upon the types of rocks. The main sources of calcium are disposal of sewage and industrial wastes. The Calcium of raw water varies from 20 to 34.4 mg/l with an average of 27.1 mg/l while maximum 34.4 mg/l Calcium in raw water in the month of March and the minimum 20 mg/l in the month of April. There is not much change in Calcium of supply water after the treatment. The concentration of the calcium is reduced at higher pH due to its precipitation as CaCO3. Calcium as such, has no hazardous effects on human health concentration up to 1800 mg/l have been found not to impair any physiological reaction in man [13].

However, their concentration in the lake water is controlled by the precipitation of carbonate minerals, which takes place once saturation with respect to the particular carbonate mineral in reached. In addition to their removal along with the precipitation of carbonate minerals, carbon is also lost from alkaline water by CO2 degassing [14].

3.7 Determination of Magnesium

The variation in Magnesium in the water at different months is shown in Tables and fig 3.7.

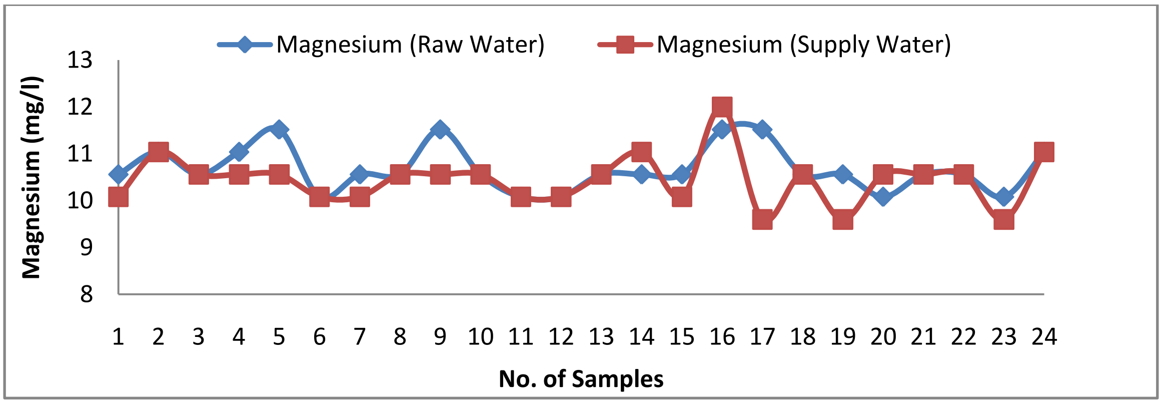

Fig 3.7: Monthly Magnesium variation in water from Jan.-April, 2015.

. Magnesium also occurs in all kinds of natural waters with calcium. Magnesium is supposed to be non-toxic at the concentration generally met in the natural water. High concentration may be cathartic and diuretic [15] for the initial user but a tolerance is developed in short time. The Magnesium of raw water varies from 4.3 to 15.8 mg/l with an average of 9.6 mg/l while in the supply water Magnesium varies from 3.8 to 14.9 mg/l with an average of 9.4 mg/l. The maximum 15.8 mg/l Magnesium in raw water in the month of May and the minimum 4.3 mg/l in the month of April. There is not much change in Magnesium of supply water after the treatment. Natural softening of water occurs during percolation through soil by exchange with sodium ions. Concentration as high as 500 mg/l impart an unpleasant taste to the water thus rendering it unpalatable.

3.8 Determination of Total Alkalinity

The variation in Total Alkalinity in the water treatment plant at different months is shown in Tables and fig 3.8

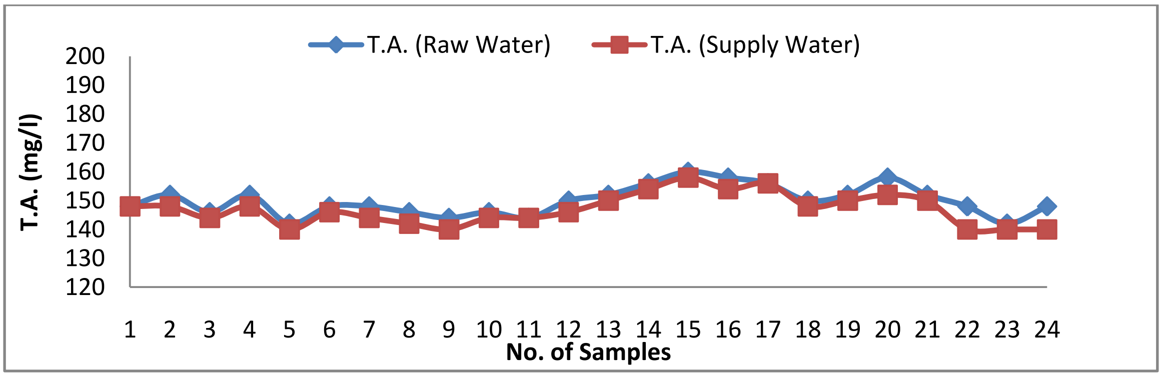

Fig 3.8: Monthly Total Alkalinity variation in water from Jan.-April, 2015.

CO2 dissociation cased the alkalinity in natural waters is. Carbonates and bicarbonates thus formed due to dissolution to yield hydroxyl ions. The source of bicarbonate in natural water is atmosphere CO2, which dissolved in water to form carbonic acid. The bicarbonate value varies from

3.0-30.0 mg/l in the collected water. It's also depends upon pH when the pH between 0.0 and 6.35 almost all the species are present in the form of carbonic acid, whereas, pH range between 6.35 to 10.33, almost all the species are in the form of HCO3-. The concentration of Total Alkalinity of raw water varies from 80 to 160 mg/l with an average of 128.7 mg/l while in the supply water Total Alkalinity varies from 44 to 158 mg/l with an average of 120 mg/l. The maximum 160 mg/l concentration of bicarbonates in raw water in the month of March and the minimum 80 mg/l in the month of April. There is some change in concentration of bicarbonates in supply water in all months after the treatment due to the change in pH. Phenolphthalein alkalinity will be absent and vice-versa.

3.9 Determination of Dissolved Oxygen

The variation in Dissolved Oxygen in the water at different months is shown in fig 3.9.

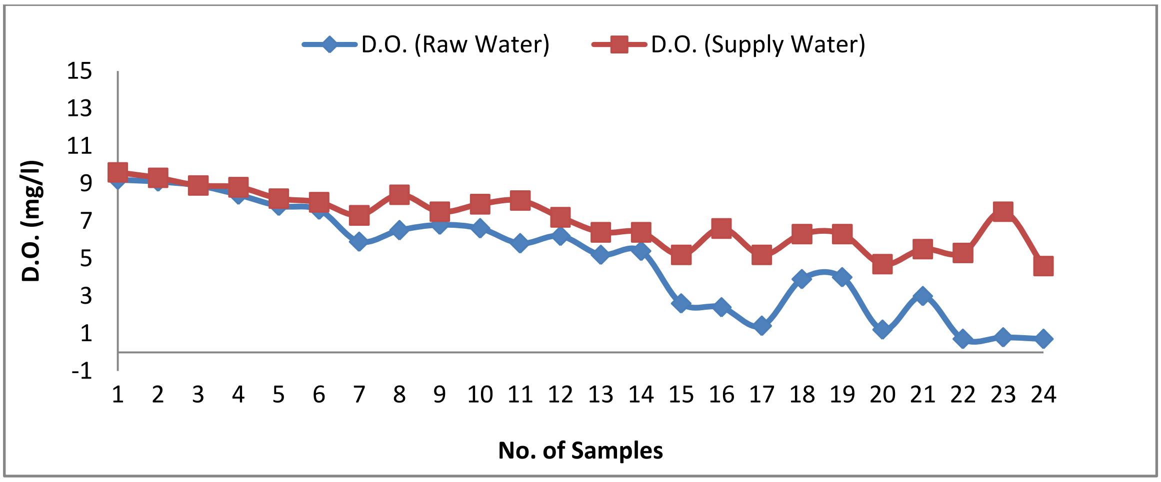

Fig3.9: Monthly Dissolved Oxygen variation in water from Jan.-April, 2015.

Dissolved oxygen is one of the most important parameters in water quality assessment and reflects the physical and biological processes prevailing in the water. Non-polluted surface waters are normally saturated with dissolved oxygen. The Dissolved Oxygen of raw water varies from 0.7 to 9.2 mg/l with an average of 4.8 mg/l while in the supply water Dissolved Oxygen varies from 4 to 9.6 mg/l with an average of 6.65 mg/l. The dissolved oxygen is lower down in the month of April, generally associated with heavy contamination by organic matter. In such condition oxygen, sometimes, totally disappears from the water. Oxygen saturated waters have a pleasant taste while the waters lacking oxygen have an insipid taste. Drinking waters are thus aerated if necessary [14]. After the treatment the dissolved oxygen is maintain to the permissible limits of the BIS.

3.10 Determination of Chloride

The variation in Chloride in the water treatment plant at different months is shown in fig. 3.10.

Chlorides occur naturally in all types of water. The source of chloride is sand dunes, air borne dry deposition of particles. Besides these anthropogenic sources such as domestic wastewater, industrial discharges also contribute to chloride. It is harmless up to 1500 mg/l concentration but produce a salty taste at 250-500 mg/l levels [16]. The Chloride concentration in raw water varies from 16 to 22 mg/l with an average of 19.8 mg/l while in the supply water Chlorides varies from 14 to 22 mg/l with an average of 19.8 mg/l. Chlorides are highly soluble with most of the naturally occurring cations and does not precipitate, sedimented and cannot be removed biologically in treatment of the wastes. The chloride concentration in not much change in supply water the low concentration of chloride in drinking water is not harmful to organisms.

4.0 CONCLUSIONS

The available physico-chemical data which have been obtained during the observation period, allowed us to study, some important characteristics of physico-chemical parameters about water quality concerning the Motijheel water treatment plant, Gwalior during the January to April, 2015 period. The data analysis indicated that the relative importance of treatment plant and the following conclusion have been drawn. It is noted that the pH in the drinking water is moderated to alkaline and within the permissible limits.The concentration of Total Dissolved Solids in drinking water is found at low level.Total dissolved solids shows strong positive correlation with electrical conductivity.The water is moderately soft with moderate alkalinity; the water is transparent in winter and pre- monsoon seasons.Dissolved Oxygen is lower down in the month of April, generally associated with heavy contamination by organic matter. In such condition oxygen, sometimes totally disappears from the water, but after treatment the dissolved oxygen is maintained to the permissible limits due to naturally aeration in various process in tanks. Residual chlorine is nil in raw water but after the Chlorination (Sodium Hypochlorite).

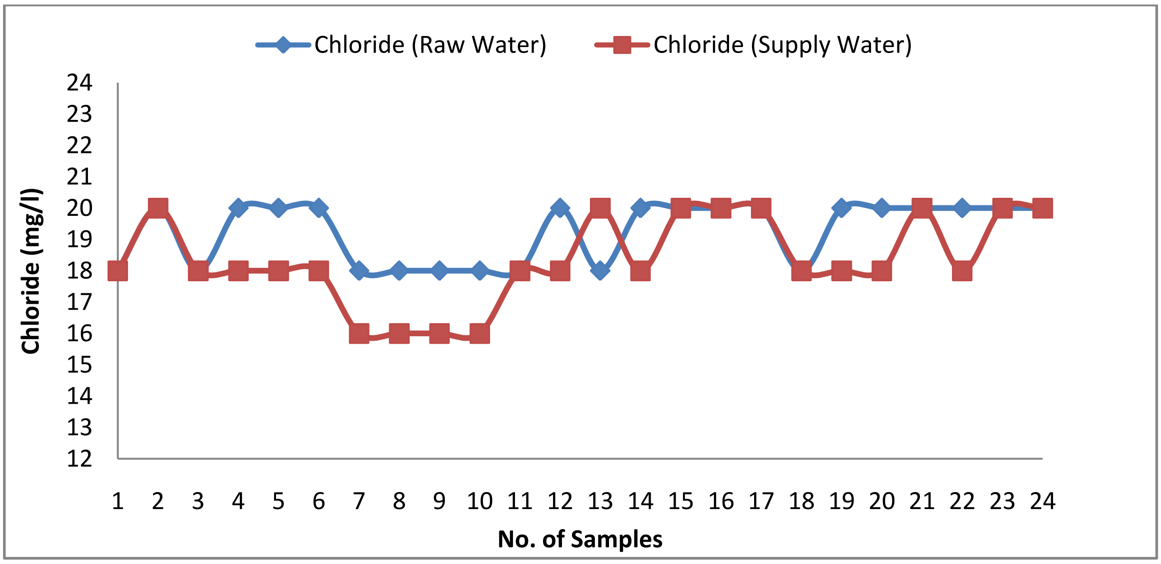

Fig. 3.10: Monthly Chloride variation in water from Jan.-April, 2015.

From the study it may concluded that supplied water quality at Motijheel water treatment plant, Gwalior is efficient enough that the characteristics of physico-chemical parameters is maintained within the permissible limits given by various agencies.

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