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Characterisation of Gorewada Lake Water with Nanofiltration Technique

Ranjit V.Jadhavar[1], Mayur B.Shende[2] and K.D. Bhuyaar[3]

[1,2,3]Priyadarshini Inst. Of Engg. & Technology, Nagpur
E-mail: [1]ranjitjadhavar@gmail.com, [2]mayur.shende8657@gmail.com, [3]kiranbhuyar@gmail.com

Abstract—*Water is the most vital resource for the living organism to survive. This paper contains the research done on the drinking water of Nagpur city. Water samples were collected from Gorewada Lake which is located in the north side of Nagpur city. The values of physico-chemical such as dissolved oxygen (DO), temperature, TOD, biological oxygen demand (BOD) ,chemical oxygen demand (COD),Mg hardness, Ca hardness and the pH were determined by applying the standard methods. All data were examined statistically, and permeate and rejection is determined by using nano filtration technique. The results show that the concentrations of the major and trace elements in drinking water are higher compared with their levels in Gorewada lake water. This indicates that the water pumped from the Gorewada lake for use as drinking water for Nagpur city is mixed with underground water before supplying.*

Keywords*: Gorewada lake, water quality; physico- chemical properties, Nano filtration technique.*

1. INTRODUCTION

Water is one of the earth natural resource and approximate three fourth part of earth surface covered by it. Water is the most vital resource to survive for the living organisms and it referred as the universal solvent because most of the biochemical reaction .5% fresh water is used accounts of total water present on earth and 80% water is available in the form of ice caps and snow fields and remaining around 10% surface and ground water is present . surface water has unique set of contaminants contain most bacteria and other micro-organisms. Surface water can be affected by numerous physical variables such as topography, land cover , soil conditions, mineralogy. Various studies observed that detection of califorms, HUB(hydrocarbon utilizing bacteria), hetrotrophic bacteria in surface water , so it is important that water for drinking and domestic use must be free from significant concentration of toxic and stray substances(WHO, 1984).

Gorewada Lake is located at the north of Nagpur city which provide the drinking water to whole city. The physico-chemical parameters investigated such as dissolved oxygen (DO), temperature, TOD, biological oxygen demand (BOD) , chemical oxygen demand (COD),Mg hardness, Ca hardness and the pH.

Water is treated by various filtration processes such as nano filtration, ultra filtration ,micro filtration, RO etc. The term membrane filtration shows a family of separation methods. The basic principle is to use semi-permeable membranes to separate fluids, gases, particles. Membranes are usually shaped as a very thin film, which allows transport of some materials. Semi-permeable membranes have pores in the range 0.4 nm to 5 µm. Nano filtration produce drinkable water with the living contaminants in the highly concentration solution i.e. permeate and rejection.

2. METHODS & CALCULATION

Water is a dynamic medium and its quality varies temporarily. In order to characterize any water body studies of physico-chemical property should be carried out as follows:-

2.1 Temperature:

Apparatus required: Thermometer- 0.1^{o} C division.

Procedure: Temperature measurement is made by taking a portion of the water sample (about 1litre) and immersing the thermometer into it for a sufficient period of time (till the reading stabilizes) and the reading is taken, expressed as °C

2.2 pH:

Apparatus required*:* pH indica and test tube

Procedure*:* Colorimetric method =about 10ml of the sample is taken in a wide mouth test tube, 0.2ml of indicator is added, and shaken gently. The color developed is matched with the chart and the pH noted.

2.3 Ca hardness:

Apparatus required*:* Burettes, pipette, conical flask, beakers and droppers

Procedure: When EDTA is added to the water containing calcium and magnesium, it combines first with calcium. Calcium can be determined directly with EDTA when pH is made sufficiently high such that the magnesium is largely precipitated as hydroxyl compound. When murexide indicator is added to the solution containing calcium, all the calcium gets complexed by the EDTA. The end point is indicated from a colour change from pink to purple.

2.4 Mg hardness:

Principle: Magnesium hardness can be calculated from the determined total hardness and calcium hardness.

Calculation

Magnesium = (T - C) x 0.243

(as mg/L)

where, T = Total hardness mg\L (as $CaCO_3$)

C = Calcium hardness mg\L (as $CaCO_3$)

High concentration of magnesium proves to be diuretic and laxative, and reduces the utility of water for domestic use while a concentration above 500 mg/L imparts an unpleasant taste to water and renders it unfit for drinking. Chemical softening, reverse osmosis and electro dialysis or ion exchange reduces the magnesium hardness to acceptable levels.

2.5 Dissolved Oxygen:

Winkler's method

Principle: Oxygen present in the sample oxidizes the dispersed divalent manganous hydroxide to precipitate as a brown hydrated oxide after addition of potassium iodide and sodium hydroxide. Upon acidification, manganese reverts to its divalent state and liberates iodine from potassium iodide. The iodine is titrated against N/80 sodium thiosulphate.

Apparatus required: bottles-300ml capacity, sampling devices, lab glassware - measuring cylinder, conical flasks, etc., and Bunsen burner.

Procedure: The samples are collected in bottles, to which 2ml of manganous sulphate and 2ml of potassium iodide are added and sealed. This is mixed well and the precipitate allowed to settle down. At this stage 2ml of conc. sulphuric acid is added, and mixed well until all the precipitate dissolves. 200ml of the sample is measured into the conical flask and titrated against 0.025N sodium thiosulphate using starch as an indicator. The end point is the change of colour from blue to colourless.

Calculations:

203ml because (200) (300)/ (200-4) = 203ml.

1ml of 0.025N Sodium thiosulphate = 0.2mg of Oxygen

(0.2) (1000 ml of Sodium thiosulphate)
Dissolved--
Oxygen(as mg/L) 200

(Water analysis, APHA, 16th edn., pp 423-17)

2.6 Biological Oxygen demand:

Principle: The method consists of filling the samples in airtight bottles of specified size and incubating them at specified temperature (20 ^oC) for 5 days. The difference in the dissolved oxygen measured initially and after incubation gives the BOD of the sample.

Apparatus required: BOD bottles - 300ml capacity, air incubator - to be controlled at 20 ^oC -\+ 1 ^oC, oximeter and magnetic stirrer.

Procedure: The sample having a pH of 7 is determined for first day DO. Various dilutions (at least 3) are prepared to obtain about 50% depletion of D.O. using sample and dilution water. The samples are incubated at 20 ^oC for 5 days and the 5^{th} day D.O is noted using the oximeter. A reagent blank is also prepared in a similar manner.

Calculation: $(D_1 - D_2) - (B_1 - B_2)$ X f
BOD = --------------------------
(in mg/L)
p

D_1 - 1^{st} day D.O of diluted sample

D_2 - 5^{th} day D.O of diluted sample

P - decimal volumetric fraction of sample used.

B_1 - 1^{st} day D.O of control

B_2 - 5^{th} day D.O of control

(Water analysis, APHA, 16th edn)

2.7. Chemical Oxygen demand:

Principle: The organic matter in the sample gets oxidized completely by strong oxidizing agents such as potassium dichromate in the presence of conc. sulphuric acid to produce carbon-di-oxide and water. The remaining potassium dichromate after the reaction is titrated with Ferrous Ammonium Sulphate (FAS) using ferroin indicator to determine the COD. The dichromate consumed gives the oxygen required for the oxidation of the organic matter.

Apparatus required: Reflux apparatus, Nessler's tube, Erlenmeyer flasks, hot plate and glassware.

Calculation:

(Blank reading - Sample reading) **X** N **X** F **X** 1000

COD = --

(mg/L) Sample taken, ml

To calculate F,

10000

F = ----------------------

Titrant value of blank.

2.8 Total Oxygen demand

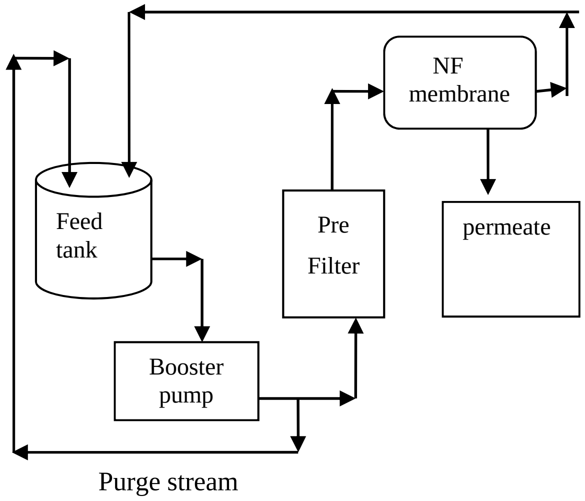
Calculation

TOD= BOD + COD

Nanofiltration:

A membrane is a selective barrier between two phases. A membrane process is a unit operation which selectively divides a feed stream into two streams (the rejection and permeate). The retentate has a higher concentration of the entities retained by the membrane than the feed, while the other outlet stream, the permeate, has a lower concentration of entities held back by the membrane than the feed. The nanofiltration process is done with various types of modules such that plate and frame, tubular, spiral wound and hollow fibre module. Concentration driven membrane processes are dialysis and reverse osmosis. In dialysis process, the transfer of the solute across the membrane occurs by separation and diffusion is obtained through differences in diffusion rates because of differences in molecular weight. Reverse osmosis is the transport of water across a selectively membrane from higher water chemical potential to lower water chemical potential until the osmotic pressures of both sides are equal. It is driven by a difference in solute concentrations across the membrane that allows passage of water, but rejects water having most solute molecules or ions.

Hollow fibre membranes can be designed for circulation, dead end and single pass operation. The advantages of this modules include reduction in space requirement, lowering in labour cost, lowering in chemical cost, delivery of high quality product water,etc. Hollow fibre membranes offer the unique benefits of high membrane packing densities, sanitary designs and due to their structural integrity and construction, can withstand permeate back pressure thus allowing flexibility in system design and operation.



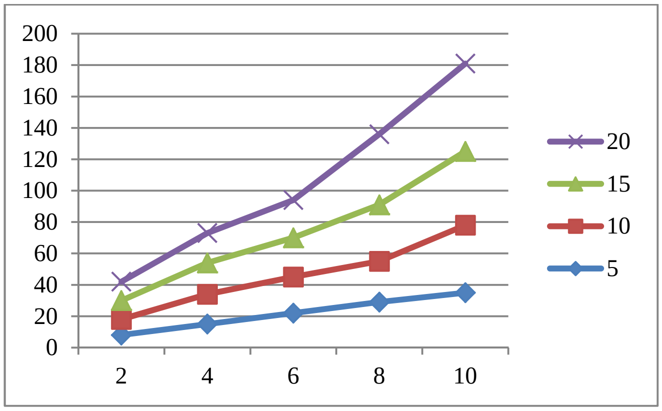
Schematic diagram of Nanofiltration unit

3. RESULT AND DISCUSSION

Nanofiltration:-

Table 1: Amount of Permeate in NF

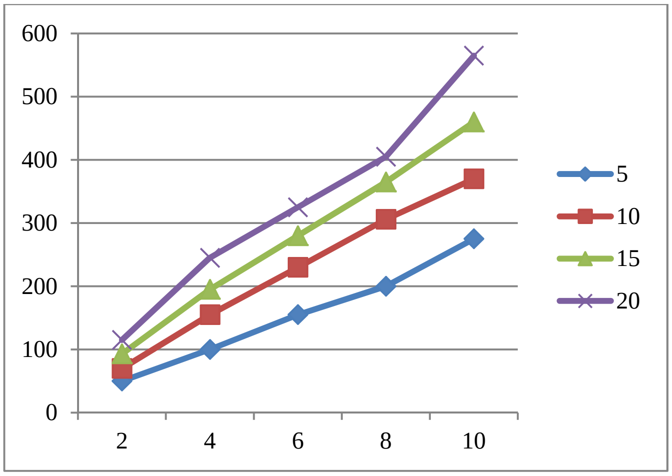
Time (min)	Amount of permeate (ml)			
	5 psi	10 psi	15 psi	20 psi
2	8	10	12	12
4	15	19	20	19
6	22	23	25	24
8	29	26	36	45
10	35	43	47	56



Graph 1: Amount for Permeate Vs Time

Table 2: Amount of rejection in NF

Time (min)	Amount of Rejection (ml)			
	5 psi	10 psi	15 psi	20 psi
2	50	70	93	115
4	100	155	195	245
6	155	230	280	325
8	200	306	365	405
10	275	370	460	565



Graph 2: Amount for rejection Vs Time

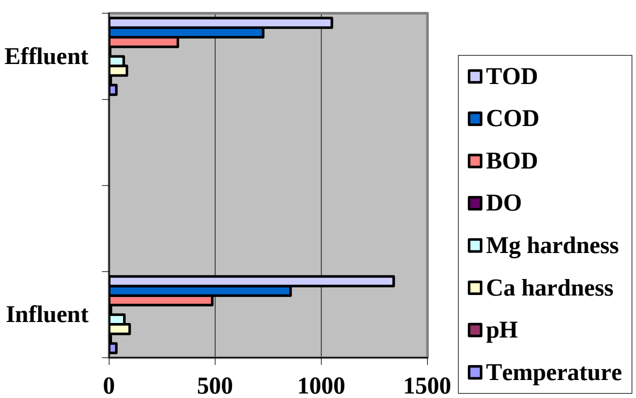
From the experiment carried out on lake water sample, we found that amount of permeate obtained increases as time increases for specific flowrate measured in LPH. This is shown in graph when plotted between amount of permeate verses time.

Experiments are carried out with different pressure ranges from 5 psi to 20 psi.

Thus, we found that amount of permeate and rejection obtained is directly proportional to the time interval.

Table 3: Comparisons of influent with effluent water characteristics.

Sr. No.	Parameters	Influent (Raw Water)	Effluent (Treated Water)
1.	Temperature	34	34
2.	pH	8.05	7.6
3.	Ca hardness	96.5	83.6
4.	Mg hardness	72.2	68.6
5.	DO	8.1	4.6
6.	BOD	486	324
7.	COD	855	726
8.	TOD	1341	1050



Graph 3: Comparisons of influent with effluent water characteristics

Table 4: Standard Data for drinkable water

Parameters	WHO,1994(World Health Organisation)	BIS,1991 {Bureau of Indian Standard)
Temperature	-	-
pH	7-8.5	6.5-8.5
Ca	75	75
Mg	30	30
DO	4-6	4-6
Alkalinity	200	200
Chlorine	250	250
Iron	0.3	0.3

Table 3 and graph 3.indicates that the water pumped from the Gorewada lake for use of drinking water for Nagpur city is mixed with underground water before supplying.

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