A STUDY OF GROUND WATER IN REFERENCE TO THE REVERSE OSMOSIS (RO) SYSTEM

Dr. DEEP GUPTA[1*], DIWAKAR SARAN[2], AKSHAT KUMAR GARG[3], ABHISHEK KUMAR[4], AKASH RAWAT[5], ANUBHAV SAINI[6], NAVEEN KUMAR[7]

[1]Head of Department, Civil Engineering, College of Engineering Roorkee, Roorkee

[2,3,4,5,6,7,] Department of Mechanical Engineering, College of Engineering Roorkee, Roorkee

*Corresponding author. E-mail addresses: deepgupta154@gmail.com

ABSTRACT-- The various contents of drinking water varies from place to place depends upon the geological conditions and mineral solubility. The main cause of variation in drinking water is due to the presence of Total Dissolved Solids (TDS). TDS in drinking water may originate from natural sources, from sewage, urban runoff and industrial wastewater.. Other than TDS, many other parameters such as pH, Total hardness, Color, Odour also influence the quality of potable water.

According to the standards there is maximum acceptable concentrations for both inorganic as well as organic substances, some microorganisms also contributes to contaminate the water quality. The TDS level in drinking water should lie up to 500 ppm and beyond this limit it comes under the category of unacceptable. Beyond the permissible limit, many of the individual minerals salts that make up TDS pose up a variety of health hazards. These includes stiffness in the joints, hardening of the arteries, kidney stones, gall stones etc. The solution to this problem is a quality Reverse Osmosis (RO) filter. A Reverse Osmosis filter reduces chemical quantities and most pollutants, including heavy metals like Lead, Fluoride, Chromium, Arsenic etc.

The water used for drinking purpose should be in the purest form with some amount of nutritive value such addition of some mineral salts. According the current situations we are facing some problems related to the RO filtration, there are some disadvantages too by using a RO filter. Many RO filters have the capability to remove the good nutrients with non essential substances like Iron, Calcium, Manganese and Fluoride these are the chemicals that, if taken in appropriate amount are beneficial for the body.

Keywords :- WQI, Total Dissolved Solids, Potable water, RO System.

I. INTRODUCTION

Groundwater is used for domestic, industrial, water supply and irrigation all over the world.

Due to the scarcity of sufficient amount of water artificially-produced de-mineralized waters, first distilled water and later also deionized or reverse osmosis-treated water, had been used mainly for industrial and other commercial purposes. These methods were more extensively used in drinking water treatment in the 1960's due to the limited drinking water sources available in some coastal and inland arid areas that could not meet the increasing water demands. These situations were arising due to the rapid increasing populations, industrialization and infrastructure development. Demineralization of water was needed where the primary or the only abundant water source available was highly mineralized brackish water or sea water. Drinking water supply was also of concern to ocean-going ships, and spaceships as well. Initially, these water treatment methods were not used elsewhere since they were technically exacting and costly Due to its increasing demand and injudicious use its sustainability is under threat due to its continuous depletion and deterioration of quality Northern part of India.

Haridwar district is bounded by Shivalik hills in north direction and in the south there is a sudden decrease in altitude which forms the part of alluvial Indo-Gangetic plains. Upper Ganga Canal passing through the district has a wide network of distributaries and minors making surface irrigation prominent in Bahadrabad, Roorkee and Narsan blocks. At present there is no prominent problem of ground water pollution in these areas but, due to the presence of many industries generating considerable toxic effluents which might contaminate the

groundwater of the district in future. At present peoples are using RO system for purifying drinking water without knowing that if is beneficial or not. So due to the common use of RO Filters in the homes, it is essential to find out whether there is really a need of RO Filters in district Haridwar or not. The aim of this study is to find out the suitability of RO system with the help of physic-chemical analysis of water in terms of WQI (Water Quality Index). Moreover, Water Quality Index (WQI) is computed to assess the suitability of groundwater for various purposes.

II. METHODOLOGY

A. Study area

For this study Haridwar district was selected. Haridwar district lies between 29o33' - 30o14'N latitude and 77o57'- 78o1'E longitude at an average altitude of 230m. It is the most densely populated district of Uttarakhand having a population of 19,27,029 (Census, 2011), roughly equal to the nation of US state of west Virginia. Haridwar district has a total geographical area of 2960 km2 with a population density of 613/Km2. For assessing the groundwater quality, the water samples were collected from 4 places, namely

- Roorkee: 29.8543oN, 77.8880oE
- Laksar: 29.7538oN, 78.0215oE
- Bhagwanpur: 29.937387oN, 77.817056oE
- Haridwar city: 29.9457oN, 78.1642oE

All these samples were analyzed in Environmetal Engg. Lab of IIT, Roorkee. The water samples collected from different sources were analyzed in the laboratory as recommended by standard method of examination and wastewater [1]. The physico-chemical parameters found using lab tests were pH, TDS, Hardness, Alkalinity, Iron, Manganese and Flouride. These were then checked whether they are in the permissible limits as described by the Indian standards or not. It is then found that which parameters are in excess and what is the correct filter to be used in households for filtering the groundwater and using it for drinking purpose.

In the other part, the water quality index is calculated based on the method followed by Singh [2]. The quality rating scale and accordingly the weight values have been assigned to the selected parameters to estimate the overall water quality index.

The general methodology for the development of a water quality index can be summarized in the following four steps:

- Parameter Selection - Selection of suitable/ concerned water quality parameter.
- Development of Sub-indices Function- Transformation of concentration of water quality parameters into mathematical equations.
- Assignment of Weights – Deciding suitable weights of various selected water quality parameters.
- Aggregation of Sub-indices to Construct an Overall Index – Construction of an overall water quality index (OWQI).

B. Selection of Water Quality parameters

In India, Indian Standards (IS 10500: 1991) and Central Pollution Control Board (CPCB) standards govern the quality of water for various uses. Based on Indian and other standards, total sixteen parameters, viz. turbidity, colour, TDS, pH, DO, BOD, secchi depth, total hardness, chloride, fluoride, nitrate, total phosphate, iron, sulphate, arsenic and total coliform are considered significant to affect the surface water quality. For all these parameters, a class classification criterion has been devised to categorize the quality of water into five classes. These classes include excellent, good, fair, poor and heavily polluted.

C. Development of Sub-indices

Function Sub-indices functions are basically the equations that transform the concentration ranges into the index score through mathematical equations. These scores are then further converted to a common scale based on their relative importance to impact the quality of water. These sub-indices function are developed based on the water quality standards and their concentrations to meet in particular range. For this purpose, mathematical expressions were fitted for each parameter to obtain the sub-index equations as given in Table 3. In this index, the corresponding variation between the range of parameter and index is kept uniform to provide more accurate value of indices.

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D. Assignment of parameter Weights

Selection of parameter weight is one of the most important tasks. Therefore, due emphasis should be given to decide the weight of each parameter. The parameter which greatly impacts the quality of water shall be given higher weight and vice-versa. These weights have been decided based on the judgment of the authors and the experience gained from the literature. The weight factors of all the sixteen parameters range from 1 to 4.

E. Aggregation of sub-indices - Overall Water Quality Index (OWQI)

In order to gauge the influence of each individual parameter on a common single scale, the score generated by each parameter was averaged- out. The following weighted average aggregation function is used for this purpose.

$$OWQI = w1y1+w2y2+w3y3+\ldots\ldots+wiyi \quad \ldots(1)$$

where,

wi = weight of the its water quality parameter
Yi = sub-index value of the its parameter

Based on the status of water quality, the index value range from 0 to 100 and is classified into five categories: heavily polluted (0-24), poor (25-49), fair (50-74), good (75-94) and excellent (95-100). The status of water corresponding to different OWQI values is presented in Table 5. If the index goes down, then it indicates that some of the water quality parameters are being affected due to any particular reason and suitable measures are needed to further improve the quality of water. Thus this index may be used as a guiding rule in management of quality of surface water resources.

TABLE.1- ASSIGNMENT OF SIGNIFICANCE WEIGHT TO THE WATER QUALITY PARAMETER (SINGH ET AL., 2015)

Sl. No.	Parameter	Weight Factor	Standards (IS-10500)
1	pH	1	6.5-8.5
2	Total Dissolved Solids (mg/l)	3	500-2000
3	Total Hardness (mg/l)	1	300-600
4	Fluoride (mg/l)	3	1.5-2.0
5	Chloride (mg/l)	1	250-1000
6	Sulphate (mg/l)	2	25-1000
7	Nitrate (mg/l)	3	10-100

TABLE.2- OWQI AND CORRESPONDING CLASS AND STATUS OF WATER QUALITY (SINGH ET AL., 2015)

Class	OWQI VALUE	Status of Water
Heavily Polluted	0-24	Unsuitable for All Purposes
Poor	25-49	Special Treatment (Special Treatment)
Fair	50-74	Needs Treatment (Filtration & Disinfection)
Good	75-94	Acceptable
Excellent	95-100	Pristine Quality

TABLE.3- STATISTICAL SUMMARY OF PHYSICO-CHEMICAL PARAMETERS OF GROUNDWATER SAMPLES

Parameters	pH	TDS (mg/l)	F- (mg/l)	Cl- (mg/l)	SO42- (mg/l)	NO3- (mg/l)	T. Hardness (mg/l)
Min.	7.7	170.3	-	3.5	2.5	0.1	119.9
Max.	8.2	997.8	0.5	128.0	310.0	86.0	609.5
Ave	8.0	426.4	0.2	29.2	36.4	15.6	271.1
Std. Devi	0.2	169.2	0.1	33.6	54.7	19.0	91.8

TABLE.4- WATER QUALITY INDEX VALUE OF GROUNDWATER SAMPLES (CONSIDERING SEVEN PARAMETERS)

S.N.	Sample ID	OWQI
1	Roorkee	83.3
2	Laksar	72.8
3	Bhagwanpur	81.7
4	Haridwar	82

III. RESULTS AND DISCUSSIONS

The OWQI was computed for Roorkee, Haridwar, Bhagwanpur and Laksar area. The water quality indices are first estimates parameter-wise and then OWQI is computed for each location (TABLE 5-8). During the study of various areas it was observed (Table 4) that ground water quality of these areas is

quite well and all the parameters are within the permissible limit.

TABLE.5: WQI OF ROORKEE.

Parameters	Value	Indices	Weig. Factor	Indices×Weight factor
pH	7.5	100	1	100
TDS	80	100	3	300
Hardness (mg/l)	251	100	1	100

∑= 5 ∑=500

OWQI=500/5=100

TABLE.6:- WQI OF HARIDWAR.

Parameters	Value	Indices	Weight Factor	Indices×Weight factor
pH	7.74	100	1	100
TDS	272	100	3	300
Hardness (mg/l)	250	100	1	100

∑= 5 ∑=500

OWQI=500/5=100

TABLE.7- WQI OF BHAGWANPUR

Parameters	Value	Indices	Weight Factor	Indices×Weight factor
pH	7.62	100	1	100
TDS	278	100	3	300
Hardness (mg/l)	280	100	1	100

∑= 5 ∑=500

OWQI=500/5

TABLE.8- WQI OF LAKSAR.

Parameters	Value	Indices	Weight Factor	Indices×Weight factor
pH	7.87	100	1	100
TDS	312	100	3	300
Hardness (mg/l)	265	100	1	100

∑=5 ∑=500

OWQI=500/5=100

It is observed from Table 5-8 that OWQI for all the 4 cases is 100 (when considering the three parameters viz. pH, TDS, and hardness) this value of WQI comes under the category of "EXCELLENT".

IV. CONCLUSION

In This Paper an Overall Water Quality Index (OWQI) is developed to provide a simple tool for assessment of quality of surface water resources for drinking water supply. The OWQI is developed based on National and International standards by considering sixteen parameters covering physical, chemical and biological aspects of water. The application of OWQI is demonstrated for three different sampling locations and status of water is described on the basis of computer index. This OWQI provides a simpler means for the water quality assessment and is very useful of decision makers, planners and field engineers for maintaining good health of surface water resources. The proposed index can also be used as a decision support tool for the water quality management.

Garg [3] reported that RO-system when purified the water it lowers the pH (pH below 6.2) due to the removal of calcium and magnesium salts in excess the desirable quantity which is harmful for the human body. As ROs drain out minerals from water during its treatment, its consumption was leading to deficiency of minerals in the body. RO system for drinking water is suitable only when there is higher quantity of TDS at least more than 750 ppm. According to a study cooking in dematerialized water has been found to cause considerable losses of very essential elements from the as vegetables, pulses and cereals. Such losses may reach up to 60 percent for magnesium and calcium, 66 percent for copper, 70 percent for manganese, and 86 percent for cobalt. Whereas when hard water (not purifies by reverse osmosis) is used for cooking, there is minimal loss of these essential elements [4].

This has been an establish fact that water which has a low mineral content has an adverse effect on homeostasis mechanisms, compromising the mineral as well as water metabolism in the body. If the output of the urine is increased significantly concerned with an accelerates excretion (i.e., increased diuresis) of major intra- and extracellular ions from the body fluids, which have a negative and wrong impact on the body balance, and changes the water level in the body. This type of irregularities creates a misbalance in the body and affects the hormonal secretion process in the body. According to a study on rats it was evident that prolong intake of water with TDS ≤ 75 mg/L leads to increased water intake, diuresis, extracellular fluid volume, and serum concentrations of sodium (Na) and chloride (Cl) ions and their increased elimination from the body, resulting in an overall negative balance, and also lowers the volumes of red cells with low circulation of blood [4]. There are several health consequences evident from drinking water have less or no quantity of

calcium or magnesium. Many studies show that higher water magnesium is related to decreased risks for Cardio Vascular Disease (CVD) and especially for sudden death from CVD. Recent studies suggest that the intake of soft water, i.e. water low in calcium, is associated with a higher risk of fracture in children, certain neurodegenerative [5]. This study suggest that we should aware about the negative effects of low TDS water , we should require a balanced mineralized water for proper body functioning. At present scenario there is no need of RO system in Haridwar district.

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