Study of Some Physio- Chemical Parameters of Ground Water Near Agyara Dam, Alwar (Rajasthan), India

Paper id: 15627 Submission: 11/01/2022, Date of Acceptance: 21/01/2022, Date of Publication: 23/01/2022

Archana Kumari
Research Scholar,
Dept of Chemistry,
Govt. R.R. (P.G.)
Autonomous College,
Alwar, Rajasthan,
India

Akhalesh Kumar
Associate Professor,
Dept. of Chemistry,
Govt. R.R. (P.G.)
Autonomous College,
Alwar, Rajasthan,
India

Abstract

In this paper, the authors studied the physical and chemical quality of groundwater in the vicinity of the Agyara Dam located in Alwar. Due to the waste of industrial units located around it, the surrounding groundwater has been greatly affected, due to human and industrial activities, the groundwater is polluted. This is a serious problem not only in Alwar but all over India, so water quality analysis is very important to preserve and affect the natural ecosystem. The water quality index has been assessed for groundwater in the vicinity of the Agyara dam located in the industrial area of Alwar city

Keywords: P^H, TDS, Ground water, Water quality parameters

Introduction

Water is a very important factor of life, which is 80% of the living matter, the human body contains about 70% water, along with humans, other animals and plants also have a close relationship with water since ancient times. In the Palaeolithic period, the existence of humans has been generally traced on the banks of rivers. Water is the basis of all life forms, such as water has an important role in domestic agriculture and industrial activities. Even in today's scientific age, humankind has to depend on water in direct and indirect ways, although only a very small part of the total available water is useful for us, out of which some of it is located on the poles in the form of glacier, so available potable. Very little part of the water is present in the form of groundwater.

Groundwater is one of the main sources of drinking water in India. However, due to increasing urbanization and industrialization in India, a serious problem of groundwater pollution is being created in India. are continuously polluting the water, similarly the industrial units located around the Agyara dam are also polluting the drinking water. The water available in the cities is being polluted to a great extent by domestic and industrial waste. Even many medium and large industries located in India are mixing their waste directly into the groundwater, which leads to a large amount of human and other animals. are affecting the physiological functions of the body such as barium carbonate affects the nerves and heart in the body, Fluoride excess affects the teeth. Apart from industrial units, many chemicals like DDT, BHC etc. are also creating a serious problem of water pollution, they pose a serious threat not only to the fauna but also to the flora and many aquatic organisms. Water pollution causes typhoid, malaria, many types of diseases spread like hepatitis, tuberculosis, etc. In rural areas of India, 164 million people do not have clean drinking water, due to which many people die. Therefore, to stop the increasing water pollution in this way, strict steps should be taken immediately by the government and other social organizations or NGOs, otherwise after some time drinking water can be a huge problem. The present study is related to the study of physicochemical parameters of groundwater around the Agyara dam. The physio-chemical properties were compared with WHO and ISI standards.

Sampling of water samples

All water samples were taken in 1 liter plastic bottles. The standard grab or catch procedure was used according to the methods of APHA. All water samples were taken in propylene bottles, normally water samples were collected from tube wells and head pumps. The plastic bottles were thoroughly cleaned with hydrochloric acid and then washed with mineral water containing the acid and finally twice with distilled water. Water samples were collected in the bottle, with a volume of air at the top of the bottle. A small difference remained. The bottle was sealed with paraffin wax. All glassware casserole and pipette were first thoroughly cleaned with normal water and then deionized distilled water; the burette was chemically washed before use. Standard methods for analysis were followed, this procedure Parameters such as pH meter, conductivity meter and flame photometer instrument were used and these results were compared with BIS drinking water standards

Analysis of groundwater samples

The groundwater quality was assessed by the analysis of physicochemical parameters such as pH, colour, turbidity, electrical conductivity, total dissolved solids, alkalinity, chlorides, total hardness, calcium hardness, nitrates, sulphates, iron and fluorides using standard methods (APHA, 1995).

The physicochemical results have been subjected to statistical analysis and given in the Table 1. The observed ranges of the samples were compared with Bureau of Indian Standards (BIS- 10500: 1991). The samples collected showed considerable variations in the quality of groundwater. This might be due to irregular distribution of rocks or due to variation in the depth of sample points. A comparison of the depth of hand pump installation indicates that the deep installations are better than the shallow installations with respect to the groundwater quality, since shallow hand pumps draw water from the topmost water bearing structure, which is contaminated by various natural and anthropogenic sources percolating in the vicinity (Garg et al., 2003).

Results and discussion

Physicochemical

The pH value of the samples in the study area varied from 5.51 – 9.93 with a mean of 7.45 indicating slightly acidic to slightly alkaline nature. In the study area 19.45% of groundwater samples were found exceeding the acceptable limit of BIS. High pH value induces the formation of trihalomethanes, which are toxic, while pH below 6.5 starts corrosion in pipe thereby releasing toxic metals such as zinc, lead, cadmium and copper (Shrivastava and Patil, 2002). It was noticed that the pH value of the water appears to be dependent upon the relative quantities of calcium, carbonates and bicarbonates. The water tends to be more alkaline when it possesses carbonates (Zafar, 1966; Suryanarayana, 1995).

The colour value of the sample in the study area varied widely between 0 – 20 Hazen unit with a mean of 4.19 Hazen unit. Percentage of groundwater sample exceeding the acceptable limit of BIS were 24.07%. The presence of coloring material in the water is due to contact with organic debris, such as leaves, lignin containing materials and wood, which contributes in various stages of decomposition. Generally, tannins, humic acid and humates from the decomposition of lignin are considered as the principal colour bodies. It can also depend on vegetable extracts of considerable variety. In the present study, it can be said that the iron and its compounds contributed also to colour. Most people residing near the water source with intense colour have abandoned them as a source of drinking water.

Electrical conductivity value of the study area varied from 205 – 3084 µmhos/cm with a mean of 2071.85 µmhos/cm and 18.62% samples exceeded standards of BIS prescribed for drinking. Electrical conductivity is a measure of water's capacity to conduct electric current. As most of the salts in the water are present in the ionic form, are responsible to conduct electric current. Generally, groundwater tends to have high electrical conductivity due to the presence of Groundwater quality assessment of Agyara area.

Turbidity is an important parameter for characterizing the quality of water. Turbidity in water may be due to wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. Turbidity in the study area range from 0 – 316 NTU with a mean of 8.93 NTU and 26.32% of groundwater samples were found exceeding the acceptable limits of BIS, which indicates the presence of suspended and colloidal matter such as clays, silt and fibrous particles like asbestos minerals (WHO, 1991). Leaching of organic matter, industrial, domestic wastes etc., also contribute to turbidity in groundwater samples. Bacterial growth in the casing pipes due to improper maintenance and unaesthetic surroundings also account for higher turbidity. Inorganic nutrients such as nitrogen and phosphorus present in agricultural runoff stimulate the growth of algae, which also contributes to turbidity (Sawyer et. al., 2000). The turbidity in the water samples is an indication of pollution of water particularly due to the source near the drain, cesspool, ditches or manured grounds. There are chances for the pathogenic organisms to be enclosed in the turbidity causing particles thus

Table – 1: Statistical analysis for ground water quality.

Parameters	Observed range	Mean	Standard limits (BIS-10500: 1991) Acceptable permissible limit	Maximum limit	Standard deviation	Percentage of samples exceeding acceptable limits of standards (%)
pH	5.51–9.93	7.45	6.5 – 8.5	No relaxation	± 0.64	9.45
Colour Hazen unit	0-20	4.19	5	25	± 0.11	24.07
EC µmho/cm	205 – 3084	2071.85	1500	3000	± 5.0	18.62
Turbidity NTU	0 – 316	8.93	5	10	± 0.36	26.32
Total dissolved Solid's mg/l	14 – 7770	1034.07	500	2000	± 0.68	9.55
Alkalinity mg/l as $CaCO_3$	20 – 710	275.68	200	600	± 065	1.07
Chloride mg/l	9.89 –5918.2	218.15	250	1000	± 0.87	1.27
Total hardness mg/l as $CaCO_3$	20 – 4600	225.59	300	600	± 0.77	2.83
Calcium mg/l as $CaCO_3$	8 – 3400	152.74	75	200	± 1.2	19.98
Fluoride mg/l	0 – 16	0.84	1.0	1.5	± 0.2	10.04
Nitrate mg/l	0.01–6.72	2.00	45	100	± 1.45	0.00
Sulphate mg/l	0–1678.2	18.63	200	400	± 1.6	0.68
Iron mg/l	0 – 10.15	1.26	0.3	1.0	± 1.51	42.20
E. coli/100ml	0 – 364	12.93	Nil	10	-	31.1

leading to health hazards (Manivasakam, 2000).

high amount of dissolved salts. Electrical conductivity is a decisive parameter in determining suitability of water for particular purpose and classified according to electrical conductivity as follows,

EC in µmhos/cm at 25°C	Classification
< 250	Excellent
250 – 750	Good
750 – 2000	Permissible
2000 – 3000	Doubtful
> 3000	Unsuitable

The total dissolved solids (TDS) in the study area varied from 14 – 7770 mg/l with a mean value of 1034.07 mg/l and 9.55% of the samples were found exceeding the limit of BIS. In water samples, most of the matter is in dissolved form and consists mainly of inorganic salts, small amounts of organic matter and dissolved gases, which contribute to TDS. Based on TDS groundwater is classified as follows:

Classification	TDS in mg/l
Non – saline	< 1000
Slightly saline	1000 – 3000
Moderately saline	3000 – 10000
Very saline	> 10000

The Alkalinity ranged between 20 – 710 mg/l as

$CaCO_3$ with a mean value of 275.68 mg/l as, $CaCO_3$ indicated high alkaline nature of water in the area and 1.07% of samples were found exceeding the acceptable limit of BIS. The excess of alkalinity could be due to the minerals, which dissolved in water from mineral rich soil. The various ionic species that contribute mainly to alkalinity includes bicarbonates, carbonates, hydroxides, phosphates, borates, silicates and organic acids. In some cases, ammonia or hydroxides are also accountable to the alkalinity (Sawyer et. al., 2000).

The chlorides varied widely from 9.89 – 5918.2 mg/l with a mean value of 218.15 mg/l and 1.27% of samples were found exceeding the acceptable limit of BIS. Naturally, chloride occurs in all types of waters. The contribution of chloride in the groundwater is due to minerals like apatite, mica, and hornblende and also from the liquid inclusions of igneous rocks (Das and Malik, 1988). Human excreta, particularly the urine, contain chloride in an amount equal to the chlorides consumed with food and water (averages to about 6 g of chlorides per person per day), increases the amount of chloride in municipal wastewater to about 15 mg/l above that of the carriage water in lotic systems (Sawyer et. al., 2000). In addition, leachate from landfills (Eison and Anderson, 1980, Sharma and Kaur, 1995, Subba Rao and Subba Rao, 1995), septic tanks and pit latrines (Olaniya and Saxena, 1977, Craig and Anderson, 1979, Gillison and Patmont, 1983, Vates, 1986, Todd, 1995, Sharma and Kaur, 1995, Polprasert, 1996) also contributes a significant amount of chlorides to groundwater.

The total hardness ranged between 20 - 4600 mg/l as $CaCO_3$ with a mean value of 225.59 mg/l as $CaCO_3$ which indicated hard water and 2.83% of samples were found exceeding the acceptable limits of BIS. Hardness in water is caused by certain salts held in solution. The most common are the carbonates, fluorides and sulphates of calcium and magnesium. The principal hardness causing cations are calcium, magnesium, strontium, ferrous and manganese ions. The cations plus the most important anions that contributes are bicarbonates, sulphates, chlorides, nitrates and silicates. The hardness may be advantageous in certain conditions; it prevents the corrosion in the pipes by forming a thin layer of scale, and reduces the entry of heavy metals from the pipe to the water (Shrivastava et al., 2002). Water can be classified in terms of degree of hardness as follows,

Total hardness in mg/l	**Degree of hardness**
0 – 75	Soft
75 – 150	Moderately hard
150 – 300	Hard
> 300	Very hard

Calcium is one of the most abundant substance found in natural water in higher quantities in the rocks. Higher level of calcium is not desirable in washing, bathing and laundering, while small concentration of calcium is beneficial in reducing the corrosion in pipes. Calcium in the study area varied widely from 8 mg/l to 3400 mg/l as

$CaCO_3$ with a mean value of 152.74 mg/l as $CaCO_3$ and 19.98% of samples were found exceeding the acceptable limits of BIS. This might be due to the geology of the area. The area is basically of granitic terrain. Experts have opined that the difference in relative mobility of calcium, magnesium, sodium and potassium is more distinct in the groundwaters from granitic terrain and the higher concentrations of calcium, magnesium, chlorides and bicarbonates in several cases are probably due to their low rate of removal by soil (Somashekar et al., 2000). Fluoride content in the study area varied from 0 – 16 mg/l with a mean value of 0.84 mg/l and 10.04% of the samples were found exceeding the acceptable limits of BIS standards. Fluorides samples which exceeded the acceptable limit are not recommended for consumption without treatment. Fluoride is considered as an essential element though health problems may arise from either deficiency or excess amount (Gopal et al, 1985). Much of the fluoride entering the human body is obtained from drinking water (Saralakumari and Rao, 1993). Fluoride concentration of 0.4 ppm in drinking water causes mild type of dental fluorosis (Dinesh, 1999; Gupta et al., 1993; Yadav and Lata, 2004).

Nitrate concentration in the study area ranged from 0.01 – 6.72 mg/l with a mean concentration of 2.00 mg/l which indicates that the groundwater has not been affected by nitrate. Human and animal wastes, industrial effluents, application of fertilizers and chemicals, seepage and silage through drainage system are the main sources of nitrate contamination of groundwater (Robertson et al., 1991 and Agrawal et al., 1999). The high concentration of nitrates in drinking water causes methemoglobinemia in infants, a disease characterized by blood changes.

Sulphate in the study area varied between 0 – 1678.2 mg/l with a mean value of 18.63 mg/l and it is found that 0.68% of water samples were exceeding the acceptable limits of BIS. A sulphate ion is one of the major anions occurring in natural waters. Many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulphite ores, presence of shales and the solution of gypsum and anhydrite. In the absence of dissolved oxygen, nitrate and sulphates serve as a source of oxygen for biochemical oxidation produced by anaerobic bacteria. Under anaerobic conditions, sulphate ion is reduced to sulphide ion, which establishes equilibrium with hydrogen ion to form hydrogen sulphide. The presence of hydrogen sulphide leads to corrosion of pipes (Sawyer et al., 2000).

Iron in the study area varies between 0 – 10.15 mg/l with a mean concentration of 1.26 mg/l and 42.20% of groundwater samples were found exceeding the acceptable limit of BIS. The presence of iron in groundwater is due to processes involved during rock formation. When the groundwater with higher concentration of iron is tapped, it quickly oxidizes to ferric state in the form of insoluble ferric hydroxide, a brown substance. Iron is an essential element in human (Moore 1973). Although iron has little concern as a health hazard, it is still considered as a nuisance in excessive quantities (Dart, 1974). It causes staining of clothes and utensils. It is also not suitable for processing of food, beverages, dyeing, bleaching etc. When water with higher concentration of iron is used in the preparation of tea and coffee, it interacts with tannin to give an inky appearance with metallic taste. The high concentration of iron in groundwater might be due to rusting of casing pipes, non-usage of bore wells for a long time, percolation of iron contaminants through space between bore hole and the casing pipe, disposal of scrap iron in open areas, contamination due to industrial activities etc. To prevent the pollution of groundwater from iron, the bore wells should be used periodically, annular space between the borehole and the casing should be cemented properly (Reddy,

2003).

Bacteriological: E. coli in the study area varied from 0 – 364 /100ml and the mean concentration is found to be 12/100ml with 31.19% of the samples exceeding the acceptable limit of BIS. Natural water is not free from microorganisms. The factors that determine the type of bacteria and the number of bacteria in water are; temperature, light, organic matter, acidity, salinity, protozoa, rainfall and storage conditions. The presence of the Escherichia coli is an indication of contamination of water supplies. E. coli indicates faecal contamination of drinking water. E. coli being pathogenic bacteria causes four types of clinical syndromes namely, urinary tract infection, diarrhea or gastroenteritis, pyogenic infections and septicemias. Hence, it becomes necessary to ensure that the drinking water is free from bacteriological contamination. This can be attributed to the unhygienic conditions around the bore well, cesspool formation, broken casing pipes which serve for the growth of microorganisms.

Objective of the Study

Study of Some Physio- Chemical Parameters of Ground Water Near Agyara Dam, Alwar (Rajasthan), India

Conclusion

Groundwater is a precious natural resource. It forms an important part of the hydrologic cycle. In comparison with the surface water pollution, the groundwater contamination is difficult to control. From the analysis of 24 groundwater samples collected from 04 villages it was found that in 19 samples are not suitable for domestic purposes as specified by “Indian Standard-Drinking Water Specification-IS 10500:1991”. Of these samples 79.16% of water samples were found beyond the acceptable limit of BIS. In the above mentioned 19 samples at least one of the parameters is more than the acceptable limit of BIS. From the present study it is evident that groundwater quality is gradually getting deteriorated and it may deteriorate further with time. So public should be made aware of the water quality importance and hygienic conditions before use. Also, it is necessary to implement certain remedial measures.

Acknowledgement

Authors are thanks full to principal Dr. Hukam Singh and Head of Chemistry department Dr. Seema Gulati for the providing Laboratory facilities. We are extremely grateful to **Dr. M.P.S. Chandrawat** Ex-Director-Applied Sciences, Eternal University Baru Sahib-Sirmour (H.P.) India, for co-operation and constant suggestions throughout the research work. Authors are also grateful to Dr. O.P. Singh, Dr. Rajesh Yadav, Dr. R.N. Yadav to help in preparation of manuscript and suggestions.

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