

CHEMICAL ANALYSIS AND QUALITY OF GROUND WATER SAMPLES IN INDUSTRIAL AREA IN JAIPUR

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ABSTRACT:

Ground water is major source of urban and rural area for drinking and irrigation. Industrial waste material contain toxic substance and ingested and absorbed by humans, animals or plants. Increase in population naturally increases solid domestic and industrial wastes pollution. Requirement of water has been rising in the urban area due to population explosion and growth in commercial activities. In Jaipur urban area, surface water sources like Ramgarh Lake are generally empty and groundwater contributes over 95% of urban water supply. The Jaipur urban area occupies in part of Sanganer ((45.5 %), Jhothwara (42.5 %) and Amer (12%) blocks of Jaipur district. Quality of water for public health depends to a greater extent on the quality of drinking water be systematically collected. Due to industrial and agricultural activities the surface and ground water are subjected to frequent pollution. Geochemical studies of the under ground water in urban and rural areas in Jaipur has been taken up to evaluate its suitability for domestic purpose. Ground water samples were collected from different places of Jaipur. The analysis were carried out for the parameters such as pH, temperature, dissolve oxygen, total hardness, BOD, COD, sodium, potassium, calcium, magnesium, chloride, fluoride, TS and TDS. The observation gives indication that fluoride and nitrate levels in ground water has been recorded in the Jaipur city, particularly within the walled city and adjoining colonies including Jalmahal Lake area, Gaitor and Kala Hanuman ji Mandir area, C-Scheme, Bani-Park, Civil Lines, Jyoti Nagar, Adarsh Nagar, Tilak Nagar, Southern part of Shastri Nagar and Sikar House etc.

Key words: Groundwater Quality , Area Health assessment.

INTRODUCTION

Water contain useful compound and it is basis of all lives-ecological resources for the flora of our earth and it is necessary to for all lives without properly functioning water supply. Jaipur is one of the fastest growing cities in the country and is undergoing rapid urbanization and industrialization.

Discharged from industries contains a number of chemical pollutions, such a Ammonia, Arsenic, Phenol, Cyanide,

Thiocynide, Copper, Cadmium, Zinc, Chromium, Carbonate, Bi-carbonate, Nitrite, Phosphate, Oil and Grease in addition to total suspended solids volatile solids and score of other toxicants. It is difficult to imagine production human activity, be it agriculture or forestry, Livestock, farming & fisheries, trade or industry. The chemical, physical and bacterial characteristics of ground water determined. Its usefulness for

municipal, commercial, industrial, agricultural and domestic water supplies.

These pollutants could bring about changed in temperature, humidity, oxygen supply, pesticide stress etc. amounting to a partial or complete alteration in the physical, chemical and physiological spheres of the biota.

Ground water quality of Jaipur degradation due to rapid urbanization and industrialization. Ground water sample were collected from Jaipur from different parameter, such as total hardness, pH, Electro-conductivity, Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^-), Chloride (Cl^-), Sulphate (SO_4^{2-}), Nitrate (NO_3^-), Ferric (Fe^{3+}), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^+), Potassium (K^+), Silicon Dioxide (SiO_2^+) with the help of standard method.

Major causes of aquatic pollution include the discharge of sewage, industrial and agricultural waste, organic and inorganic, mining, cement production, fertilizer and pesticides washed off the land by rain, spills of oil, radioactivity, atmospheric fall-out, acid and irrigation. Damaging effects of dust fall is characterized by enriched toxic heavy metals such as Arsenic (As), Lead (Pb), Nickel (Ni), Chromium (Cr), Copper Cu, Zinc (Zn), Manganese (Mn) and Cadmium (Cd). Wells are the main source of drinking water and other domestic chores for inhabitants of the area surrounding the factory¹.

In recent years an increasing threat to ground water quality due to human activities has become affect important the adverse effects on ground water quality are the results of man's activity surface, unintentionally by agriculture, domestic and industrial effluents, unexpectedly by sub-

surface or surface disposal of sewage and industrial wastes.

The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use (public water supply, irrigation, industrial application, power generation etc). The quality of ground water is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. Therefore, the quality of ground water varies from place to place, with the depth of water label, and from season to season and is primarily governed by the extent and composition of dissolved solids present in it. Majority of ground water quality problem are caused by contamination over exploitation or combination of the two. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors. Generally higher proportion of dissolved constituent are found in ground water than in surface water because of greater interaction of ground water with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and non living organism and excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans for example Cobalt, Copper etc. but large quantities of them may cause physiological disorders. Industrial waste is a valuable raw material located at wrong place & can be converted into useful product by making use of appropriate technology. Industries using cadmium, mercury or polychlorinated biophenyls (PCB) including heavy metals in

which bio-concentrative industrial waste readily adjustable to atmosphere should be disposed, reclaimed or precipitated by using proper condition. Toxic industrial waste affect living organisms either by ingestion through the food chain, respirator system or through the surface of skin. Toxicity of material has different degree but to prevent ultimate destruction, handling is critical. Few of the heavy metals are extremely essential to the humans, like copper, cobalt etc., but large quantities of them may cause physiological disorder². Explosive industrial wastes have possibility of explosive determination with or without ignition.

Collection of solid industrial wastes includes all the activities associated with the gathering of industrial wastes and hauling of the wastes collected to the location from where the collection vehicle will ultimately transport it to the side of disposal.

The surface and ground water collect some harmful organism, which are injurious to health of the people. Turbidity is a measure of suspended organic material or soil particles present in water. It is caused by finely divided soil till particles or by microscopic organism held in suspension. Waste from agriculture and industries can also cause serious health risks.

MATERIAL AND METHODS

Water sample collected from different tube well, hand-pumps, tank, hand pumps, tanks, ponds and house tapes and from various sources at covering extensively populated area, industrial, commercial, agricultural and residential colonies various depths according to the standard method of collecting sample

at international level i.e. APHA procedure. Ground water samples collected from different location from the industrial area of Jaipur were analyzed during pre as well as post monsoon season. Water sample collected in good quality polyethylene which cleaned, dried and sterilized with bottles which 2.5 liter capacity. Sample was carried out without adding any preservative in rinsed bottles directly for avoiding any contamination and brought directly to the laboratory³. All water sample properly labeled as A, B,C,D,E,... and record was prepared indicating the source of the sample, location, source and data of collection.

The sample collected were analyzed for major cations like Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) by Titrimetry, Sodium (Na^+) and Potassium (K^+) by Flame photometer ;(ELICO-CL-220) (APHA [2] et al, 1985), anion Chloride (Cl^-), Carbonate (CO_3^{2-}) and Bicarbonate (HCO_3^-) by Trimetric, Sulphate (SO_4^{2-}), PO_4^{3-} and H_2SiO_4 by Spectrophotometer. Trace metal Fe, Pb, Ni, Br, I and Al. Fe was analyzed in Atomic Adsorption Spectrophotometer. Different physical parameter – pH, HC & TDS determined at the site with the help of digital portable water analyzer kit. The total hardness (TH) in ppm was determined by following Richard equation:

$$\text{TH} = 2.497 \text{Ca}^{2+} + 4.115 \text{Mg}^{2+}$$

All respective value result are compared with standard limit recommended by the Bureau of Indian Standard (BSI), Indian Council Of Medical Research (ICMR) and WHO⁴.

RESULT AND DISCUSSION :

All sample analyzed and compare the standard drinking water quality .

S.No.	Parameters	WHO: 2003	BIS: 1999	ICMR: 1975
01.	TDS	600	2000	500
02.	Ph	6.5 - 9.5	6.5 8.5	7.0 8.5
03.	Na ⁺	-	-	-
04.	K ⁺	-	-	-
05.	Ca ²⁺	100	200	200
06.	Mg ²⁺	150	100	200
07.	Cl	250	1000	200
08.	CO ₃ ²⁻	-	-	-
09.	HCO ₃	-	-	-
10.	SO ₄ ²⁻	250	400	200
11.	NO ₃	50	100	50
12.	TH	500	600	600

Total Dissolved Solid (TDS): Total dissolved solid in an important parameter for drinking water and water to be used for other purpose. Maximum permissible limit of TDS is 500 mg/L (ICMR). It is represented by the weight of residue left when a water sample has been evaporate to dryness. Beyond the prescribed limit, it imparts a peculiar taste to water and reduce its portability. TDS value varied from 239.60 to 1435 mg/L.

pH : All biological & chemical reaction are directly dependent upon the pH of water system. Lower pH value may cause tuberculation and corrosion while higher may cause incrustation, sediment deposit and difficulties in chlorination for

disinfection of water pH value varied from 7.40 to 8.03.⁵

Chloride (Cl⁻): It is anions and trouble for irrigation water. Chloride contents water largely influenced by evaporation and precipitation. It is recommended that chloride content should not exceed 250 mg/L. Chloride value varies from 32.49 to 624.81 mg/L.⁶⁻⁷

Fluoride : It is important in human nutrition for development of bones. High concentration of fluoride in ground water may develop molting of teeth, skeletal fluorosis, deformation in knee joint. Fluoride salts are commonly used in steel, aluminum, bricks and tiles industries. Fluoride value varied from 0.6 to 1.4 mg/L.⁸

Sulphate (SO₄²⁻): Sulphate ion is one of the major anions occurring in natural water. Higher value of Sulphate may cause intestinal disorder. Sulphate in most of the samples was found to be lower than highest desirable level i.e. 200 mg/L. Sulphate value varied from 8.55 to 112.5 mg/L.

Nitrate (NO₃⁻) : High concentration of nitrate in water, infants, less than six month old, are suffering from “methamoglobinemia” or “BLU BABY” disease. It is affecting plant nutrient and moderately toxic. Repeated heavy doses of nitrates on ingestion may also cause carcinogenic disease.⁹ Nitrate value varied from 40 to 360 mg/L & maximum permissible limit is 50 mg/L (ICMR).

Alkalinity: Desirable limit for total alkalinity is 200 mg/L (ICMR). Value of water sample varies from 160 to 300 mg/L.

In ground water, most of the alkalinity is due to carbonate and bicarbonates.

Total Hardness (TH): Hardness is an important factor for determine the usability of water for domestic, drinking and may industrial supplies. TH value of water sample varies from 150 to 260 mg/L. The desirable limit for total hardness is 300 mg/L(ICMR). The hardness of water is due to the presence of alkaline earth such as calcium and magnesium. Higher value of hardness responsible for incrustation and scaling in pipelines.

Sodium (Na^+) : High sodium value is not suitable for irrigation purpose due to sodium sensitivity of crops and plant. Its value varies from 20.67 to 200 mg/L.

Potassium (K^+) : It is an essential element for humans, plants and animals and derived chain mainly from vegetation and soil. The main water weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation. It is more abundant in sedimentary rocks and commonly present in feldspar, mica and other clay minerals. BIS has not included potassium in drinking water standard but Europeans Economic Community (EEC, 1980) has prescribed guideline level of potassium 10 mg/L in drinking water. Higher value content in ground water is indicate of ground water pollution.

Electrical Conductivity (EC) : EC of ground water is varies from 345 to 2550 microsiemens/cm (WHO, 2003).

Calcium (Ca^{2+}): Desirable limit of calcium for drinking water is 100 mg/L (WHO), 200 mg/L (BIS:1999) AND 200 mg/L

(ICMR:1975). Ground water of metropolitan city, the value of calcium range from 21 to 222 mg/L in pre-monsoon & 19 to 222 mg/L in post-monsoon season.

Magnesium (Mg^{2+}) : Desirable limit of Magnesium for drinking water are 200 mg/L (BIS:1999). In ground water of Jaipur the value of varies from 2.9 to 133 mg/L in pre while 8 to 117 mg/L in post-monsoon.

Carbonate (CO_3^{2-}) and Bicarbonate (HCO_3^-) : Presence of carbonates and bicarbonates are the main cause of alkalinity in nature water. Bicarbonate represent the major form since they are formed in considerable amount from the action of carbonates upon the basic materials in the soil. Carbonate value varies from 6-42 mg/L & Bicarbonate value varies from 6.10 to 503.25 mg/L.

Water Quality Evaluation for Irrigation Purpose:

Quality of water is an important consideration in any appraisal of salinity or alkali conditions in an irrigated area. Good quality water has the potential to cause maximum yield under good soil and water management. Determine suitability of ground water for irrigation purpose as follows :-

- Salinity
- Proportion of Sodium to other Cations (SAR)
- Residual Sodium Carbonate (RSC)
- Boron

Salinity: Ground water with highly salinity has limitations in its use for irrigation purpose. Salinity is highly related to total dissolved solid (TDS) and electrical

conductivity (EC). High concentration of TDS and EC in irrigation water may increase the soil salinity, which affect the salt intake of the plant. Salt present in the water, affecting the growth of the plant directly, also affect the soil structure permeability and aeration, which indirectly affect the plant growth. Soil water passes into the plant through the root zone due to osmotic pressure. Dissolved solid content of the soil water in the root zone increase, it is difficult for the plant to overcome the osmotic pressure and plant root membrane are able to assimilate water and nutrients. Dissolved solid contents of the residual water in the root zone also has to be maintained within limits by proper leaching

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Proportion of Sodium to other Cations (SAR):

High concentration in water to formation of saline soil and high sodium to development of an alkali soil. Sodium or alkali hazard in the use of water for irrigation is determined by the absolute and relative concentration of cations and is expressed in terms “ Sodium Absorption Ratio “ (SAR) . It is the proportion of sodium is high , the alkali hazard is high and conversely, if calcium and magnesium predominate, the hazard is less. There is a significant relationship between SAR value of irrigation water and the extent to which sodium is absorbed by the soil. If water used for irrigation is high in sodium and low in calcium, the cations exchange complex may become saturated with sodium. This can destroy the soil structure. Method of evaluating the danger of high sodium water is the sodium adsorption ratio, SAR (Rishards, 1954):

$$SAR = \frac{Na^+}{\sqrt{(Ca^{2+} + Mg^{2+})2}}$$

Sodium percentage is calculated as

$$Na \% = \frac{Na^+ + K^+}{Ca^{2+} + Mg^{2+} + Na^+ + K^+} \times 100$$

Lower SAR (2 to 10) indicate little danger from sodium; medium between 7 and 18, high between 11 and 26. Value of SAR in the ground water ranged from 0.44 during pre-monsoon and 0.42 to 3.17 during post-monsoon.

Residual Sodium Carbonate:

Ground water containing high concentration of carbonate and bicarbonate ions tends to precipitate calcium and magnesium as carbonate. As the result, the relative proportion of sodium increases and gets fixed in the soil there by decreasing the soil permeability. Quality of bicarbonate and carbonate in excess of alkaline earth also influence the suitability of water for irrigation purpose. Excess is denoted by Residual Sodium Carbonate (RSC) and it determined as :-

$$RSC = (HCO_3^- + CO_3^{2-}) - (Ca^{2+} + Mg^{2+})$$

RSC exceeds 2.5 ppm, the water is generally unsuitable for irrigation and cause the soil structure to deteriorate. If value less than 1.25 ppm indicate that the water is safe for irrigation.¹²

Boron: It is essential to the normal growth of all plants when concentration is very small and when exceed may cause injury. Boron is essential nutrient for plant growth, generally it be comes toxic beyond 2 mg/L

in irrigation water. It does not affect the physical and chemical properties of the soil but high concentration affects the metabolic activity of the plant.¹³

CONCLUSION :

Rural and Urban area of Jaipur are growing very fast due to fast and rapid urbanization. Ground water bodies are being polluted by industrial effluents and municipal waste disposal. The general taste of ground water is good and layman cannot determine the possible hazards of water quality. The problem of ground water pollution is several parts of the country has become so acute that unless urgent steps for detailed identification and abatement are taken, extensive ground water resources may be damaged. A major problem in urbanized areas in the collection and disposal of domestic wastes. Because a large volume of sewage is generated in a small area. Ground water supply has registered high value of nitrate in the area where sewage system is not provided for last 20 – 30 years. Solid wastes from urban area are disposed off in scientifically located and designed site and structure for recycling and reuse. Liquid waste from the cloth printing and dyeing industry in Sanganer has to an increase in fluoride content in ground water. High fluoride values has been detected in Sarwalwas area near Jal-mahal, Ramgarh road and in the south east of the city near Sitapura area. Bacteriological analysis of the sample indicates some of bacterial contamination. Inadequate maintenance of hand pump, improper sanitation and unhygienic conditions. Industries may adopt cleaner methods of production so as to minimize their waste generation and

material energy waste.¹⁴⁻¹⁶ Education and involvement of people in its management development, conservation, protection and augmentation projects will be prime request to protect resources against quality degradation and guarantee quality assurances. In irrigation sector sprinkler and drip system of irrigation should be promoted and made mandatory in phased manner, wherever feasible. Low water requirement crop needs to be promoted at suitable and markets should be developed accordingly. In domestic waste water for gardening, recharge and promotion economic use of water in bathing, cleaning, cooking, leakage from domestic taps, pipelines for water supply to urban areas be checked. In Industrial sector, treatment of industrial effluents so as to check pollution of fresh ground resources. Pesticide analysis indicate the presence of some chlorinated at certain location but their content was well within the permissible limits for drinking water at most of the location. The suitability of ground water for irrigation purpose has been evaluated based on Salinity, Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC) and boron content.

Effective solid waste disposal mechanism needs to be properly developed. This can be utilized for manufacturing biogas. Use of nitrate fertilizer for gardening should be banned. Promoting de-fluoridation devices like activated alumina in the affected areas. Sewerage disposal system should be developed in proper way. All the ground water abstraction structure for drinking including hand pumps with high nitrate and fluoride concentration should be marked by red paint so as to avoid their utility by the common people for drinking purposes.

Central Ground Water Board, Jaipur has organized such programs at many places in Jaipur. Also awareness campaigning has for schools, colleges. Message of water conservation was also broadcast & telecast on Akashwani, Door Darshan. Organizing Mass Awareness Programmes, electronic and press media have provide a meaningful ways and means to educate the masses for water conservation at grass root level.

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