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# Geochemical Study of Ground Water Samples in Industrial Area in Jaipur (Rajasthan)

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***Abstract*-Ground water is a major source of drinking water in all urban and rural of India. Quality of water for public health depends to a greater extent on the quality of drinking water is systematically collected and monitored. In general, ground water is clean and fresh. 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 of Rajasthan has been taken up to evaluate its suitability for domestic purpose. Twenty-five ground water samples were collected from different places of Jaipur. The analysis were carried out for the parameters such as temperature, pH, dissolve oxygen, BOD, COD, total hardness, sodium, potassium, calcium, magnesium, chloride, fluoride, TS and TDS. The observation gives indication that fluoride and nitrate levels are unacceptable in drinking water sample.**

**Key-words -Groundwater, Water quality, Major ions, Hydro geochemistry, Trace metals, Industries, Health risk assessment, Sevier Health infections.**

## I. INTRODUCTION

Jaipur city capital of Rajasthan and it is one of fastest growing cities in country & undergoing rapid industrialization. Jaipur city is also popular known as Pink City and is situated towards central part of the district. Jaipur is very much on the world tourist map, known for jems & jewelry and is also popular for Sanganer & Bagru prints. Water is vital for life, well-being, food security and socio-economic development of mankind. In may developing countries, availability of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system.(Okonko et al.,) [1]. Increase threat of pollution from urbanization, industrial development, agriculture and mining activities (Oluseyi et al,) [2]. 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 (Nwanjei et al.,) [3]. 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), Maganese (Mn) and Cadmium (Cd) [4-5]. Wells are the main source of franking water and other domestic chores for inhabitants of the area surrounding the factory [6]. Analysis of water for physical, biological and chemical properties including trace element contents are very important for public health(Chinedu et al,) [7].Heavy metals is capable of changing salt content of water leading to serious disruption of aquatic communities and also decrease quality of water used for drinking. Human body is very sensitive to fluoride & it is essential for growth of teeth & bones (upto 1 ppm.). Water used for drinking purpose should be free any toxic elements living and nonliving organism and excessive amount of minerals that may be hazardous to health. Few of the heavy metals are extremely essential to the humans, like copper, cobalt etc., but large quantities of them may cause physiological disorder [8]. Recently heavy metals & pesticides is greater effect to their toxicity so they appears is a prime target in environmental research today. Population of Jaipur city is 3,548,512 and literacy rate in the city was 75.51% and the participation of the male was found to be

86.05% and female was 64.02%. Sex ratio is 909 females for every 1000 males. According to PHED, Jaipur the daily drinking water supply of Jaipur city is 330 mld, out of which 290 mld is used for domestic & remaining 40 mld is for industrial and non-domestic purposes. Actual demand is 150 lpcd and actual per capita supply is 149 lpcd. 98.2% of the supply is through ground sources and 1.8% through surface sources, 64.5% population is covered by sewerage system. The total number of hand pumps existing in city is 1777, out of which 1736 are operational. There are 48 overhead tanks of 40 mld capacity.

## II. MATERIAL AND METHOD

Water sample collected from different hand-pumps, tube-wells, tanks, ponds and house tapes, from various sources at various depths covering extensively populated area, commercial, industrial agricultural and residential colonies of 25 sampling points 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 laboratory [9]. All water samples 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, anion Chloride ($Cl^{-}$), Carbonate ($CO3^{2-}$) and Bicarbonate ($HCO3^{-}$) by Trimetric, Sulphate ($SO4^{2-}$), PO4 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:

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

All respective value result is compared with standard limit recommended by the Bureau of Indian Standard (BSI), Indian Council of Medical Research (ICMR) and WHO [10].

## III. RESULT AND DISCUSSION

All samples 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. | $CO_3^{-}$ | - | - | - |
| 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 evaporating 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 [11].

*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 [12-13].

*Fluoride:* It is important in human nutrition for development of bones. High concentration of fluoride in ground water may develop molting of teeth, skeletal flurosis, and deformation in knee joint. Fluoride salts are commonly used in steel, aluminium, bricks and tiles industries. Fluoride value varied from 0.6 to 1.4 mg/L [14].

*Sulphate ($SO_4^{2-}$):* Sulphate ion is one of the major anions occurring in natural w ater. 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 ($NO_3^-$ ) :* 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 [15]. 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 have 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 represents 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 is able to assimilate water and nutrients. Dissolved solid contents of the residual water in the root zone also have to be maintained within limits by proper leaching [16-17].

*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 (Richards,) [18]:

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

Sodium percentage is calculated as

$$Na\,\% = \frac{Na^+ + K^+}{Ca^{2+} + Mg^{2+} + Na^+ + K^+} \text{ X } 100$$

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 deteriote. If value less than 1.25 ppm indicate that the water is safe for irrigation [19].

*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 [20].

## IV. CONCLUSION

The general taste of ground water is good and layman cannot determine the possible hazards of water quality. 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. 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 dying industry in Sanganer has to an increase in fluoride content in ground water. 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 [21-22]. 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 indicates 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 suitable of ground water for irrigation purpose has been evaluated based on Salinity, Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC) and boron content.

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

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