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Assessment of Anionic Concentrations in Industrial Area Ground water of Vijayawada, Andhra Pradesh, India

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ABSTRACT

Water is a universal solvent and is the major component of all living things. Living things can't survive without water, and it operates dual behaviour for chemical and biochemical reactivity. The main objective of this work is to assess the water quality in and around the industrial region of Vijayawada. Around 30 samples collected in the Vijayawada industrial region of water. The anions studied in this area are carbonates, bicarbonates, chlorides, sulfates, nitrates and fluoride. The results indicate that the quality of water is decreased due to an increase in industries, increases in domestic waste and unwanted matters are throwninto the water. According to WHO, these results showed that the groundwater is highly contaminated and this causes many health problems to the human beings.

Graphical Abstract

Ground water analysis study area

Keywords: Anions, contamination, Industrial area, Vijayawada, Water.

INTRODUCTION

The main constituent present in living organisms is water. It is the naturally occurring substance and present in three state liquid (water), solid (ice) and gaseous state (water vapour). Water occupies nearly 70% of the earth's surface. Majorly water is present in oceans and only 1.5–2% in ground level (aquifers). The remaining water is present in the air as water vapour, clouds, etc. The human beings are survived by the high quality of water and this is basic important to human physiology [1]. India uses only 5% of the total water surface, but the population is nearly 130 crores. In the future generation, water distribution is very difficult among the neighbouring states and countries. This leads to disputes between peoples.

Groundwater quality determination is the main aspect in the study of groundwater in the industrial regions. Water causes 80% of all diseases in human beings, this is according to WHO, and 70% of groundwater is not suitable for consumption [2]. The water management is a continuous process of periodic study of water for various parameters to test it suitability safety and hydrogeological cycle. According to UNICEF, the unsafe and improper sanitation of water leads to killing about 2 million people every year, mostly these problems are common for children less than five years.

MATERIALS AND METHODS

Study Area: Vijayawada is one of the city in Andhra Pradesh with an area of 260 km^2. The municipal city limits have a population of 11,75,280 (2011 Census) while the population of the metropolitan area is 14,695,25. The Study area is shown in Fig. Oneis located at 16.50° north latitude, 80.61° east longitude and an average height of the land of the city of Vijayawada is around 39 feet above the sea level. The north, northwest and southwest percentages of the city are covered by a low range of hills while the central, southeast and northwest parts are covered by rich and fertile agricultural lands with three major irrigation canals. The major recyclization area of groundwater in the study area is Krishna River and Eluru canal. The Krishna River passes on the south side and Eluru canal passes on the North-East of Vijayawada city. Due to an increase of industrialization of Vijayawada city, the groundwater quality becomes decreases [3]. The groundwater levels in open-dug and bore wells vary from 2.5 to 3 meters below the ground level. The study areas are Morampudi, Atmakuru, IDL Ibrahimpatnam, Autonagar and Pedavadlapudi in and around Vijayawada shown in figure 1.

Figure 1. Ground water analysis study area

Soil type and Geology in the study area: Sampling location has modified lithological formations ranging in age from archaean crystallines to recent alluvium. Depending on the availability of these rock productions, the sampling location can be divided into three lithological provinces. The primarily north and west part, covered by a crystalline group of rocks involving khondalites,The second one is a North-east and central part, covered by Sandstones of Gondwana group.The third one is the East and south part covered by River and Coastal Alluvia[4]. Mainly four possible soils are in the area, viz., black cotton soils about 55 percent, sandy clay earth about 25 percent, red loamy soils 17% and sandy soils about 3 %. The sandy soils form a marginal along the coast.The black cotton soil iscostlier and more available in the Western part. The sandy clay loam formed along the river. The climate is an integral part of the geography of Vijayawada,marked by hot summers, the temperature in the summer months go up from 46 to 50°C. The winter months, on the other hand, are cool and pleasant, and the temperature varies from 14 to 26°C. The region practices regular rainfall, caused by the south-west and north-east monsoons.

Collection of water samples: The groundwater samples were collected from bores and wells in the study area in December in 2015 in the sampling location given in figure 1. The samples were collected in clean HDPE bottles which were prewashed with grade laboratory detergent followed by adequate rinsing with deionized water. Two samples were collected at each sample site, and the samples were acidified with 1.5 mL of nitric acid per litre and stored at 4°C before analysis. Deionised water was used for the preparation of all the solutions throughout the study.

Sample Analysis: Samples were characterized in five sections, as listed in table1.

Table 1. Categorization of samples

S. No.	Industry type	No. of Samples	Area/ Sample location
1.	Electroplating Alloys	5	Kanuru,Vijayawada
2.	Power plants	6	Kondapally,Vijayawada
3.	Beverage/Diary	4	Morampudi,Vijayawada
4.	Automobiles and Mechanical works	8	Autonagar,Vijayawada
5.	Chemical companies	7	Ibrahimpatnam,Vijayawada

Methods and Analysis: All the 30 samples were labelled. Samples were analyzedfive times (n=5), and the minimum, maximum and average anion concentrations in the above-reported regions of Vijayawada [5-7] were presented. The samples were analysed for carbonate, bicarbonate, chloride, sulfate, nitrate and fluoride using standard procedures described in the NEERI Manual (1984) (Figure 2). The methods used for the estimation of various anions are given in table 2 and the analysis results are presented in table 3.

Table 2. Method of determination of anions

S.No.	Parameter	Method
1.	Carbonate	Titration
2.	Bicarbonate	Titration
3.	Chloride	Ion Selective Electrodes
4.	Sulphate	Turbidimetric Method(elico)
5.	Nitrate	Phenol disulphonicacidmethod
6.	Fluoride	Colorimetric method

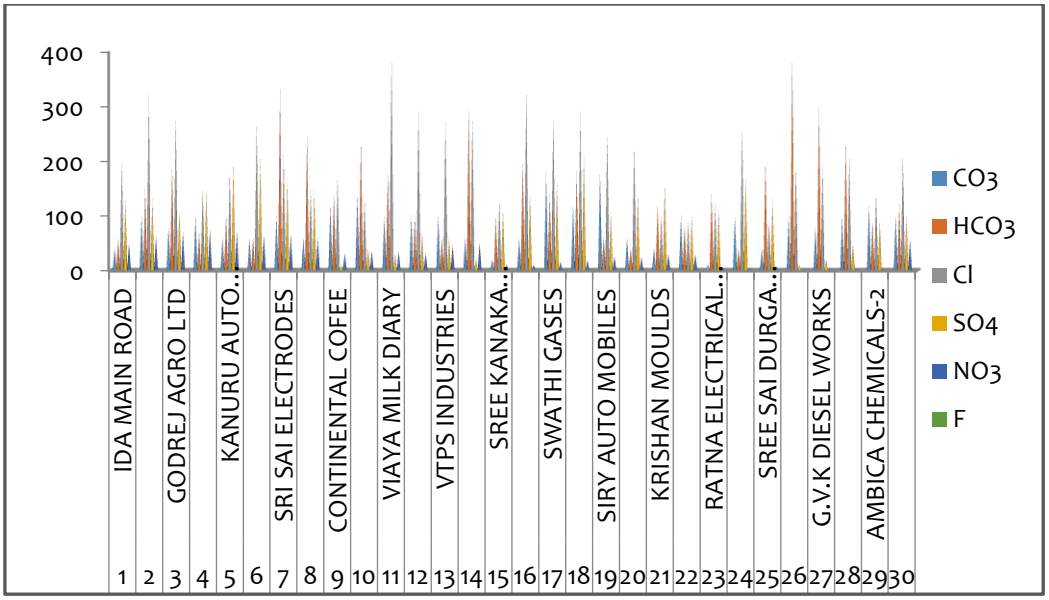

Figure 2. Graphical representation of all samples of anions.

Table 3. Analysis Results of ions

Sample Code	Sample Collection	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	F^-
1	Ida Main Road	40	60	200	130	47.92	0.2
2	Alekhya Chemicals	100	150	320	130	62.34	0.9
3	Godrej Agro Ltd	80	190	280	110	70.32	0.6
4	Siris Chemical Industries	100	70	150	150	75.42	0.6
5	Kanuru Auto Mobile Works	60	100	180	200	71.42	0.9
6	Lakshmi Chaithanya Alloys	60	60	270	210	66.4	0.4
7	Sri Sai Electrodes	100	330	210	170	65.36	0.4
8	Vardam Electrodes-2	60	250	150	150	59.67	0.2
9	Continental Cofee	120	140	170	10	30.47	0.7
10	CocacolaIndPvt Ltd	140	240	130	40	35.47	0.9
11	Viaya Milk Diary	100	180	390	30	33.91	1
12	Lanco Industry	100	100	290	70	31.87	0.4
13	Vtps Industries	100	60	270	60	45.5	0.5
14	Zenith Polymers	60	300	280	20	50.23	0.2
15	Sree Kanaka Durga Works	20	100	130	110	10.42	0.7
16	Sri Gayatri Industries	60	200	330	140	9.94	0.5
17	Swathi Gases	180	140	280	160	15.55	0.4
18	Syshame Enterprises	120	180	290	210	19.43	0.6
19	Siry Auto Mobiles	180	60	250	110	25.42	0.2
20	Sree Uma MaheswaraMech	60	40	230	140	24.23	0.4
21	Krishan Moulds	40	120	100	160	30.42	0.2
22	Sai Durga Turning Works	100	80	90	100	29.84	0.1
23	Ratna Electrical Works	10	140	120	110	6.23	0.4
24	Sree Sai Oil Works	100	40	260	170	5.24	0.1
25	Sree Sai Durga Rubber Works	40	200	90	130	7.42	0.4
26	Visak Industries	100	390	190	10	0.84	0.3
27	G.V.K Diesel Works	80	300	190	20	1.34	0.4
28	Sai SagarIndusties	100	240	210	50	1.74	0.2
29	Ambica Chemicals-2	120	90	140	90	1.85	0.5
30	Sri Sai Industries	100	120	210	100	56.42	0.7

RESULTS AND DISCUSSION

Carbonate ion (CO_3^{2-}): The carbonate ion appeared in chemical analysis by dissolving water in carbon dioxide. The major criterion to find the concentration of carbonate ion is carbondioxide, dissolved salts, hydrogen concentration and temperature. Carbonate represents a linkage between the carbon cycle and the hydrologic cycle. The maximum availability of atmospheric carbon dioxide is partly intercepted by photosynthesizing vegetation [**8-9**]. They convert it to cellulose starch and related carbohydrates. These products are later reduced via respiration to carbon dioxide and water with the release of stored energy. One more important point for this carbonate ion, a considerable part of the anionic load of many streams is a contribution from carbon dioxide to the atmosphere rather than from the rocks of the drainage basin. The carbonate concentrations found in this study area were in the range of 10-180 mg L^{-1}.

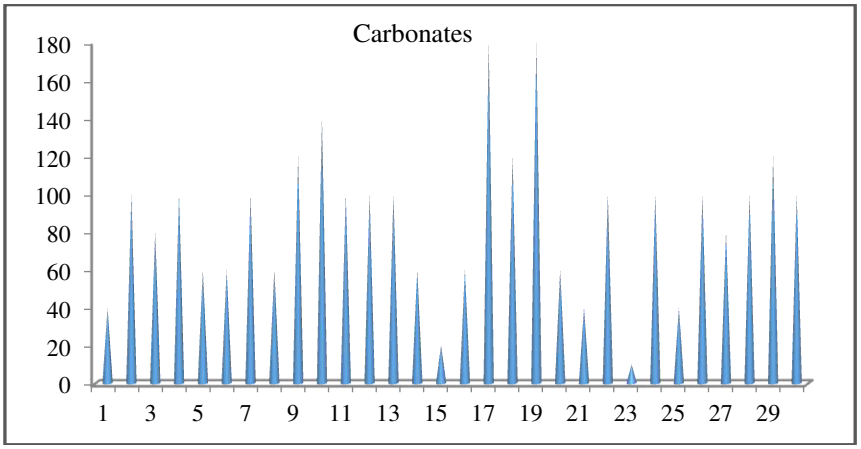

Figure 3. Analysis of Carbonate ion in experimental samples.

Bicarbonate: Bicarbonate ion is secreted by the stomach, and it is the important major ion in our body. All body fluids contain bicarbonate ion, and these organs play themain role in acid-base balance in the body. Bicarbonate ion and many acids produce from the mucous membrane of the human stomach, and it has nearly 30 million glands. Nearly 0.5 g of bicarbonate secretes daily in our stomach [**10**]. While comparing with acid secretion, the rate of gastric bicarbonate secretion is 2-10% more. On neutralization by acid, CO_2 is produced from bicarbonate. It provides mainly biochemical role in the physiological pH buffering system. The bicarbonates present in the analyzed samples were found to be in the range 40-390 mg L^{-1}.

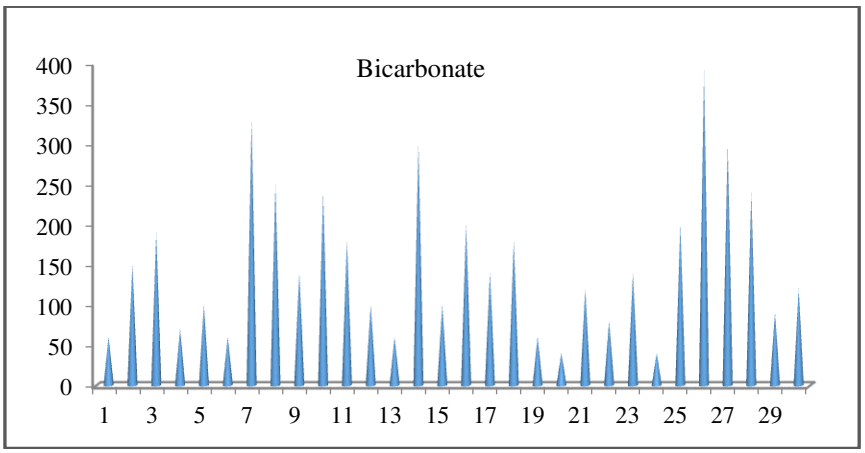

Figure 4. Analysis of bicarbonate ion in experimental samples.

Chloride (Cl^-): In industrial water and potable water, the major ion present is chloride, and it doesn't produce any health problems but gives abad taste to water. This chloride ion is the indication of pollution by sewage. The higher percent of chloride leads to dangerous. Chlorides of bore well water in the study area were found to be in the range of 90-390 mg L^{-1}.

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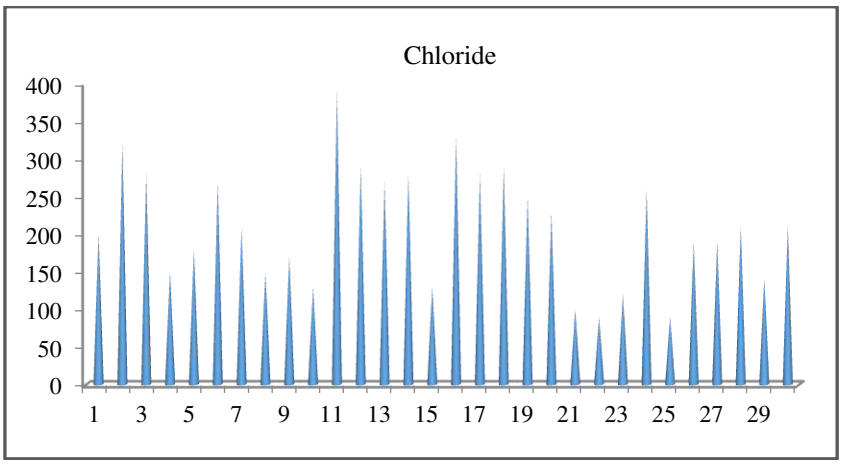

Figure 5. Analysis of chloride ion in experimental samples.

Sulphate(SO_4^{2-}): In groundwater analysis of anions, the sulfate ion is present in very small quantities [**11**]. Mainly sulfate fertilizers are the main source of sulfate ion present in groundwater. Sulphate ion of groundwater in the study area was found to be the range 10-210 mg L^{-1}. The sulfate values of the all the samples in the regions were within the permissible limits of WHO.

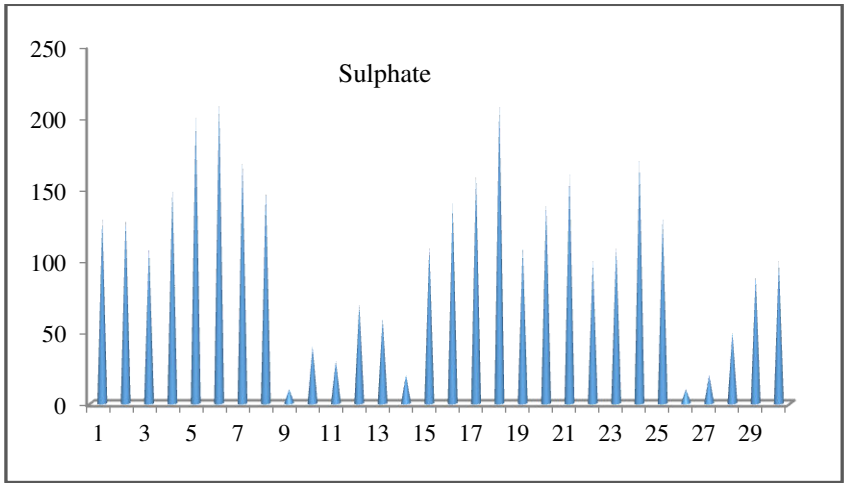

Figure 6. Analysis of chloride ion in experimental samples.

Nitrate (NO_3^-): Organic pollution means the content of nitrogen is higher in percentage. It produces from the added nitrogenous fertilizers, the decay of dead plants and animals, animal urine, etc. They are all oxidized to nitrate naturally, and hence nitrogen is present in the form of nitrate. Groundwater in this area ranged from 9.94-75.42 mg L^{-1}. The groundwater contamination is due to the leaching of nitrate present on the surface with percolating water. Increased nitrate levels in drinking water adversely affect the central nervous system.

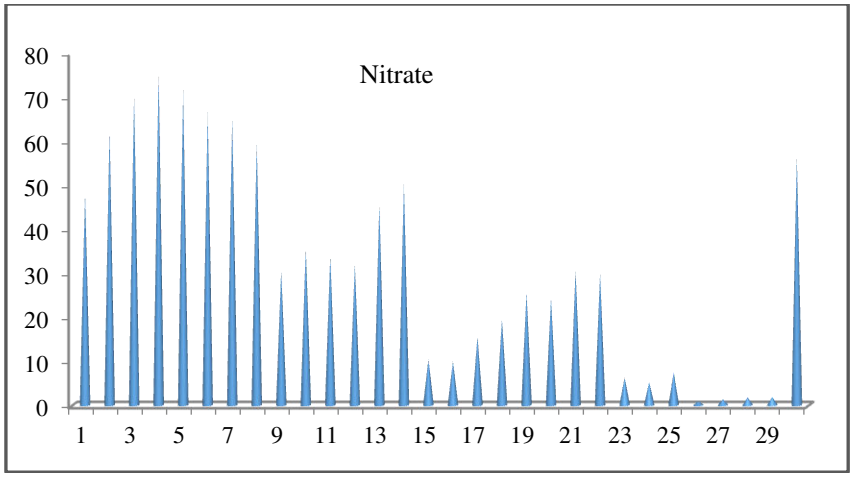

Figure 7. Analysis of nitrate ion in experimental samples.

Fluoride (F^-): The concentration of fluoride in groundwater is approximately 0.5 mg $L^{-1}$is required for strong growth of teeth and bones. The concentration of fluoride content exceeds 1.5 mg L^{-1} leads to teeth becomes yellow to brown. Theconcentration of fluoride content more or less depends upon the anthropogenic or natural phenomena. Groundwater in this area ranged from 0.1-1.0 mg L^{-1}.

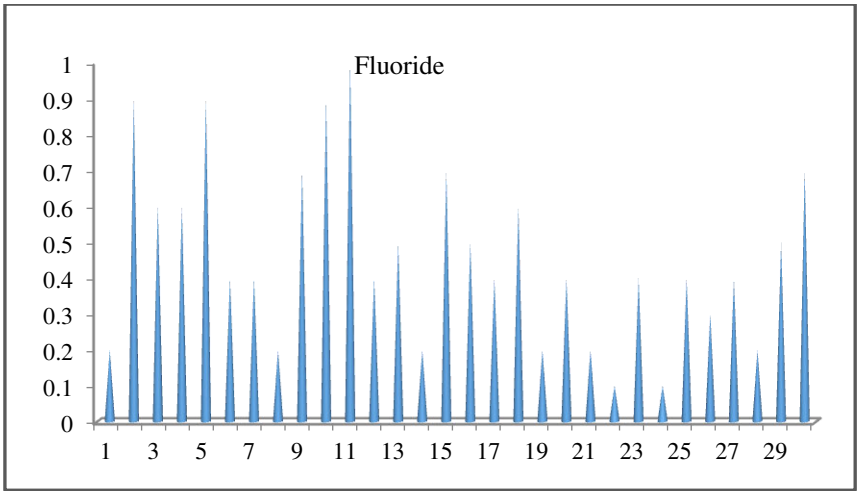

Figure 8. Analysis of fluoride ion in experimental samples.

APPLICATION

The results indicate the potability of water in this area. Some samples are not suitable for drinking purpose due to some anions is high and some are low. Where fluoride is low i.e< 0.5 mg^{-1} fluoride toothpaste is suggestible and by some other way ingestion is needed.

CONCLUSION

The present study indicated a considerable change in the concentrations of anions for the few samples. Maximum samples do not comply with ICMR and WHO standards of potable water. The water quality investigated in the study area is found to be suitable for drinking only in a few locations.The minimum and maximum anion concentrations in different areas are: for carbonates 10-180 mg L^{-1}, bicarbonates 40-390 mg L^{-1}, chlorides 90-390 mg L^{-1}, sulphates 10-210 mg L^{-1}, nitrates 9.94-75.42 mg

L^{-1} and fluoride 0.1-1.0 mg L^{-1}. The anions sulphate and nitrate exceeded the maximum limits for potable drinking water in several samples of bore wells in the industrial region of Vijayawada. It is recommended to adopt some kind of inexpensive treatment to reduce the levels of non-metals in areas supplying water directly to consumers without any treatment.

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