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Physico- Chemical Characterization of Rain Water Collected from Industrial Areas of Hisar, India

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Abstract: *Rain water samples were collected from five locations from Jindal Chowk, Red Square Market, Grain Market, Milgate and Gangwa of Hisar for physico-chemical properties of rain water, during the months of June, July and August 2013. The first four locations were industrial and market layouts while the last one was a rural, non-industrialized community on the outskirt of Hisar. The result of the rainwater samples indicated the average values of colour (6.6, 6.0, 6.2, 6.0 and 5.0 Hazen units); turbidity (0.18, 0.162, 0.161, 0.163 and 0.16 NTU); chloride (14,12.6, 13.3, 12.6 and 10.6 mg/l); total hardness (23.0, 21.3, 22.0, 15.1 and 14.3 mg/l) at Jindal Chowk, Red Square Market, Grain Market, Milgate and Gangwa respectively. The pH values of the rain water from the four industrial locations indicated slightly acidic i.e. pH<6.6 in the month of June 2013. In this study a correlation was established between the industrial sites and rainwater that water became acidic due the gases emitted by industries.*

Keywords: Industrial, Physico- Chemical, Pollution, Rainwater, Season

Introduction

Hisar is located between latitude 29°09 N and 75°42E of the India. It has an average elevation 215 m (705 ft) above mean sea level and located 164 Km to the west of New Delhi India's capital region to develop as an alternative centre of growth. The continental climate with very hot summer and relatively cool winter, which affects the quality and quantity of the water resources results from the influence of two main wind systems the moist, relatively cool monsoon wind which blows from the south-west across the Indian Ocean towards the country and brings rainfall and hot, dry, dust-laden wind which blows from the north-west across the Rajasthan. The mean temperature is generally between 32°C and 38°C during the summer season. Rainwater is an important source of fresh water especially for those who live in rural areas, where water use is limited due to scarcity or where surface and underground water quality is poor. In many areas, rainwater is still considered as a safe and suitable source of potable water, and it is commonly used as such Vikaskumar *et al*, (2007). Developments in science and technology have brought improved standard of living, but have also unwittingly introduced some pollution into our environment. Substances are regarded as pollutants if they are present in concentration toxic to man, animals or plants, have an odour or in some other ways that irritate our senses. These include emissions and effluent outflow from factories, refineries, waste treatment plant, oil or gases of varying quality and quantity directly into the atmosphere. As noted by Ayodele and Abubakar *et a.,* (1998) the concentrations of pollutants correlated with the industrial activities of city. These chemicals are mostly odourless, colourless and tasteless and most importantly, are health hazards. The massive increase in chemical utilization due to

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recent development in science and technology has greatly increased different contaminant present in water generally, regardless of its source. In an industrial area, there is possibility of acidic rain.

Acid rain is formed through a complex process of chemical reaction involving air pollution Kemp et al, (1971). The most important pollutants that contribute to the formation of acid rain are nitrogen oxide and sulphur-dioxide, which react with moisture in the atmosphere, to form nitric and sulphuric acid. The sulphur and nitrogen compounds that contribute to acid rain primarily come from manmade source, such as industries, utilities, automobiles, and other form of transportation and industrial process, such as melting. Acid rain has recently become a serious environmental problem in many industrialized countries including Japan, in Europe and in the northeast areas of the United States and Canada Adachi, *et al* (1990). Many researchers including Evans *et al* (2006), Yasunori and Akira (1981), Nicole and Robert (2001) and Susumu *et al,* (2001) have considered the effect of acid rain on human health. These acid pollutants can be deposited in a dry form through dust. Pollutant that contributes to acid rain may be carried hundreds of miles before being deposited on the earth. Because of this, it is sometimes difficult to determine the specific sources of these acid rain pollutants. Hisar is a steel industrialized city of Haryana. Many of the factories in Hisar freely release their effluents and emissions to the environment. In the neighborhoods of these industrial centers, some forms of farming activities take place. The farmers and horticulturists in the areas depend on rainfall and the water harvested by the usual methods of rainwater harvesting (RWH). Beside farming and horticultural activities, the quality of rainwater has the potential to affect aquaculture Adewolu *et al (*2009). There is a need therefore, to investigate the effects of these pollutants on the rainfall occurring in the vicinity of these industries. Such study may form the basis for the recommendation of remedial actions. In this study, rainwater samples from five locations namely (Jindal Chowk, Red Square Market, Grain Market, Milgate and Gangwa) were collected in order to check for the physical and chemical properties.

Materials and Methods

Rainwater samples were collected by rainwater harvester placed on the roofs of houses in open and carry them in clean plastic containers to ensure that the water have no contact with any object before getting into the container. These samples were analyzed on the same day of collection to preclude chemical reactions that may occur in the samples. Physical analysis for water samples were done on site. This is because some of these characteristics are subject to changes with time. The physico-chemical analysis of rainwater - colour, turbidity, odour, taste, and conductivity were measured as per APHA (2012). Immediately after each rain event, the temperature of the rainwater was determined using glass thermometer. Turbidity in water is caused by the presence of suspended particles, dissolved organic and inorganic matter and microscopic organisms in the environment. The colour of the samples was observed by filling a matched Nessler tube to mark 50 ml with the water to be examined and comparing it with the standards (distilled water). The tube was looked vertically downward toward white surface placed at an angle that light is reflected upward through the columns of liquid. The tubes were placed in the comparator (Nessleriser Dis. NSA) and the true colour was read. The results of colour determinations were expressed in whole number and recorded as Hazen units (1 Hazen unit is equivalent to a solution of potassium chloroplatinate containing 1 part permillion of platimum) or Alpha platinum cobalt standardized.

Chemical Analysis

The following tests were carried out on the rain water samples: pH value, magnesium hardness, acidity, chloride, and chlorine, free

CO_2, salinity, hardness and total alkalinity as per APHA (2012).

pH Test

The PH of water was taken as a measure of the degree of acidity or alkalinity of water and its logarithm of the reciprocal of the hydrogen-ion concentration. Pure water at 24ºC is balanced with respect to H^+ and OH^-. 10 ml of water sample was placed in test tubes and 20 ml of bromothymol blue solution was added to each test tube and then a glass electrode dipped into the solution to test the pH of the water sample.

Chloride Test

100 ml of water sample was measured into a conical flask and 1 ml of potassium chromate solution was added as an indicator. The mixed solution was then titrated against silver nitrate. The end point was indicated by the solution changing from yellow to red. The same procedure was carried out for distilled water as blank.

Total Acidity

100 m1 of water sample was poured into a conical flask and two drops of phenolphthalein indicator were added. The resulting solution was titrated against 0.02N sodium hydroxide solution until a pink colour was obtained which indicated end point.

Total Alkalinity

The alkalinity of water is a measure of its capacity to neutralized acids. In natural waters, the alkalinity is related to the bi-carbonates HCO_3, carbonate CO_3 and hydroxide OH concentration. 100m1 of water sample was poured into a conical flask and three drops of methyl orange indicator was added. The resulting solution was titrated against sulphuric acid until the appearance of orange colour was obtained.

Total Hardness

100 m1 of water sample was measured into a conical flask and two drops of crichrome black-indicator were added and mixed properly. Then 2ml of ammonium chloride (NH_4Cl) and ammonium hydroxide (NH_40H) buffer solution were added and mixed properly. The resulting solution was titrated against standard ethylene-di amine tetra-acetic acid (EDTA) solution and the volume at the end point was recorded.

Calcium Hardness

To 100m1 of sample 2 ml of sodium hydroxide buffer solution was added while mixing so as to avoid excess of buffer solution. 0.4g of murexide (ammonium purpate) indicator was added and the solution was titrated against sequestric acid until the colour changes from pink to purple. After taking the burette reading, one or two drops of the sequestric acid were added to make sure that no further change in colour occurs.

Residual Chlorine

The concentration of residual chlorine was estimated by matching colours. The comparator cells were washed with the water samples and consequently filtered. A tablet each of diethyl-p-phenylene diamine (DPP) was added to the water samples impacting some degree of colouration after standing for about 5 minutes. The cells were then placed one at a time, in the comparator and the standard chlorine disc 387 R.R. Dinrifo, S.O.E. Babatunde, Y.O. Bankole and Q.A Demu rotated until the colours matched. The number indicated on the matched colour disc indicates the residual chlorine in mg/l.

Nitrate Test

A few drops of water sample were taken in an evaporating dish, and then two drops of diphenyl amine were added to sulphuric acid in a conical flask. The content of the flask was poured into the evaporating dish and the solution was heated. Blue colour indicates the presence of nitrate. The absorbance of the mixture was read on a spectrophotometer at 520nm.

Carbon (IV) Oxide

To 10 ml of rain water sample in a measuring cylinder was added 4 drops of phenolphthalein. The colourless solution was then titrated with 0.045 M of sodium carbonate solution. It was stirred gently with iron rod and sodium carbonate was added in bits. A faint pink colour that remains for at least 30 seconds indicates the presence of carbon (IV) oxide. The quantity of CO_2 was calculated as *volume of sample,*

$$CO_2\,(mg\ l) = \frac{NaCO_3\ XNX\ 22\ X\ 100}{\text{Volume of sample}}$$

Results and Discussion

The average temperature of the three sampling periods for the five samples collected from these locations (Jindal Chowk, Red Square Market, Grain Marke, Milgate and Gangwa) confirm with World Health Organization standard which range from 20-32^{0}C (Table1). The average colour of the water for the five samples for the period (June, July and August) were 6.6, 6.0, 6.2, 6.0 and 5.0 Hazen units for Jindal Chowk, Red Square Market, Grain Market, Milgate and Gangwa respectively. The pH values of the samples show that rain water from the four industrial locations showed slight acidity. Comparatively, the pH of the sample from Gagwa fell within the range. This shows that it is possible to have acidic rain in these locations and thus suggestive of immediate corrective actions. Particularly for the month of June 2013, this for the year under consideration marked the onset of the rainy season after a spell of dryness. The first flush of rain water that occurs at the beginning of rains usually contains a high proportion of the pollutant load. The main cause of this phenomenon is the deposition and accumulation of pollutant during dry periods. As noted by Muhammad and Han (2000), the longer the dry period, the greater the probabilities of higher pollutant load in the first rain. However, this was probably due to the fact that most of the accumulated pollutants must have been washed down back to the surface as a result of frequent rainfall occurring in the period. The average pH value for all the period (June, July and August) for the whole sample fell within range of WHO standard for drinking water. Turbidity is a measure of the cloudiness of water. It is used to indicate water quality.

Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria and dissolved chemicals. The mean hardness of the five samples was 23.0, 21.3, 22.0, 15.1 and 14.3 mg/l respectively. This fell below the WHO standard which ranges between (100-300 mg/l). It was observe that the calcium available in the rainwater was below the W.H.O standard for drinking which is (20-200mg/l). Although, it has no side effect medically, the calcium should be increased to fall within the WHO standard for drinking water. The average total acidity of the samples was 18.3, 20.7, 17.3, and 10.7 respectively, for the four locations. The values confirm to the WHO standard. For the month of June (2013) all the locations showed high level of CO_2 in the rain water. Although this is still within the WHO upper limit, it however showed that there were appreciable emissions of this gas. Carbon (IV) oxide is a colourless, odourless, and poisonous gas. It is produced in large amount when the carbon in fuel is burnt incompletely. This could be traced to the use of electricity generators to provide power for the industries, beside the ones coming from the automobiles in the environment. If carbon (ii) oxide if inhaled, it competes with oxygen for the haemoglobin in the blood and thus causing a reduction in the amount of oxygen that is carried to the body.

Table 1: Physio- Chemical Properties of Rainwater Samples Collected from Different Sites

S/N	Parameters	**Jindal Chowk** June July Aug.			**Red Square Markt** June July Aug.			**Grain market** June July Aug.			**Milgate** June July Aug.			**Gangwa** June July Aug.			****WHO** Standard
1	Temperature (ºC)	24	25	24	23	25	25	23	25	24	25	25	24	25	25	25	20 – 32
2	Colour (Hazen unit)	7	6	7	6	5	7	6	6	6	6	7	5	5	5	5	5-35
3	Turbidity (*NTU)	0.25	0.15	0.16	0.18	0.16	0.15	0.17	0.15	0.16	0.18	0.15	0.16	0.17	0.15	0.16	0.25
4	pH value	6.3	6.5	7.1	6.2	6.8	6.9	6.3	6.5	7.2	6.2	6.7	7.1	6.9	7.3	7.1	6.5-9.5
5	Total Acidity (mg/l)	18	22	25	17	23	24	18	22	26	17	24	25	24	26	24	47-146
6	Nitrite (mg/l)	34	38	40	36	40	38	34	38	40	32	38	40	20	40	38	50
7	Residual chlorine (mg/l)	0.1	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1-0.5
8	Chloride (mg/l)	16	12	14	12	14	12	15	13	12	14	12	12	10	12	10	200-300
9	Calcium Hardness (mg/l)	18	16	10	18	12	12	20	12	12	12	10	12	10	14	10	20-200
10	Mg Hardness (mg/l)	60	62	65	62	64	64	68	62	64	60	64	66	60	62	60	80-100
11	T. Hardness (mg/l)	25	23	21	25	22	17	26	22	18	20	13	12	18	12	13	100-300
12	T. Alkalinity (mg/l)	34	20	26	36	22	25	28	22	26	20	18	19	22	26	28	30-50
13	Free CO_2 (mg/l)	46	34	12	44	42	14	24	18	16	28	22	24	24	16	16	6-60

*Nephelometric Turbidity Units. ** World Health Organization (Rain water Standard)

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