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Studies on ground water pollution in industrial areas of Chennai

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ABSTRACT:

In the present study an attempt has been made to evaluate the physicochemical parameters of ground water samples collected from 10 selected locations of five different industrial areas of Chennai. Physico-chemical parameters such as DO, Salinity, Alkalinity, pH, Calcium, Magnesium, Hardness, Iron Nitrite, Phosphate, Silica and Chloride were estimated following the procedures of NEERI. Highest nitrate level of (0.15mg/L) was observed at Guindy Industrial Estate, whereas the lowest level (0.02mg/L) was noticed at Avadi Industrial area. Silica content was found to be highest (66.67mg/L) at Ambatthur Industrial Estate and the lowest level (12.29mg/L) was observed at Guindy Industrial Estate. Highest iron content (0.59mg/L) was recorded at Ambatthur Industrial Estate and the lowest level (0.13mg/L) was noticed at Pallavaram Industrial area. Chloride level was highest (861mg/L) at Ambatthur Industrial area and the lowest level (223mg/L) was noticed at Pallavaram Industrial area. The results are discussed in the light of available literature.

Keywords:
Physicochemical parameters, Ground water pollution, Permissible limit, Industrial area.

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INTRODUCTION

Water is extremely essential for the survival of all living organisms. Ground water is the ultimate and most suitable fresh water resource for human consumption in both urban as well as rural areas. The importance of ground water for existence of human society cannot be overemphasized. Increasing population and its necessities have led to the deterioration of surface and sub-surface water (Dhiviyaa Pranavam *et al.,* 2011). There are several states in India where more than 90% populations are dependent on groundwater for drinking and other purpose (Ramachandraiah, 2004). Ground water is also frequently used as alternative source for agricultural and industrial sector.

The ground water pollution is caused by the bleaching of industrial waste into the aquifers. Water being a universal solvent, contains materials such as bicarbonates, chlorides, sulphate, calcium, potassium and sodium in ionized or dissolved forms, nitrite and iron are also present in small amounts. Good quality drinking water can be consumed in any desired amount without any adverse effect on health and also free from impurities is declared as potable. Improper use of water resources is causing catastrophic effects (Kumar, 2004). The most common problem in ground water is attributed to hardness, iron, sulphate, sodium chloride and acidity (Ranjana, 2009).

Ground water has been contaminated by various ways, for e.g. application of chemical fertilizers in agriculture field (Altman & Parizek, 1995), seepage from effluent bearing water body (Adekunle, 2009). Most of the industries discharge their effluent without proper treatment into nearby open pits or pass them through unlined channels, resulting in the contamination of ground water (Jinwal and Dixit, 2008). The incidence of ground water pollution is highest in urban areas where large volumes of waste are concentrated and discharge into relatively small areas (Rao & Mamatha, 2004). The present study was conducted to evaluate the physico chemical properties of ground water in the industrial areas of Chennai.

MATERIALS AND METHODS

Ground water samples were collected during March 2008 from 10 selected locations of five different industrial areas of Chennai namely, Guindy, Pallavaram, Ambatthur, Avadi and Manali. Samples were collected in one litre polythene sterilized bottles without any air bubbles and transported to laboratory immediately for analysis.

The following Physico-Chemical parameters, pH, Chlorides, Sodium, Calcium, Magnesium, Phosphates, Nitrites, Iron, Silica, Chloride, Hardness, Dissolved Oxygen, Salinity, Alkalinity and Turbidity were estimated by following procedure suggested by NEERI and compared with standards of the World Health Organization (WHO) and the Bureau of Indian Standards (BIS) (Table.1).

RESULTS

The results showed that the pH varied from 6.0 to 7.5 (Fig.1). Magnesium hardness varied between 30 and 75mg/L whereas calcium hardness ranges from 100 to 246mg/L as showed in Fig.2 & Fig. 3 Dissolved oxygen (DO) content ranges from 0.6 to 1.8mg/L (Fig.4).

Salinity levels were ranged between 0.3 and 1.6mg/L (Fig.5). Alkalinity was ranging from 260 to 776mg/L (Fig.6). Phosphate levels were varied from 0.10 to 0.14mg/L (Fig.7).

Nitrite levels were varied from 0.02 to 0.15mg/L. Highest nitrite level was observed at Guindy Industrial Estate (0.15mg/L) whereas the lowest level was noticed at Avadi Industrial area 0.02mg/L (Fig.8). The highest iron content (0.59mg/L) was recorded at Ambatthur Industrial Estate and the lowest level (0.13mg/L) was observed at Pallavaram Industrial area (Fig.9).

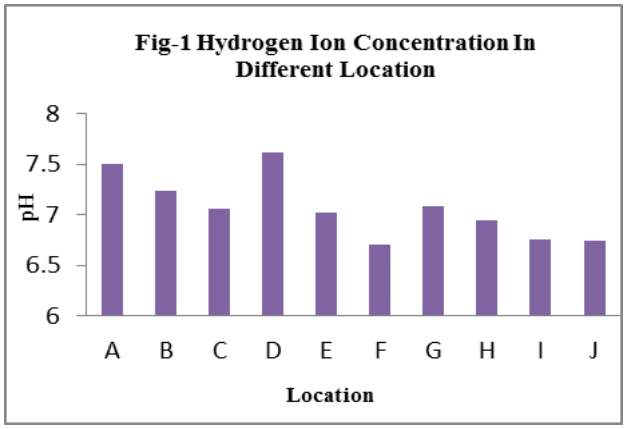


Fig-1 Hydrogen Ion Concentration In Different Location
pH
8
7.5
7
6.5
6
A B C D E F G H I J
Location

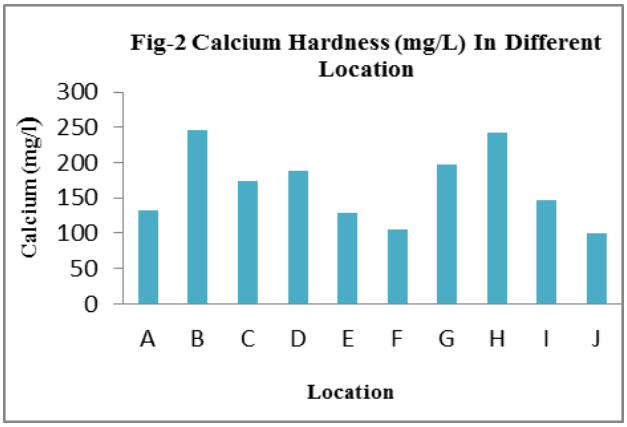


Fig-2 Calcium Hardness (mg/L) In Different Location
Calcium (mg/l)
300
250
200
150
100
50
0
A B C D E F G H I J
Location

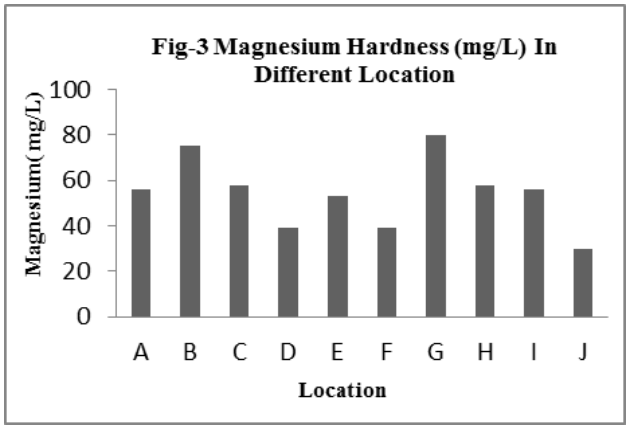


Fig-3 Magnesium Hardness (mg/L) In Different Location
Magnesium(mg/L)
100
80
60
40
20
0
A B C D E F G H I J
Location

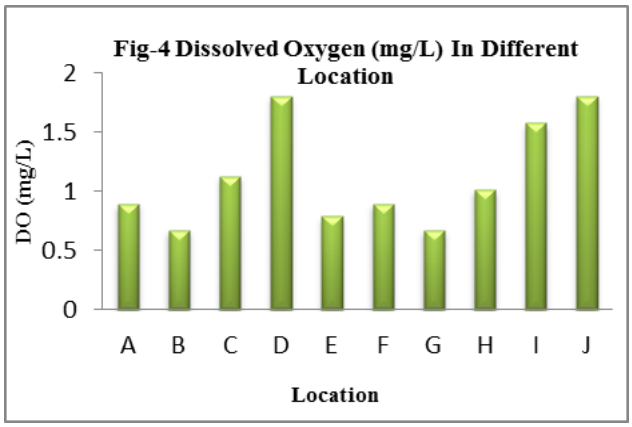


Fig-4 Dissolved Oxygen (mg/L) In Different Location
DO (mg/L)
2
1.5
1
0.5
0
A B C D E F G H I J
Location

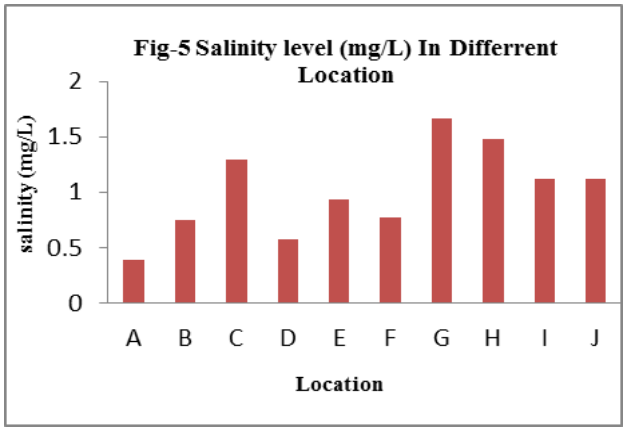


Fig-5 Salinity level (mg/L) In Differrent Location
salinity (mg/L)
2
1.5
1
0.5
0
A B C D E F G H I J
Location

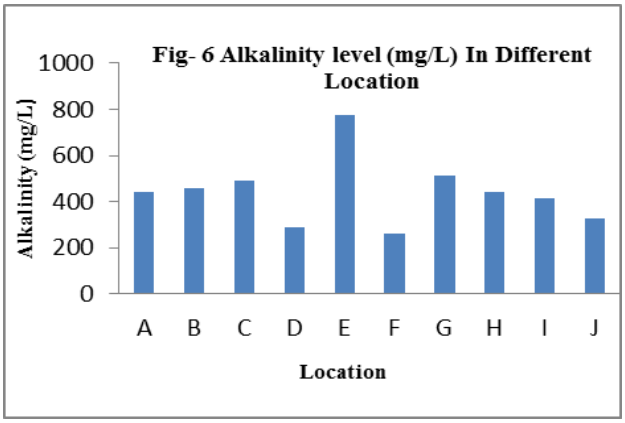


Fig- 6 Alkalinity level (mg/L) In Different Location
Alkalinity (mg/L)
1000
800
600
400
200
0
A B C D E F G H I J
Location

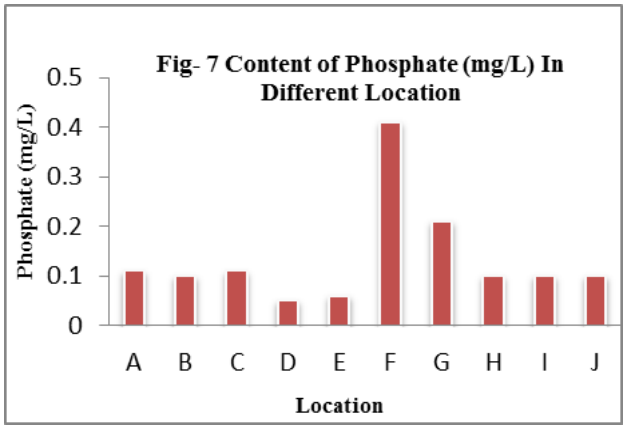


Fig- 7 Content of Phosphate (mg/L) In Different Location
Phosphate (mg/L)
0.5
0.4
0.3
0.2
0.1
0
A B C D E F G H I J
Location

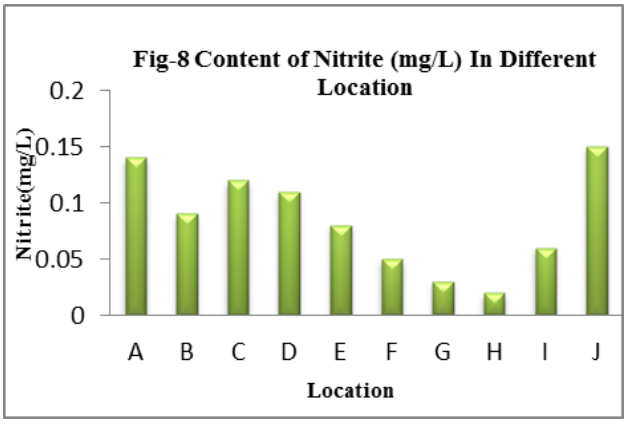
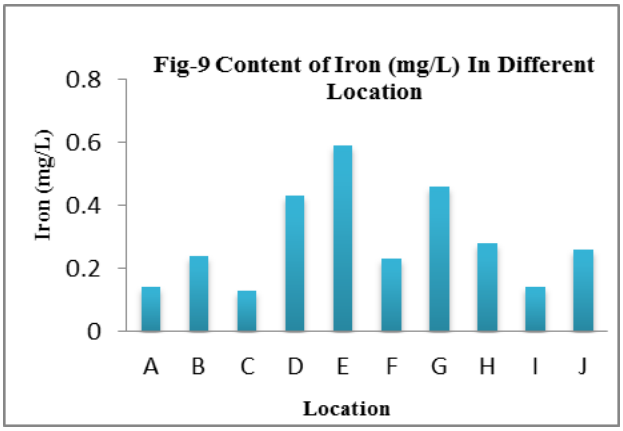
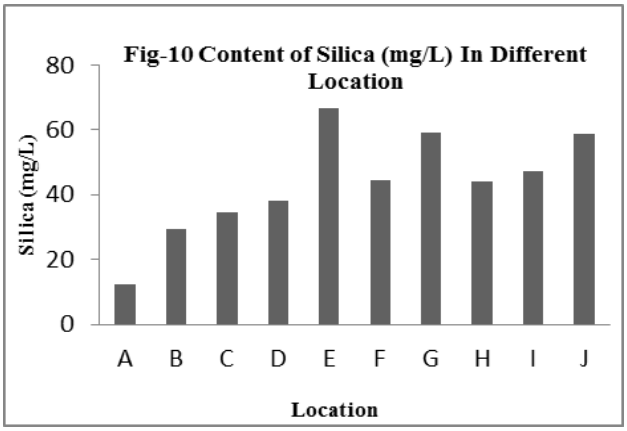
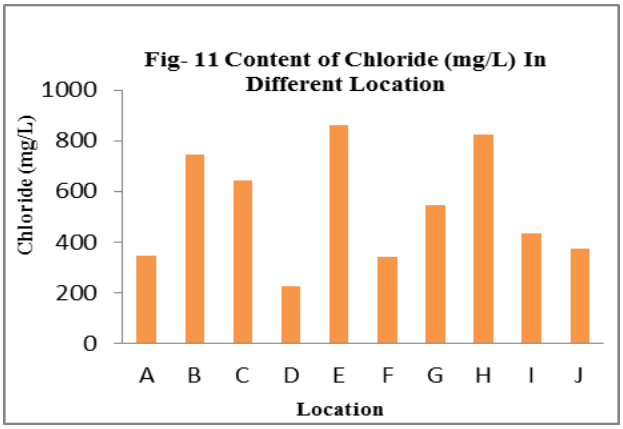


Fig-8 Content of Nitrite (mg/L) In Different Location
Nitrite(mg/L)
0.2
0.15
0.1
0.05
0
A B C D E F G H I J
Location







A-M.K.N. Road, Chennai-32, B-Thiru.Vi.Ka Industrial Estate, Chennai-32, C-Kannapiran Kovil Street, Chennai-43, D-Narayana Samy Pillai Street, Chennai-43, E-Pillaiyar Kovil Street, Chennai-50, F-M.T.H. Road, Chennai-50, G-Periyar Street, Chennai-54, H-Jothiraman Street, Chennai-54, I-Thillaipuram First Cross Street, Manali, Chennai-68, J-Thillaipuram First Street, Manali, Chennai-68

Silica levels were ranged between 12.29 and 66.67mg/L highest silica content (66.67mg/L) was noticed at Ambatthur Industrial Estate and the lowest level (12.29mg/L) was observed at Guindy Industrial Estate (Fig.10). In the present analysis, chloride content ranges from 223 to 861mg/L highest chloride content was found to be at Ambatthur Industrial Estate (861mg/L) and lowest chloride content (223mg/L) was recorded at Pallavaram industrial area (Fig.11).

DISCUSSION

In the present Study an attempt has been made to study the Physico-Chemical parameters of ground water from 10 different locations of five selected industrial areas in Chennai city. The physical parameters were analyzed for appearance, odour, and turbidity levels were within the limits prescribed by WHO and BIS. Water samples were colorless, clear and odourless indicating the absence of colloidal substances, suspended and decomposed vegetation. Chemical properties of water were analyzed for pH, Dissolved Oxygen, salinity, alkalinity, magnesium, calcium, phosphate, iron, silica and chloride.

pH is a term used universally to express the intensity of the acidic or alkaline condition of a solution. In this study the pH levels were found within the limits set for domestic use as prescribed by WHO and Indian standards. Most of the waters are slightly alkaline due to the presence of carbonates and bicarbonates, the range less than or more than the permissible level is hazardous (Ravisankar & Poongothai, 2008).

In the present investigation, the magnesium hardness values are found within the permissible norms whereas the calcium hardness values found more than the permissible limit of WHO and Indian Standards. Magnesium hardness shows minimum 30mg/L and maximum of 75mg/L, while calcium hardness shows minimum 100mg/L and a maximum 246mg/L. Hardness is defined as the sum of the polyvalent cations present in the water, notably calcium and magnesium. According to Dufor and Beckers, 1964 water with more than 180mg/L hardness is very hard. Excessive hardness may cause

Table1: Drinking Water Standards

	WHO STANDARDS		INDIAN STANDARDS	
PHYSICAL PARAMETERS	**Permissible**	**Excessive**	**Permissible**	**Excessive**
Colour	CLEAR	CLEAR	CLEAR	CLEAR
Turbidity (NTU)	5	25	10	25
Odour	Unobjectionable		Unobjectionable	
CHEMICAL PARAMETERS				
pH Ranges	7	8.5	6.5	8.5
Dissolved Oxygen (mg/L)	0.3	1.1	-	-
Salinity (mg/L)	0	5	0	5
Alkalinity (mg/L)	45	200	Not Perscribed	
Ca Hardness (mg/L)	20	75	20	75
Mg Hardness (mg/L)	30	100	30	100
Po_4	0.1	-	-	-
Nitrite (mg/L)	0.5	1	Not Perscribed	
Iron (mg/L)	0.3	1	0.05	1.5
Silica (mg/L)	0	60	Not Perscribed	
Chloride (mg/L)	200	600	250	1000

health hazards like kidney stones and other ailments (Jain *et al.,* 1999).

Dissolved oxygen (DO), a vital parameter in the stability of their aquatic eco-system, was found within the prescribed norms of 0.6 to 1.8mg/L. It depends on physical chemical, biochemical and microbial factors. In general unpolluted water has dissolved oxygen level of 3 mg/L. Water depleted in oxygen provides shelter for anaerobic bacteria which is injurious to human health (Karnath, 1987). The range of salinity is within the permissible limit of WHO. Highest amount of salinity is recorded in Avadi industrial area whereas lowest amount of salinity was observed in Guindy Industrial area. Salinity in general depends on four major cations namely, calcium, magnesium, sodium, potassium and major anions like bicarbonates, chlorides, carbonates and phosphates Wetzel, (1983) reported that the concentration of sodium and chloride predominate in concentration which contribute to salinity.

Alkalinity of samples ranges between 260 and 776 mg/L which are above the normal limit prescribed by WHO indicates that water from all locations are very hard. Vass *et al.,* (1977) reported that total alkalinity value of 60mg/L or more indicates hard water. Alkalinity of water depends on concentration of hydroxides. Hydroxides are generally absent in natural waters however their concentration may increase in the polluted water. The water for domestic use having alkalinity less than 100mg/L is safe (Saravanakumar and Ranjith Kumar, 2011).

Important sources of phosphate depend on geochemical conditions, surface runoff from surrounding field and cattle dung. The high concentration of phosphate give rise to an algal bloom and it also brings eutrophication (Pulle and Khan, 2003). Concentration of phosphate in the samples ranges from 0.05 to 0.4mg/L. A fairly high amount of phosphate is found in Ambatthur industrial Estate and low in Pallavaram industrial area.

Phosphate content may increase when contamination with sewage occurs. In general high amount of phosphate that occurs in natural waters is usually harmful to human health (Ellis *et al.,* 1948).

Concentration of nitrate varies from 0.02 to 0.15mg/L and found to be within the permissible limit of WHO. Highest level of nitrite was found in Manali industrial area and the lowest level was observed in Avadi industrial area. It may be due to agricultural runoff from field (Wagh *et al.,* 2009). High nitrate concentration in water bodies lead to organic pollution that causes blue baby syndrome or cyanosis and methemologlobinemia in infants (Young *et al.,* 1976; Vigil *et al.,* 1965, Karunakaran *et al.,* 2009) and development of cancer in adults (Gass, 1978, Udayalaxmi *et al.,* 2010).

Iron occurs in both soluble and insoluble form in water. It is present as ferric hydroxide in concentration renders water turbid and cause light yellowish brown color to water. Concentration more than 1 to 2mg/L is generally held as an indication of the state of pollution. In the present analysis iron content varies from 0.13mg/L to 0.59mg/L which was found to be within the permissible limit of WHO and Indian standards. In general surface water contains less than 0.5mg/L of iron whereas the concentration perhaps increases in the ground water due to low cost iron pipes in bore wells laid some decades ago could have been rusted. The rusted iron piece peels off and retained in particulate and colonial form in drinking water. Further holes that develop in rusted pipes pave the way for mixing up of the sewage water (Karunakaran *et al.,* 2009).

Silica of water samples lies in the range from 12.29 to 66.67mg/L. Sample has moderately high values of silica and exceeds the permissible limit proposed by BIS and WHO. Silica released as a result of chemical breakdown of silicate minerals in rocks and sediments by chemical weathering is acquired by circulating groundwater and therefore the source of silica (SiO_2) in groundwater is almost exclusively and unequivocally a result of water – rock interaction (Hem, 1985, Ali Khan and Umar 2010). Concentration of SiO_2 in ground water varies from 60 to 100mg/L is very rare. Higher concentrations of silica are found in alkaline waters as also in some acidic waters (Suerdrup *et al.,* 1961).

Relatively high concentration of chloride content is observed in the collected groundwater samples. The amount of chloride ranges from 223 to 861mg/L all the values were found to be slightly higher than the permissible limits of WHO. High chloride concentration gives an undesirable taste to water and cause many harmful effects in human beings (Suresh *et al.,* 1992).

CONCLUSION

The physico-chemical parameters of groundwater from industrial areas of Chennai showed that the pH, mg hardness, salinity, phosphate, nitrate, Iron and chloride were within the permissible norms while some of the parameters like calcium hardness; alkalinity and silica have the values more than the permissible limit as per WHO and BIS norms for drinking purposes in the studied area. The findings of the present work are also recommended ground water is suitable for irrigation and domestic use. Some of locations in the study area are unfit for drinking as well as other domestic purpose.

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