[Chahar, 5(4): April 2018]
ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

STUDY OF CHEMICAL PROPERTIES OF GROUND WATER AND ANALYZING THE CHARACTERISTICS OF POTABLE GROUND WATER USING PIPER DIAGRAMS

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ABSTRACT

The availability and chemical quality of groundwater are closely related to precipitation. As a general rule, the least mineralized water, both in streams and underground, occurs in areas of greater amount of rainfall. As inland, precipitation decreases, water supplies diminish, and the quality deteriorates. The composition of water bearing rocks may override the role of precipitation. In India, out of total water balance, 70% are used for agriculture, 25% by industries and remaining 5% are used for drinking purposes. The demand for country's water supply at present is 30 cubic km. This would increase to 52 cubic km in 2025. The demand is not only due to population but also due to improvement in living standards. The use of water resources due to the development of industries, power, engineering, transport, urbanization, intensification of agriculture exert grater qualitative and quantitative impacts on the hydro geological regimes of inland waters.

Keeping in view all the above factors are systematic study was conducted to evaluate the stability of groundwater of different areas. In the studies localities ground water was free from color and odour. The taste was slightly to moderately brackish in most of the private installations whereas the water was non saline in case of deep installation.

Keywords: *Ground water, pH, piper diagram, contamination, etc.*

I. INTRODUCTION

Safe drinking water is crucial to humans and other life forms. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe drinking water and over 2.5 billion lack accesses to adequate sanitation. There is a clear and direct correlation between access to safe potable water and GDP per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing safe water-based vulnerability. A report published in November 2009 suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50 percent. Water plays a significant role in the world economy, as it functions as a solvent for a wide diversity of chemical substances and facilitates industrial cooling and transportation. Approximately 70 percent of the fresh water used by humans goes to agriculture.

Ground Water

Groundwater is water located beneath the earth's surface in soil pores and in the fractures of rock formations. A unit or a part of rock or an unconsolidated deposit is called an aquifer when it can yield a functional quantity of water. The depth at which soil pores or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology.

Overview of Ground water

Certain problems have beset the use of groundwater around the world. Just as river waters have been over-used and polluted in many parts of the world, so too have aquifers. The big difference is that aquifers are out of sight. The other major problem is that water management agencies have often counted the same water twice, once in the aquifer, and once in its connected river.

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As water moves through the landscape it collects soluble salts, mainly sodium chloride. Where such water enters the atmosphere through evapotranspiration, these salts are left behind. In irrigation districts, poor drainage of soils and surface aquifers can result in water tables coming to the surface in low-lying areas. Major land degradation problems of soil salinity and waterlogging result, combined with increasing levels of salt in surface waters. As a consequence, major damage has occurred to local economies and environments.

Four important effects are worthy of brief mention. First, flood mitigation schemes, intended to protect infrastructure built on floodplains, have had the unintended consequence of reducing aquifer recharge associated with natural flooding. Second, prolonged depletion of groundwater in extensive aquifers can result in land subsidence, associated with infrastructure damage – as well as (thirdly) saline intrusion. Fourth, draining acid sulphate soils, often found in low-lying coastal plains, can result in acidification and pollution of formerly freshwater and estuarine streams.

Another reason for concern is that groundwater drawdown from over-allocated aquifers has the prospective to cause severe damage to both terrestrial and aquatic ecosystems – in some cases very conspicuously but in others quite imperceptibly because of the extended period over which the damage occurs.

Overuse of Ground water

Groundwater is a highly useful and often abundant resource. However, over-use, or overdraft, can cause major problems to human and to the environment. The most evident problem is a lowering of the water table beyond the reach of existing wells. Wells must consequently be deepened to reach the groundwater; in some of the reasons the water table has dropped hundreds of feet because of extensive well pumping. In the Punjab region of India, for example, groundwater levels have dropped 10 meters since 1979, and the rate of depletion is accelerating. A lowered water table may cause other problems such as groundwater-related subsidence and saltwater intrusion.

Pollution of Ground Water

Pollution of groundwater, from pollutants released to the ground that can work their way down into groundwater can create a contaminant plume within an aquifer. Movement of groundwater and dispersion within the aquifer spreads the pollutant over larger area which can then intersect with groundwater wells or daylight into surface water such as seeps and springs, making the water supplies unsafe for humans and wildlife.

The stratigraphy of the area plays an vital role in the transport of these pollutants. An area can have deposits of clay, sandy soil, hardpan, or fractured bedrock. Areas of karst topography on limestone bedrock are sometimes vulnerable to surface pollution from groundwater. Earthquake faults can also be served as entry routes for downward contaminant entry. Water table conditions are of great significance for drinking water supplies, agricultural irrigation, waste disposal (including nuclear waste), wildlife habitat, and other ecological issues.

Love Canal was one of the most widely known examples of groundwater pollution. In 1978, residents of the Love Canal neighborhood in upstate New York noticed high rates of cancer and an alarming number of birth defects. This was ultimately traced to organic solvents and dioxins from an industrial landfill that the neighborhood had been built over and around, which had then infiltrated into the water supply and evaporated in basements to further contaminate the air. Eight hundred families were compensated for their homes and moved, after extensive legal battles and media coverage.

Another example of extensive groundwater pollution is in the Ganga's Plain of northern India and Bangladesh where severe contamination of groundwater by naturally arising arsenic affects 25 percent of water wells in the shallower of two regional aquifers. The pollution take place because aquifer sediments comprise organic matter that generates anaerobic conditions in the aquifer. These conditions result in the microbial dissolution of iron oxides in the sediment and thus the release of the arsenic, normally strongly bound to iron oxides, into the water.

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II. METHODOLOGY

This study was divided into two parts:-

- Sample of groundwater from hand pumps and waterworks of different areas of Karnal, Panchkula, Barara and Mullana in such a manner that ground water of whole areas get represented
- Chemical analysis of procured samples analysed water quality parameters include ph, Alkalinity(Co3, Hco3), Sulphate content, Chloride content, Co2 acidity, T.D.S, values of Sodium (Na), Potassium (K), Calcium (Ca), Magnisium (Mg).

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Sample collection

Sr no.	Sample no.	Place of Sample	Depth
1	A	Hand Pump (Barara)	80 ft
2	B	Tube Well (Karnal)	200 ft
3	C	Submersible (Karnal)	190 ft
4	D	Bore Well (MCD,Panchkula)	350 ft
5	E	Tube Well (MMU, Mullana)	80 ft

Samples were collected in cleaned, sterilized, polyethylene bottles of 1 litre capacity. It was ensured every time that bottle satisfies the following requirements:

- Free from contamination
- Resistant to any internal pressure
- Don't affect water characteristics.

While sampling, all the precautions were taken APHA(1989) and NEERI manual of water analysis. The sample were kept in ice box and brought to lab within 5 hrs of sampling and were refrigerated to avoid any change in chemical properties due to various contaminations.

III. RESULTS AND DISCUSSION

Following results were obtained after conducting various experiments on the samples available for testing. Standard test procedures were followed and results were noted accordingly. These results were then combined, studied and compared as per guidelines for potable drinking water.

pH (Hydrogen ion Activity)

Sr no.	Sample No.	pH	Temperature(°C)
1	A	7.2	31.2
2	B	8.1	32.5
3	C	8.6	33
4	D	8.1	29
5	E	7.8	30.8

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a) **Chloride content (Cl^-)**

Sr no.	Sample no.	Chloride Content (mg\l)
1	A	8
2	B	12
3	C	4
4	D	32
5	E	8

b) **Sulphate content (SO_4^{2-})**

Sr no.	Sample no.	Sulphate Content (mg/l)
1	A	0.576
2	B	0.576
3	C	0.247
4	D	0.164
5	E	0.494

c) **Acidity**

Sr no.	Sample no.	CO_2 Acidity
1	A	2.08
2	B	1.28
3	C	0.80
4	D	1.60
5	E	0.56

d) **Total Alkalinity**

Phenolphthalein alkalinity (P)

Sr no.	Sample no.	mg/l
1	A	0.16
2	B	0.08
3	C	0.08
4	D	0.08
5	E	0.08

Methyl orange alkalinity (M)

Sr no.	Sample no.	mg/l
1	A	0.48
2	B	0..88
3	C	0.56
4	D	0.56
5	E	0.48

Carbonates and Bicarbonates

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S. No.	Sample no.	Hydroxide Alkalinity as CaCo3	Carbonate Alkalinity 2P (mg/l)	Bicarbonate Alkalinity T-2P (mg/l)
1	A	0	0.32	0.16
2	B	0	0.16	0.72
3	C	0	0.16	0.40
4	D	0	0.16	0.40
5	E	0	0.16	0.32

e) Total Dissolved Solids (T.D.S.)

Sr no.	Sample no.	Total Solids (mg/l)	Suspended Solids (mg/l)	T.D.S (mg/l)
1	A	0.6	0.6	0.0
2	B	1.8	0.2	1.6
3	C	0.8	0.6	0.2
4	D	0.4	0.2	0.2
5	E	0.2	0.2	0.0

Piper Diagram

A **piper diagram** is a graphical representation of the chemistry of a water sample or samples.

The cations and anions are shown by separate ternary plots. The apexes of the cation plot are magnesium, calcium and sodium plus potassium cations. The apexes of the anion plot are chloride, sulphate and carbonate plus hydrogen carbonate anions. The two ternary plots are then projected onto a diamond. The diamond is a matrix transformation of a graph of the anions (sulphate + chloride/ total anions) and cations (sodium + potassium/total cations).

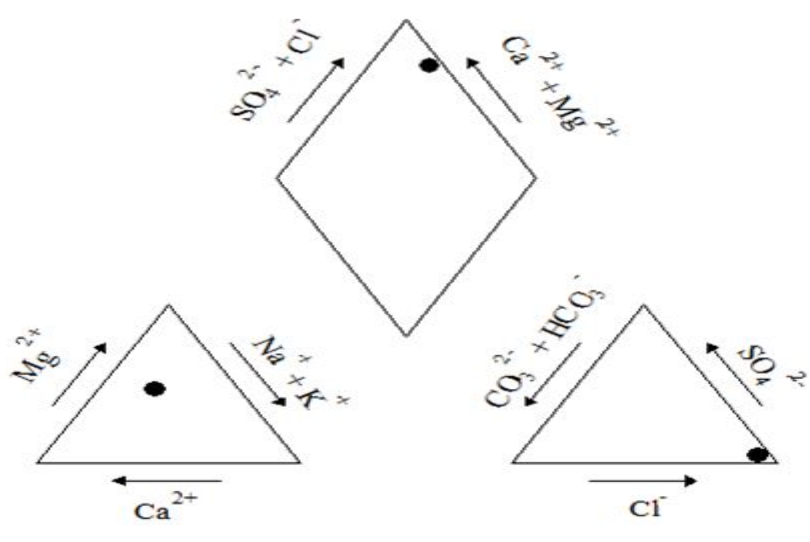

Fig.1 Sample-A (Hand pump Barara, 80ft)

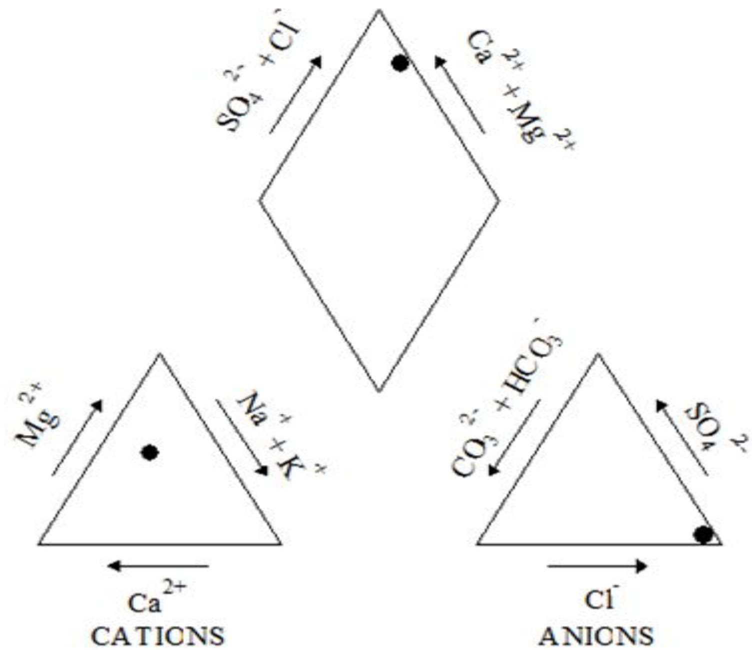

Fig.2 Sample-B (Tube well Karnal, 200ft)

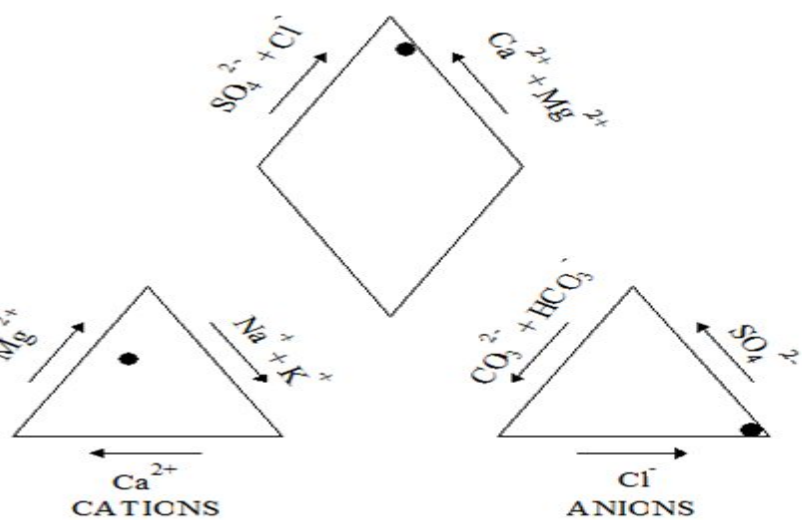

Fig.3 Sample-C (Submersible Karnal, 190ft)

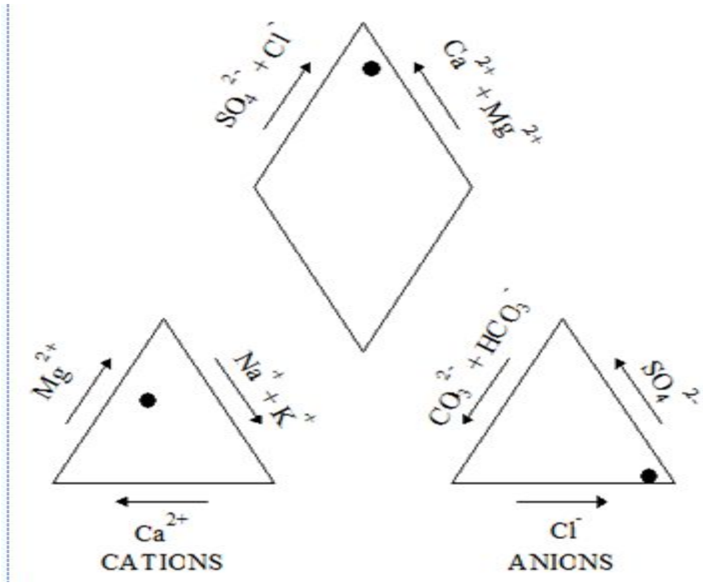

Fig.4 Sample-D (Bore well Panchkula M.D.C, 350ft)

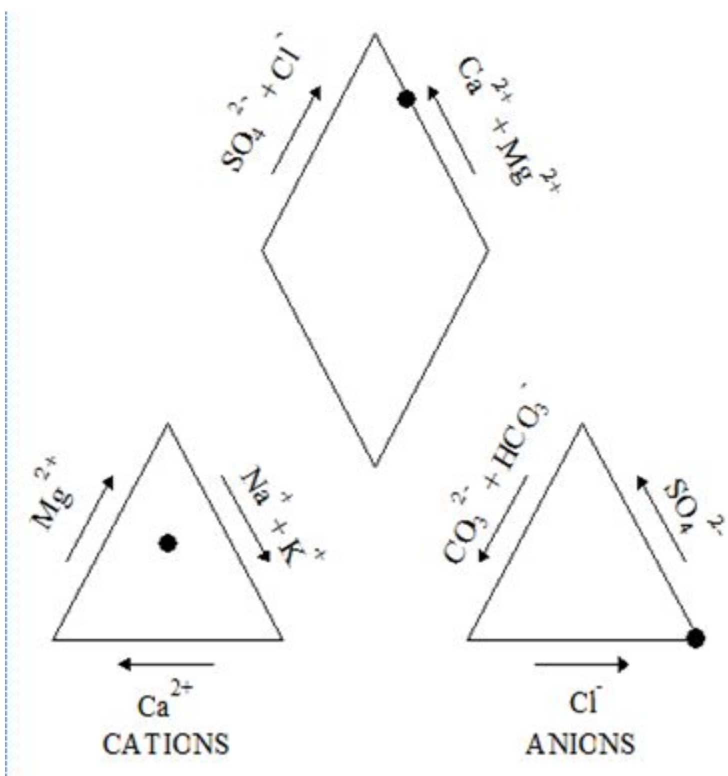

Fig.5 Sample-E (Tube well MMU, Mullana, 80ft)

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IV. CONCLUSION

On the basis of the analytical findings following conclusions can be drawn for the study area:

a) In the present study, the pH value of most of the water samples are within the permissible limit. The pH value ranges from neutral to alkaline range. The pH value varies between 7.2 to a highest of 8.6 at a given temperature.
b) The value of chloride content in the given ground water samples is far less than the permissible limit, as the concentration of chloride content in the ground water depends on the geological formation of that given study area.
c) In the present study of ground water samples, the value of sulphate content and Total dissolved solids (TDS) is also found within the permissible limit.
d) Since, the ground water is free from the presence of atmospheric CO2, thus the value of CO2 acidity and mineral acidity is very less which indicat that the given ground water samples are fit for human consumptions, agricultural and industrial uses.
e) The given samples of ground water having carbonate and bicarbonate alkalinity due to the presence of carbonates and bicarbonates, which may impart hardness in the given ground water samples.

Interpretation of hydrochemical analysis reveals that the ground water samples collected from different nearby areas is fit for human consumption, agricultural use and industrial use. The given ground water sample are fresh to slightly saline and slightly alkaline in nature. Piper diagram characterizes the water types. The ground water samples collected from Karnal at a depth of 190ft and 200ft was found to be of Ca-Mg-SO4-Cl type but sulphate content is comparatively far less in respect with other parameters, whereas in the ground water sample collected from Panchkula MDC having Ca-Mg-SO4-Cl in equal proportions. But the water samples collected from Barara at a depth of 80ft consist only Ca-Mg type. Principal quality was mainly controlled by geology, agricultural uses and domestic discharges. Almost all the parameters like pH, Na+, K+, Ca2+, Mg2+, SO42-, CO3-, HCO3- and Cl- are within the permissible limits prescribed by prescribed by ISI, ICMR, WHO.

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