International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Ground Water Pollution in Sangli-Miraj-Kupwad Corporation Industrial Area – Remedial Treatment, Prevention and Management

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Accepted 30 Sept 2015, Available online 10 Oct 2015, **Vol.5, No.5 (Oct 2015)**

Abstract

The study of physico-chemical characteristics of ground water (bore well and dug well) in region near Sangli Miraj Kupwad, MIDC is to be done, to know its suitability for domestic use and irrigation. Water samples were collected from different sites covering borderline area of MIDC and neighboring village downstream to it. These samples were analyzed for various parameters such as pH, EC, TDS, total hardness, chlorides, sulphate, nitrate and BOD, COD, Cu, Zn, Fe, Cd, Hg, Pb, As using standard method. The values of parameter are out of the highest desirable limit or exceeded the permissible limit. This is because of industrial effluent, which is percolated through ground as well as mixed with water stream causing deterioration of water resources. The analyze of sample collected for the physical chemical and biological parameter to be check with respect to WHO Standard and BIS Standards for use of Potable purpose and industrial purpose. The relative result will gives us the idea of pollutants identity, quantity, Quality, and concentration in the ground water source. The source of pollution and the remedial measure to be followed for use this water were suggested in this paper. The prevention technics and manegment technics also elabriated in this paper.

Keywords: *Effluent, Ground water, MIDC, Mnagement, Physico-chemical parameters, Prevention, Quality, Remedial measures*

1. Introduction

Water is essential for the survival of any form of life. On an average, human being consume about 135 liter of water per day. The demand of water has been growing day by day due to exploding population and industrialization. In recent years an increasing threat to ground water quality due to human activity has become of great importance. The adverse effect of ground water quality is due to excessive use of fertilizer in agriculture practices, domestic, and industrial effluents, disposal of sewage and industrial wastes on surface water. The quality of ground water is resultant of all the reactions and processes that have acted on the water from the moment it condensed in atmosphere to the time of discharge by a well.

Therefore quality of ground water varies from place to place, with the depth of water table and from season to season. A vast majority of ground water quality problems are caused by contamination, over-exploitation or combination of the two. Most ground water quality problems are difficult to detect and hard to resolve. Ground water quality is slowly but surely declining everywhere. The wide range of contamination sources is one of the many factors contributing to the complexity of ground water assessment.

1.2 Pollutant Types

Contaminants found in groundwater cover a broad range of physical, inorganic chemical, organic chemical, bacteriological, and radioactive parameters.

Pathogens Patogens enters into ground water via human or animal feces,causes cholera, diarrheaetc.

Nitrate : Nitrate pollution in groundwater from pit latrines, excessive use of fertilizers, including manure, Nitrate levels above 10 mg/L (10 ppm) in groundwater can cause "blue baby syndrome"

Volatile organic compounds Volatile organic compounds (VOCs) are introduced to the environment through careless industrial practices. Many of these compounds were not known to be harmful until the late 1960s and it was some time before regular testing of groundwater identified these substances in drinking water sources.

Others: Organic pollutants can also be found in groundwater, such as insecticides and herbicides, a range of organohalides and other chemical compounds, petroleum hydrocarbons, various chemical compounds found in personal hygiene and cosmetic products, drug pollution involving pharmaceutical drugs and their

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metabolites. Inorganic pollutans might include ammonia, nitrate, phosphate, heavy metals or radio nuclides.

1.3 Naturally Occurring Pollutant

Arsenic

In the Ganges Plain of northern India and Bangladesh severe contamination of groundwater by naturally occurring arsenic affects 25% of water wells in the shallower of two regional aquifers. The pollution occurs because aquifer sediments contain 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. As a consequence, arsenic-rich groundwater is often iron-rich, although secondary processes often obscure the association of dissolved arsenic and dissolved iron.

Fluoride: In areas that have naturally occurring high levels of fluoride in groundwater which is used for drinking water, both dental and skeletal fluorosis can be prevalent and severe.

1.4 Causes

Landfill leachate: Leachate from sanitary landfills can lead to groundwater pollution.

On-site sanitation systems: A traditional housing a shallow water supply well is in close proximity to the pit latrine leading to contamination of the groundwater.

Groundwater pollution with pathogens and nitrate can also occur from the liquids infiltrating into the ground from on-site sanitation systems such as pit latrines and septic tanks, depending on the population density and the hydro geological conditions.

Liquids leach from the pit and pass the unsaturated soil zone (which is not completely filled with water). Subsequently, these liquids from the pit enter the groundwater where they may lead to groundwater pollution. This is a problem if a nearby water well is used to supply groundwater for drinking water purposes. During the passage in the soil, pathogens can die off or be adsorbed significantly, mostly depending on the travel time between the pit and the well. Most, but not all pathogens die within 50 days of travel through the subsurface.

The degree of pathogen removal strongly varies with soil type, aquifer type, distance and other environmental factors. For this reason, it is difficult to estimate the safe distance between a pit latrine or a septic tank and a water source. In any case, such recommendations about the safe distance are mostly ignored by those building pit latrines. In addition, household plots are of a limited size and therefore pit latrines are often built much closer to groundwater wells than what can be regarded as safe. This results in groundwater pollution and household members falling sick when using this groundwater as a source of drinking water.

Sewage treatment plants : The treated effluent from sewage treatment plants may also reach the aquifer if the effluent is infiltrated or discharged to local surface water bodies. Therefore, those substances that are not removed in conventional sewage treatment plants may reach the groundwater as well.

Others: Groundwater pollution can also occur from leaking sewers. Further sources are over application of fertilizer or pesticides, spills from industrial operations and infiltration from urban runoff.

1.5 Mechanisms

The passage of water through the subsurface can provide a reliable natural barrier to contamination but it only works under favorable conditions. The stratigraphy of the area plays an important role in the transport of pollutants. An area can have layers of sandy soil, fractured bedrock, clay, or hardpan. Areas of karst topography on limestone bedrock are sometimes vulnerable to surface pollution from groundwater. Earthquake faults can also be entry routes for downward contaminant entry. Water table conditions are of great importance for drinking water supplies, agricultural irrigation, waste disposal (including nuclear waste), wildlife habitat, and other ecological issues.

Interactions with surface water : Although interrelated, surface water and groundwater have often been studied and managed as separate resources. Surface water seeps through the soil and becomes groundwater. Conversely, groundwater can also feed surface water sources. By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. non-point source may be irrelevant. A spill or ongoing release of chemical or radionuclide contaminants into soil (located away from a surface water body) may not create point or non-point source pollution but can contaminate the aquifer below, creating a toxic plume.

2. Materials

pH of water analyzed by Toshcon industries pvt. Ltd hardware pH meter CL 54+ , EC and TDS by Toshcon industries pvt. Ltd hardware Autoranging Conductivity/ TDS meter, COD by Biotechnics India COD reflux, BOD by Narang Scientific Works Pvt. Ldt, Heavy metals detection by Chemito AA 203, Thermofisher Scientific AAS. Chlorides, Sulphate, nitrates, Total Hardness calculated by titration method.

3. Methodology

The sample was collected from Kupwad and Miraj MIDC contaminated Zone at different location , namely as KS1, KS2 KS3 KS4 KS5 KS6 KS7 KS8, and MS1, MS2 MS3 MS4 MS5 MS6 MS7, MS8, Drain1, Drain2, Drain3,Drain4 in sterilize plastic bottles of 1 liter and stored at temperature 40 C in refrigerator.

Table.1 Analysis Result before treatment Charts Kupwad MIDC Ground Water Sample Analysis Result

Sr. No.	Parameter	Normal range	KS1	KS2	KS3	KS4	KS5	KS6	KS7	KS8
1	pH	7 -8.5	7.06	6.75	6.83	6.65	7.12	6.68	7.01	6.82
2	Ele. condutivity mS/cm	<1	1.35	1.59	1.21	4.52	1.39	1.68	1.68	1.53
8	TDS mg/lit	500 mg/lit	880	1050	780	2970	910	1120	1130	1010
4	Chlorides (mg./ lit)	200 mg/lit	187.88	145.34	145.34	670	159.52	187.88	202	258.78
5	Sulphates (mg./ lit)	200 mg/lit	0	588.44	497.91	0	0	0	0	0
6	Nitrates (mg/ lit)	45 mg/lit	9.56	23.83	0.78	4.39	7.52	10.03	7.68	9.408
7	BOD(mg/lit)	30 mg/lit	60	0	0	420	0	240	420	0
8	COD(mg/lit)	250 mg/lit	0	0	0	1600	0	0	200	0
9	Copper (PPM)	0.05 ppm	0.12	0.2	0	0	0.14	0.15	0	0.2
10	Ferrous (mg/L)	01-0.05 ppm	0	0.75	1.04	0	0.8	4.98	0	0.81
11	Zinc (PPM)	5ppm	0	0	0	0	0	0	0	0
12	Cadmium (PPM)	0.01ppm	0	4.8	0	0	0	0	0	0
13	Mercury (PPM)	0.01 mg/lit	0	20.36	0	0	0	91.56	0	0
14	Lead (PPM)	0.1ppm	0	4.45	0	13.04	0	0	0.15	0.57
15	Arsenic (PPM)	0.05 ppm	0.61	0	0.26	0.3	0.26	0.49	0	0.44
16	Total Hardness (mg/L)	200 ppm	550	580	500	2090	600	700	600	650

Table.2 Analysis Result before treatment Charts Miraj MIDC Ground Water Sample Analysis Result

Sr. No.	Parameter	Normal range	MS1	MS2	MS3	MS4	MS5	MS6	MS7	MS8
1	pH	7 -8.5	7.11	6.6	7.74	6.8	6.57	6.73	6.67	7
2	Ele. condutivity mS/cm	<1	0.82	3.85	0.57	1.52	2.9	2	2.29	8.35
8	TDS mg/lit	500 mg/lit	540	2530	370	980	1920	1130	1520	5510
4	Chlorides (mg./ lit)	200 mg/lit	74.44	570.7	145.3	145.3	485.7	273	386.4	1776
5	Sulphates (mg./ lit)	200 mg/lit	761.3	0	967	0	0	0	0	0
6	Nitrates (mg/ lit)	45 mg/lit	5.17	13.95	6.42	8.93	8.31	5.01	4.7	19.12
7	BOD(mg/liter)	30 mg/lit	0	120	240	0	0	540	120	0
8	COD(mg/liter)	250 mg/lit	0	0	0	270	320	420	1130	50
9	Copper (PPM)	0.05 ppm	0.67	0	0	0	0.62	0	0.12	0.41
10	Ferrous (mg/L)	01-0.05 ppm	0	0	0	0	0	0	1.53	0.97
11	Zinc (PPM)	5ppm	0	0	0	0	0	0	0	0
12	Cadmium (PPM)	0.01ppm	0	0	0	0	0	0	0.12	0
13	Mercury (PPM)	0.01 mg/lit	0	0	17.44	0	0	0	0	0
14	Lead (PPM)	0.1ppm	0	2.78	5.27	0	18.78	1.19	10	2.6
15	Arsenic (PPM)	0.05 ppm	0	0	0	0.28	0	0	0.55	0
16	Total Hardness (mg/L)	200 ppm	260	1350	130	610	1130	960	840	2990

Table 3 Surface industrial drain water sample analysis result

Sr. No.	Parameter	Normal range	Drain 1	Drain2	Drain 3	Drain 4
1	pH	5.5-9.0	6.84	6.89	6.69	6.7
2	Ele. condutivity mS/cm	<1	5.28	5.32	5.12	5.1
3	TDS mg/lit	2100 mg/lit	3490	3540	3340	3450
9	Chlorides (mg./ lit)	1000mg/lit	726.72	730.27	701.91	680.64
10	Sulphates (mg./ lit)	1000mg/lit	5818.6	5863.9	5781.6	5781.6
11	Nitrates (mg/ lit)	50 mg/lit	19.75	19.77	19.71	1.97
14	BOD(mg/liter)	350 mg/lit	1200	1230	1210	1215
15	COD(mg/liter)	250 mg/lit	1600	1680	1660	1675
16	Copper (PPM)	3.0 ppm	0	0	0	0
17	Ferrous (mg/L)	0.1-0.05ppm	1.34	1.54	1.44	1.55
18	Zinc (PPM)	15ppm	0	0	0	0
19	Cadmium (PPM)	1ppm	0	0	0	0
20	Mercury (PPM)	0.01ppm	1	0	0	0
21	Lead (PPM)	1ppm	1.04	1.11	0.91	1.05
22	Arsenic (PPM)	0.2ppm	0	0	0	0
23	Total Hardness (mg/L)	200 mg/lit	1500	1520	1520	1535

Table 4 Azadirachta Indica (Neem leaves) adsorption Result and Sugarcane bagasse Adsorption Result

Sr. No.	Parameter	Normal range	Kbw2	Neem Treated GW	Baggage treated GW
1	pH	7 -8.5	6.75	6.75	5.54
2	Ele. condutivity mS/cm	<1	1.59	1.35	2.51
3	TDS mg/lit	500 mg/lit	1050	680	1110
9	Chlorides (mg./ lit)	200 mg/lit	145.34	173.7	131.16
10	Sulphates (mg./ lit)	200 mg/lit	588.44	5970.86	5925.6
11	Nitrates (mg/ lit)	45 mg/lit	23.83	0	0
14	BOD(mg/liter)	30 mg/lit	0	0	0
15	COD(mg/liter)	250 mg/lit	0	0	0
16	Total Hardness (mg/L)	200 ppm	580	250	150
17	Copper (PPM)	0.05 ppm	0.2	0.12	0
18	Ferrous ppm	01-0.05 ppm	0.75	0.35	0.12
19	Zinc (PPM)	5ppm	0	0	0
20	Cadmium (PPM)	0.01ppm	4.8	0.002	0.01
21	Mercury (PPM)	0.01 mg/lit	20.36	0	0
22	Lead (PPM)	0.1ppm	4.45	0	0.01
23	Arsenic (PPM)	0.05 ppm	0	0	0

4. Result

Analysis Result before treatment Charts Kupwad MIDC Ground Water Sample Analysis Result (Table no. 1)

Analysis Result before treatment Charts Miraj MIDC Ground Water Sample Analysis Result (Table no. 2)

Analysis Result Discussion

Form table it conclude that Values of EC TDS chloride sulphate BOD COD Copper Mercury Lead Arsenic Total Hardness exceeding BIS Standard limits.

Surface industrial drain water sample analysis result (Table No 3)

This result shows that high TDS, Sulphates, BOD, COD, Ferrous, Lead Total hardness values. The contains of industrial effluent further on percolation in soil may mix with the ground water aquifer causing contamination of ground water.

5. Suggested Remedial Treatment

Groundwater pollution is much more difficult to abate than surface pollution because groundwater can move great distances through unseen aquifers. Non-porous aquifers such as clays partially purify water of bacteria by simple filtration (adsorption and absorption), dilution, and, in some cases, chemical reactions and biological activity; however, in some cases, the pollutants merely transform to soil contaminants. Groundwater that moves through open fractures and caverns is not filtered and can be transported as easily as surface water. In fact, this can be aggravated by the human tendency to use natural sinkholes as dumps in areas of karst topography.

Pollutants and contaminants can be removed from ground water by applying various techniques thereby making it safe for use. Ground water treatment (or remediation) techniques span biological, chemical, and physical treatment technologies. Most ground water treatment techniques utilize a combination of technologies. Some of the biological treatment techniques include bioaugmentation, bioventing, biosparging, bioslurping, and phytoremediation. Some chemical treatment techniques include ozone and oxygen gas injection, chemical precipitation, membrane separation, ion exchange, carbon absorption, aqueous chemical oxidation, and surfactant enhanced recovery. Some chemical techniques may be implemented using nanomaterials. Physical treatment techniques include, but are not limited to, pump and treat, air sparging, and dual phase extraction. If treatment or remediation of the polluted groundwater is deemed to be too difficult or expensive then abandoning the use of this aquifer's groundwater and finding an alternative source of water is the only other option.

The specimen was tested after the Suggested Remedial Treatment. Out of these remedies Neem Leaf and Bagasse powder as adsorbent technique was tried for Sample KS2.

5.*1 Azadirachta Indica (Neem leaves)*

Preparation of Neem leaves

The Neem leaves were dried for a period of three days. The Neem leaves were cleaned with distilled water and dried at room temperature. The leaves were grounded with the grinding mill. The ground Neem leaves was sieved and was of particle size 0.25 to 0.5mm. This was to allow for shorter diffusion path, thus allowing the adsorbate (Neem leaves) to penetrate deeper into the effluent more quickly, resulting in a higher rate of adsorption. [Innocent OBOH, Emmanuel ALUYOR, et.al (2009)]

Adsorption Experiment

The bottles with 500ml capacity were filled with 50ml of the ground water, and 1g of Neem leaves (ground).

The bottles were shaken for a predetermined period at room temperature in a reciprocating shaker for 2 hours at 300 rpm. The separation of the adsorbents and solutions was carried out by filtration with Whatman filter paper No. 42 and the filtrate stored in sample cans in a refrigerator prior to analysis. The residual metallic ion concentrations were also determined using an Atomic Absorption Spectrophotometer (AAS).

5.2 Sugarcane Bagasse Powder

Sugarcane bagasse Preparation

Preparation of Sugarcane Bagasse Sugarcane Bagasse was exetensively washed with distilled water and soak with distilled water.

This was carried out in order to clean Sugarcane bagasse from impurity that may interfere with the adsorption result and to remove colour. Then Sugarcane Bagasse was dried in oven at 100 0 C for 24 Hour. After drying , it was ground to get average adsorbent size of 850 μm.

Adsorption Experiments

The effect of adsorption was studied by 0.1 g of adsorbent in 50 ml ground water, agitation speed 200 rpm at room tempreture and contact time 60 minites and at constant pH as initial ground water.

After adsorption, the mixture was filtered through Whatman Filter paper no 40. The concentrations of heavy metals were determined by Atomic Absorption Spectrometer.

Azadirachta Indica (Neem leaves) adsorption Result And Sugarcane bagasse Adsorption Result (Ref. Appendix Table no. 4 Page no 4)

Adsorption result discussion

The absorption result Neem absorption shows that the Ground Water Sample EC reduction Efficiency is 15%, TDS 35 %, Nitrates 100%, Total Hardness 56%, Copper 40%, Ferrous 53%, Cadmium 100%, Mercury 100%, Lead 100%.

The absorption result by Sugarcane Powder absorption shows that the Ground Water Sample Chlorides reduction efficiency 9%, Nitrates 100%, Total Hardness 74%, Copper 100%, Ferrous 84%, Cadmium 100%, Mercury 100%, Lead 100%.

6. Prevention

Locating on-site sanitation systems

On-site sanitation systems can be designed in such a way that groundwater pollution from these sanitation systems is prevented from occurring. Detailed guidelines have been developed to estimate safe distances to protect ground water sources from pollution from on-site sanitation.

As a very general guideline it is recommended that the bottom of the pit should be at least 2 m above groundwater level, and a minimum horizontal distance of 30 m between a pit and a water source is normally recommended to limit exposure to microbial contamination (Y.T. Yu *et al*, 2015) However, no general statement should be made regarding the minimum lateral separation distances required to prevent contamination of a well from a pit latrine. For example, even 50 m lateral separation distance might not be sufficient in a strongly karstified system with a down gradient supply well or spring, while 10 m lateral separation distance is completely sufficient if there is a well-developed clay cover layer and the annular space of the groundwater well is well sealed.

7. Management

Point-of-use treatment

Portable water purification devices or "point-of-use" (POU) water treatment systems and field water disinfection techniques can be used to remove some forms of groundwater pollution prior to drinking, namely any fecal pollution. Many commercial portable water purification systems or chemical additives are available which can remove pathogens, chlorine, bad taste, odors, and heavy metals like lead and mercury.

Techniques include boiling, filtration, activated charcoal absorption, chemical disinfection, ultraviolet purification, ozone water disinfection, solar water disinfection, solar distillation, homemade water filters.

Conclusion

Groundwater is one of the main sources of drinking water and irrigation in and around the Sangli- Miraj Kupwad Corporation Area. Its quality is getting deteriorated due to untreated discharge of industrial and urban effluent. The urban population relies on dug wells, boreholes, hand pumps and tube wells for all their groundwater requirements. The uncontrolled disposal of industrial and urban wastes and the use of chemical substances in agriculture (fertilizers, herbicides and pesticides) are the primary causes of the groundwater contamination.

The results considered that the groundwater of the study area in general cannot be considered of good quality because its are above the permissible levels set by WHO (1996).

The contains of industrial effluent further on percolation in soil may mix with the ground water aquifer causing contamination of ground water. The contents of effluent may cause for soil contamination and also harmful to irrigated crop quality.

The suggestion for remedies of ground water are Locating on-site sanitation systems, Point-of-use treatment, Low cost Adsorbents, Bioaugmentation, Bioventing, Biosparging, Bioslurping, Phytoremediation, Permeable Reactive Barriers, Chemical precipitation, Ion exchange, Carbon absorption, Chemical oxidation, Surfactant enhanced recovery, Permeable reactive barriers Pump and treat Air sparging Dual phase vacuum extraction Monitoring-Well Oil Skimming.

Acknowledgements

I would like to express my sincere thanks to my project guide Mr. S. M. Bhosale, Department of Technology, for his systematic & stimulating suggestions and back-up helped me throughout the project work and writing of this project report. It would not have been possible for me to complete this report within a short time without his encouragement, guidance and in time assessment. Approach in getting me familiarized with all the details needed for the project and constantly guiding me at every step.

I extend my sincere thanks to Mr.A.C.Ranveer, Co-ordinator, (Env.Sci. & Tech.)Department of Technology, Shivaji University, Kolhapur for his kindly guidance in my dissertation work completion .I am thankful to my family for their constant support and inspiration. At the end I would like to thank all persons who directly or indirectly helped me to complete this work.

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