Water Quality Assessment and Treatment of Tube Well Water from Selected Areas in Mandalay Region, Myanmar

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Abstract- In this research work, the tube well water samples (1, 2, 3 and 4) were collected from Kanthayar Ward, Chanmyathazi Township, Mandalay on August, 2018 to determine the quality of groundwater. The physical and chemical properties of collected water samples such as color, pH, total dissolved solid (TDS), total hardness, total alkalinity, calcium, magnesium, sulphate and chloride were determined. Organic pollutant parameters such as DO (dissolved oxygen), BOD (biochemical oxygen demand) and COD (chemical oxygen demand) were also investigated. The content of heavy metals such as arsenic, lead and cadmium were determined by using atomic absorption spectrophotometer (AAS). The bacteriological examination of all water samples were investigated. The collected water samples from site 2 was treated by using rice-husk charcoal, sand and sponge as adsorbents. The physicochemical properties and heavy metals of tube well water sample before and after treatment were also determined. The present study provides information on the quality of tube well water from collected area in Mandalay Region.

Index Terms- tube well water, groundwater, heavy metals, bacteriological examination

I. INTRODUCTION

The chief resources of fresh water body generally obtained from surface water (lakes, ponds, rivers, streams etc.) and ground water (bore holes and well water).Groundwater plays an important role in various purposes such as domestic uses, industrial supply and irrigation in all over the world. As a result of increasing in world's population, industrialization and urbanization may cause contamination of groundwater. The groundwater should not be used for drinking purposes until it has not been tested. Hence it is necessary to protect quality of groundwater. According to WHO 80% of diseases are arises due to contamination groundwater (Smith, A.H., 2000).

The quality of globle freshwater supplies is under increased threat of contamination. While water contains natural contaminants, it is becoming more and more polluted by human activities, such as open defecation, inadequate wastewater management, dumping of garbage, poor agricultural practices, and chemical spills at industrial sites. Chemical contamination of drinking water both naturally occurring and from pollution is a very serious problem. Ansinic and fluoride alone threaten the health of hundreds of millions of people globally. But even more serious is microbiological contamination, especially from human feces. Fecal contamination of drinking water is a major contributor to diarrheal disease. Globally, an estimated 2,000 children under the age of five die every day from diarrheal diseases. Almost 90% of child deaths from diarrheal diseases are directly linked to contaminated water, lack of sanitation, or inadequate hygiene. (UNICEF Canada., (2013))

Heavy metals in water refers to the heavy, dense, metallic elements that occur in trace levels, but are very toxic and tend to accumulate, hence are commonly referred to as trace metals. The major anthropogenic sources of heavy metals are industrial wastes from mining sites, manufacturing and metal finishing plants, and domestic waste water and run off from roads. Many of these trace metals are highly toxic to human, such as Hg, Pb, Cd, Ni, As, and Sn. Their presence in surface and underground water at above background concentration is undesirable. Some heavy metals such as Hg, Pb, As, Cd, Fe, Co, Mn, Cr etc., have been identified as deleterious to aquatic ecosystem and human health. (American Public Health Association.,(1998), 20 Ed.,)

In this research work, the investigation of four contaminates tube well water samples were collected from different sites of Chanmyathazi Township, Mandalay Region. The most contaminated tube well was also carried for treatment.

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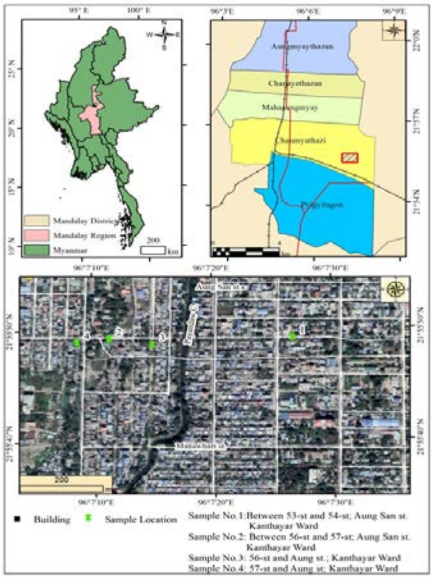

Figure (1) Location Map of Tube Well Water Samples Collected Area

II. Materials and Methods

Sample Collection

The value of a water analysis is largely dependent on correct sampling. The water samples were collected in clean plastic or glass bottles which had been washed with a detergent and rinsed with tap water and distilled water and then two or 3 times with water which were to be collected.

The water samples were analyzed as soon as possible after collection. In this research, water samples were collected directly from tube wells as well as reservoirs at four different sites of Chanmyathazi Township, Mandalay Region on August, 2018.

All of the tube well waters located within Chanmyathazi Township were found to be the range of (120-183 ft).
Site 1 = Between 53 street and 54 street, Kanthayar Ward
Site 2 = Between 56 street and 57 street, Kanthayar Ward
Site 3 = 56 street, Kanthayar Ward
Site 4 = 57 street, Kanthayar Ward

Determination of Physical Properties of Water Samples

Estimation of Total Dissolved Solid

The total dissolved of tube well water samples were determined by evaporation method. (S.P. GAUTAM., (2005), 21st Edition)

The evaporating porcelain basin was cleaned thoroughly with concentrated nitric acid and washed with distilled water. The basin was dried in an oven at 200°C for 1 hour. The basin was cooled, desiccated, weighed and stored in desiccators. 100 mL of water sample was quantitatively transferred to the preweighed basin and evaporated to dryness on a steam bath. Then the sample in the basin was dried in an oven at 103-105°C for 1 hour. The basin holding residue was cooled in desiccators and weighed. The cycle of drying at 103-105°C, cooling, desiccating and weighing was repeated until the constant weight was obtained.

Estimation of pH Value

The pH value of tube well water samples were determined by electrometric method direct measurement with pH meter. (S.P. GAUTAM., (2005), 21st Edition)

The basic principle of electrometric pH is the determination of the activity of the hydrogen ions by potentiometric measurement using a glass electrode and reference electrode. The pH of a specific solution can be measured by a pH meter or by pH indicators. pH meter is an apparatus with electrodes sensitive to hydrogen (hydronium) ions. This instrument measures the small voltage produced by the presence of hydrogen ions and reads out the pH.

Electrodes were rinsed with distilled water and dried by gently cleaning with a soft tissue. The instrument was standardized by immersing electrodes in a buffer solution of pH 7. Then the pH of sample was measured by dipping electrodes after cleaning into well stirred for 1 minute.

Estimation of Color

The color of tube well water samples were determined by platinum cobalt standard method (spectrophotometer). (S.P. GAUTAM 2005, 21st Edition)

Color is determined by comparison of sample with known concentration of colored solution. It is the standard method, until of color being that produced by 1 mg platinum/L in the form of the chloroplatinate ion. The color of water is extremely pH dependent and invariably increases as the pH of the water is raised.

25 mL of water sample was placed in the sample cell and the color was determined at 455 nm of dematerialized water as blank.

Determination of Chemical Properties of Water Samples

Estimation of Total Hardness

The total hardness of tube well water samples were determined by EDTA titrimetric method. (S.P. GAUTAM., (2005), 21st Edition)

20 mL of the water sample was pipetted out into a clean conical flask. 5 mL ammonia buffer and 2 drops of EBT indicators are added and titrated against EDTA from the burette. The end point was the change of color from wine red t o steel blue. For blank titration, distilled water was used instead of water sample.

Estimation of Total Alkalinity

The total alkalinity of tube well water samples were determined by (acid-base titration) titrimetric method. (S.P. GAUTAM., (2005), 21st Edition)

20 mL of water sample was titrated with standard 0.02 N H_2SO_4 solution using indicator until color changed from pink to colorless. Then, 2 drops of methyl orange indicator were added and the titration was continued until the color turned faint red orange.

Estimation of Calcium

The calcium of tube well water samples were determined by EDTA titrimetric method. (S.P. GAUTAM., (2005), 21st Edition)

25 mL of water sample was mixed with 25 mL of distilled water. 2 mL of NaOH solution and 0.2 g of murexide indicator were added to the sample. The sample was titrated immediately with EDTA solution until the color changed as blank. EDTA titrant was added to the blank to procedure as unchanging color. For blank titration, distilled water was used instead of water sample.

Estimation of Magnesium

Magnesium can be calculated by the following formula.

$$\text{Mg mg/L} = [\text{Total hardness as } CaCO_3/\text{L} - \text{Ca hardness as } CaCO_3/\text{L}] \times 0.244 \times 1000.$$

(S.P. GAUTAM., (2005), 21st Edition)

Estimation of Sulphate

The sulphate of tube well water samples were determined by gravimetric method. (S.P. GAUTAM., (2005), 21st Edition)

The pH of 150 mL sample was adjusted with HCl to 4.5-5.1. $BaCl_2$ solution was added with stirring until precipitation appears to be complete, then about 2 mL in excess $BaCl_2$ was added wherever the amount of precipitate was small. The precipitate was digested to 80°C to 90°C. The precipitate was filtered and washed with warm distilled water until washing were free of chloride as indicated by testing with $AgNO_3$-HNO_3 reagent. The precipitate was dried, ignited 800°C for 1 hour, cooled in desicator and weighed.

Estimation of Chloride

The chloride of tube well water samples were determined by argentometric method. (S.P. GAUTAM., (2005), 21st Edition)

10 mL of sample was mixed with 90 ml of distilled water. 1 mL of K_2CrO_4 indicator solution was added and titrated with standard $AgNO_3$ solution to a pinkish yellow end point. For blank titration, distilled water was used instead of water sample.

Determination of Organic Pollutant Parameters

Estimation of Dissolved Oxygen (DO)

The dissolved oxygen of tube well water samples were determined by the Winkler's method. (S.P. GAUTAM., (2005), 21st Edition)

Estimation of Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand of tube well water samples were determined by titrimetric method. (S.P. GAUTAM., (2005), 21st Edition)

Estimation of Chemical Oxygen Demand (COD)

The chemical oxygen demand of tube well water samples were determined by permanaganate method. (S.P. GAUTAM., (2005), 21st Edition)

Determination of Heavy Toxic Metals (Arsenic, Lead and Cadmium)

The content of heavy metals (arsenic, lead and cadmium) of water samples were examined by Atomic Absorption Spectrophotometer. The arsenic, lead and cadmium of tube well water samples were determined by inductively coupled plasma method/AAS. (S.P. GAUTAM., (2005), 21st Edition)

Determination of Bacteriological Examination of Tube Well Water Samples

Probable coliform count and *E.coli* of the water samples were measured at Public Health Laboratory, Mandalay City.

Preparation of Filter and Supporting Media

Sand and activated carbon are used as a filter media in treatment process. The sand was collected from Chanmyathazi Township, Kanthayar Ward, was purified step by step washing with water to obtain pure sand, dried in room temperature and sieved with 40-60 mesh screen.

200 g of rice-husk charcoal were placed into a plastic container. 1L of 5% NaOH solution was added to neutral rice-husk charcoal and stand for 1 hour. The mixture filtered and washed with distilled water until neutral.

Finally, 1 liter of 5% NaOCl solution was added to neutral rice-husk charcoal and stand for 24 hours. The mixture were filtered and neutralized by washing the distilled water and dried in sunlight. The activated charcoal powder was sieved by 40-60 mesh size sieves. The activated decolorized rice-husk charcoal was obtained.

The sponge was used as a supporting media and collected purchased from local market and purified by washing with water. 3 pieces of sponge were placed into a plastic container. 1 L of distilled water was added to the sponge and stand for 3 hours. Then, the mixture were filtered and washed with distilled water until neutral. The sponge was placed in sunlight to dry. The activated sponge was obtained.

Treatment of Water Sample (Site 2)

The water sample site 2 was treated by filtration method using adsorbents. Rice-husk charcoal was used as biosorbents. Sand was used as geochemical sorbents. Sponge and cotton were used. 95.92 g of sand, 23.24 g of rice-husk charcoal and 2 in of sponge were put into 900 ml column by successive layers. The water sample was added slowly into the column containing adsorbents, and stand for one hour. Then, the water was allowed to flow a rate of 4 ml per min. One liter of filtered water was collected. The heavy metals of collected water were determined.(Hala Ahmed Hegazi., (10 March 2013), *HBRC Journal*).

III. Results and Discussion

Table 1. The Results of Physical Properties of Tube Well Water Samples (August, 2018)

No	Physical Parameter	Site-1	Site-2	Site-3	Site-4	WHO Recommendation*	
						Highest desirable level	Maximum permissible level

1	Color (Pt-Co)	5	5	5	6	5	50
2	pH	8.3	8.2	8.2	8.0	7 to 8.5	6.5 to 9.2
3	Total dissolved solids (mg/L)	875	1030	920	1150	500	1500

The physical properties of tube well water samples in August, 2018 the color of the site 4 water sample was greater than other sites. The pH of all water samples were between 7 to 8.5, they are slightly alkaline. The amount of total dissolved solids of site 4 water sample was higher than other sites. According to the physical properties, site 4 water sample is more polluted than other sites.

Table 2. The Results of Chemical Properties of Tube Well Water Samples (August, 2018)

No	Chemical Parameter	Site 1	Site 2	Site 3	Site 4	WHO Recommendation*	
						Highest desirable level	Maximum permissible level
1	Total Hardness (mg/L)	105	130	170	130	100	500
2	Total Alkalinity (mg/L)	630	760	670	890	200	950
3	Calcium (mg/L)	24	53	35	50	75	200
4	Magnesium (mg/L)	15	12	20	50	30	150
5	Chloride (mg/L)	20	40	50	40	200	600
6	Sulphate (mg/L)	115	113	95	79	200	400

*World Health Organization standard for drinking water (2006)

According to the chemical properties of water samples, the amount of total alkalinity of site 4 water sample was greater than other sites. The amount of total hardness of water samples were found to be in the range WHO recommendation limits.

The amount of calcium, magnesium, chloride and sulphate of all water samples were found within the range of WHO standard limits. According to the physical and chemical properties site 4 water samples was found to be more polluted than other sites.

Table 3. The Results of Bacteriological Examination of Tube Well Water Samples (August, 2018)

No	Test	Site-1	Site-2	Site-3	Site-4
1	Probable Coliform Count	0/5	0/5	0/5	0/5
2	Escherichia coli Count	Not Isolated	Not Isolated	Not Isolated	Not Isolated

E.coli was not isolated with all sites of water samples.

Table 4. The Results of Organic constituents of Tube Well Water Samples (August, 2018)

No	Chemical Parameter	Site 1	Site 2	Site 3	Site 4	WHO standard*	EPA Std**
1	DO (mg/L)	3.4	3	3	3.5	-	4-6
2	BOD (mg/L)	2.5	1.5	1.5	1	6	5
3	COD (mg/L)	5.221	2.309	0.659	0.735	10	5

*World Health Organization standard for drinking water (2006)
**Environmental Protection Agency for domestic water (2003)

According to the results of dissolved oxygen (DO) value of all water samples were found within the range of 3 to 3.5 mg/L. These values fall within the range of 4 to 6 mg/L proposed by EPA for drinking water standard. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values of site 1 water samples were higher than those of other sites.

Table 5. The Results of Heavy Metals in Tube Well Water Samples (August, 2018)

No	Element	Site 1	Site 2	Site 3	Site 4	WHO Recommendation*	
						Highest desirable level	Maximum permissible level
1	Lead	0.000	0.005	ND	ND	0.3	1.0
2	Cadmium	ND	ND	ND	ND	1	3
3	Arsenic	0.004	0.009	0.007	0.001	0.05	0.01

*World Health Organization standard for drinking water (2006)
ND = not detected

According to the results of heavy metals, the amount of lead and arsenic contents at site 2 water samples were higher than other sites. Cadmium content of tube well water samples was not detected.

Treatment of Tube Well Water Sample from Site 2 by Using Adsorbents

The Atomic Absorption Spectrophotometer (AAS) of site 2 was most polluted than other sites. So site 2 was treated by filtration with adsorbents.

Method = 95.92 g sand, 23.24 g rice-husk charcoal, 2 in sponge

Treatment of tube well Water form site 2 by using sand, rice-husk charcoal and sponge as adsorbents. 95.92 g of sand, 23.24 g of rice-husk charcoal and 2 in of sponge were placed at the column. Site 2 water sample was added slowly into the column and stand for 1 hour. The water was along to flow adsorbents at a range of 4 ml per min. 2 L of filtered water were collected. The physicochemical properties and heavy metals of collected water sample were determined.

Figure (2) Treatment of Tube Well Water Sample 2

Table 6. Comparison of Physical and Chemical Properties of Site 2 Water Samples (Before and After Treatment)

No	Test	Sample 2		WHO Recommendation*	
		Before Treatment	After Treatment	Highest desirable level	Maximum permissible level
1	Color	5	5	5 Units	50 Units
2	pH	8.2	8.2	7.0 to 8.5	6.5 to 9.2
3	Total dissolved solid (mg/L)	1030	945	500	1500
4	Total Hardness (mg/L)	130	110	100	500
5	Total Alkalinity (mg/L)	760	740	600	950
6	Calcium (mg/L)	53	32	75	200
7	Magnesium (mg/L)	12	10	30	150
8	Chloride (mg/L)	40	50	200	600
9	Sulphate (mg/L)	118	130	200	400

After filtration with sand, rice-husk charcoal and sponge the color of water sample were the same as before water. The amount of total dissolved solid (TDS), total hardness, total alkalinity and calcium of after treatment water were found to lower than that of before water.

Table 7. Comparison of Heavy Metals (Lead and Arsenic) of Site 2 Tube Well Water Samples (Before and After Treatment)

No	Test	Water Sample On August “2018”		WHO Recommendation*	
		Before Treatment	After Treatment	Highest desirable level	Maximum permissible level
1	Lead	0.006	ND	0.3	1.0
2	Arsenic	0.009	0.001	0.05	0.01

According to the comparison of heavy metals, after treatment site 2 water sample the content of lead and arsenic were reduced than that of before treatment.

IV. Conclusion

In August, 2018 the tube well water samples were collected from Kanthayar Ward, Chanmyathazi Township, Mandalay Region. The quality of different sites of water samples were compared. The pH, calcium, chloride and sulphate of all the water samples were found within the range of WHO standard limits. The colour, the amount of total dissolved solid, total hardness, total alkalinity and magnesium of water samples were existed between the highest desirable level and maximum permissible level. DO value of all water samples were found within 3 to 3.5 mg/L. BOD and COD value of site 1 water samples were higher than those of other sites. According to the physicochemical properties, site 4 water samples were found to be more polluted than other sites. *E.coli* was not isolated of all sites of water samples. The amount of lead and arsenic contents at site 2 water samples were higher than other sites. Cadmium content of tube well water samples were not detected.

According to the result of heavy toxic metals, site 2 was found to be more polluted than other sites. So according to the physical and chemical parameters site 2 water sample was chosen for treatment. Rice-husk charcoal, sand and sponge were used as adsorbents for filtration. Sand and activated carbon are used as a filer media and sponge for supporting media in treatment process. After treatment of site 2 water sample, the amount of total dissolved solids (TDS), total hardness, total alkalinity and calcium were found to be less than before treatment. The content of heavy metals lead and arsenic were significantly decreased after treatment. However, according to this overall studies result, the quality of water is unsatisfactory. So, the tube well waters from Kanthayar Ward, Chanmyathazi Township not be used for drinking purpose without treating.

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