Water Quality Assessments of Tube-well Water from Southern Pyi-Thar-Yar in Meiktila Township, Mandalay Region

Tin Tin Han
Natural Science Department, University of Computer Studies, Meiktila
tintinhan1977@gmail.com

Khin Nyo Win
Department of Physics, Dagon Univerisity
khinnyowin69@gmail.com

Yin Yin Myint
Department of Chemistry, Meiktila University
yinyinmyint093@gmail.com

Abstract

In this study, the experimental works have been done in three portions, physical examination, determination of elemental constituents and toxic metal analysis. Water quality assessment has been made to assess the quality of water sample obtained from 4th Street of Southern Pyi-Thar-Yar near Myanmar Aerospace Engineering University (MAEU), Meiktila Township in Mandalay Region. Most of the methods used in this investigation are from the World Health Organization guidelines limits for drinking water. The water sample has been tested in Water and Sanitation Department in Mandalay City Development Committee. Upon the whole considering the various parameters studied, the observed values indicate that the quality of tube-well water from Southern Pyi-Thar-Yar in Meiktila Township, Mandalay Region is satisfactory.

Keywords: Water Quality Assessment, Tube-well water, Physical examination, Elemental constituents, Toxic metals.

1. Introduction

Water is a substance combination of the chemical elements hydrogen and oxygen with a chemical symbol H_2O and chemical name as dihydrogen monoxide. It can be existed in three states, gaseous (vapour), liquid (water), and solid (ice) states. Water is an unusual compound with various properties. It is one of the most plentiful and essential of compounds. Water is a tasteless and odourless liquid at the room temperature and it has the important ability to dissolve many other substances.

Water, food and shelter are three main essential elements for the existence of human being and animals. Clean water, basic toilets and good hygiene practices are essential for the survival and development of human. Every living thing requires water. Without water, there can be no life. Water is rated to be the greatest. It is estimated that two-third of the human body is constituted of water. Today, there are around 2.4 billion people who do not use improved sanitation, and 663 million who do not have access to improved water sources.

Water carries nutrients to all cells in our body and oxygen to our brain. Water allows the body to absorb and assimilate minerals, vitamins, amino acids, glucose and other substances. Water flushes out toxins and waste. Water helps to regulate body temperature. Human body uses water in all its cells, organs, and tissues to help regulate its temperature and maintain other bodily functions. Because human body loses water through breathing, sweating, and digestion, it's important to rehydrate by drinking fluids and eating foods that contain water.

In recent years, an increasing to ground water quality due to human activities has become of great importance. The adverse effects on ground water quality are the results of man's activity at ground surface, unintentionally by agriculture, domestic and industrial effluents, unexpected by sub-surface or surface disposal of sewage and industrial wastes.

The quality of water is great importance in determining the suitability of particular water for a certain use. The quality of water can be varied from place to place, with the depth of water and from season to season and can be primarily governed by the extent and composition of dissolved solid present in the water. As water is one of the great importances, the usage of water is increasing rapidly with our growing population.

The objective of this investigation is to find out the water quality of the water sample in order to study the effectiveness of all living beings and plants. The physical, elemental analysis and toxic metals are investigated for the water sample and the results are shown in the table and compared with the drinking water standard proposed by World Health Organization.

2. Literature Survey

2.1 Characteristics of Water from Natural Sources

Water is one of the most abundant widely distributed and essential substances on earth. It can be occurred in the solid, liquid and gaseous states such as ice or snow, water and steam or vapour respectively. Water can be never found pure in nature. Glacier water is probably the purest natural source of water and rain can be next.

Natural water is available from the different sources. They are (i) pure water (ii) rain water (iii) surface runoff water (iv) river water (v) lakes and pond water and (vi) ground water.

2.2 Physical Characteristics

The physical characteristics of water supplied to a community should be examined regularly. Turbidity,

color, odour and taste should not be very high as to offer the sense of sight, taste or smell. Maximum acceptable values for water used without treatment other than disinfection are 5 units for turbidity, 15 units for color and a threshold odour number of 3.

2.3 Elemental Characteristics

Elemental characteristics should be determined at least twice a year. Drinking water should not contain impurities in hazardous concentration. Substances that are deleterious physiologically should not be permitted to reach the community.

2.4 Toxic Chemical Substances

Attention of largely directed to the detection and estimation of certain toxic chemical substances for the protection of users of public water supplies from danger to health. A number of chemical substances, if present in certain concentrations in supplies of drinking water, may constitute danger to health. A list of such substances and of the levels of concentration which should not be exceed in communal drinking water in the Table 1.

Table1. Maximum allowable concentrations of toxic substances in communal drinking water supplies

Substances	Maximum Allowable Concentration (mg/L)
Lead	0.05
Arsenic	0.05
Selenium	0.01
Chromium	0.05
Cyanide	0.20
Cadmium	0.01
Barium	1.00

These data are referred from Guidelines for Drinking-Water Quality, 4th Edition Incorporating the First Addendum, Geneva, WHO 2017.

3. Water Quality Assessment

3.1 Temperature

Water temperature has a large influence on the organisms living in the water, as it influences biological activity and chemical processes. The temperature of water is influenced by latitude, altitude, season, time of day, air circulation, cloud over and the flow and depth of the water. The water temperature also affects physical, chemical and biological processes in water bodies and the concentration of many variables. Surface water is usually within temperature range 0°C to 30°C, although hot springs may reach 40% or more.

3.2 Color

Water may be colored for a variety of reasons. The water color can change due to inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. Organic matter (eg. compost, dead plants), which causes yellow or brown. Algae group algae also cause yellowish or greenish yellow. Ground water causes brownish (green tea) color. True color of pure water can be measured on water from which turbidity has been removed by centrifugation or filtration. Apparent color is due to suspended matter as well as due to substances on solution removed by filtration. Unit for color measurement is based on platinum cobalt scale.

3.3 pH

The pH of water can be measured by its hydrogen ion concentration. It ranges from 0 to 14 and indicated that water is acidic (pH<7), neutral (pH=7) or basic (pH>7). Normally, the pH of most natural water is between 6.0 and 8.5. The pH ranges for environmental water are shown in the Table 2.

Table 2. pH ranges for environmental water

pH range	Type of water
5.3-7.4	Soft water
7.6-8.8	Hard water
8.2-9.2	Sea water
2.2-4.8	Water affected by acidic pollutants
5.6	pH of water in equilibrium with atmosphere

These hardness ratings are referred from Water Chemistry Text Book using in Chemistry Department of Meiktila University.

3.4 Turbidity

The turbidity in water is the reduction of transparency due to the presence of particulate matter such as clay or slit, finely divided organic matter, plankton or other microscopic organisms. The flow of water from the wells, called tube-wells, usually increases turbidity. Solids that are difficult to mix with water molecules are called suspended matter. Disinfection of turbid water is difficult because of the adsorptive characteristics of some colloids and because the solids may partly shield organisms from disinfectant. Turbidity may impart brown or other color to water in natural water and it may interfere with light penetration and photosynthetic reaction in streams and lakes.

3.5 Conductivity

Conductivity measurements are used to determine the purity of water and total dissolved solids in boiler and cooking water. Most purified water has the

conductivity values less than 50 μ s/m. In SI unit conductivity is reported μ s/m.

1 μ s/m = 10 μ mhos/cm

3.6 Hardness

Hardness can be measured as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in mg/L. Water hardness was understood to be measure of the capacity of eater to precipitated soap. Soap is precipitated chiefly by calcium and magnesium ions present. Other prevalent cations also precipitate soap but they are often in complex forms and minimal concentration shown in the Table 3.

Table 3. Hardness rating of different types of water

Hardness rating	Concentration of Calcium Carbonate (mg/L)
Soft	0-50
Moderately soft	50-100
Slightly hard	100-150
Moderately hard	150-200
Hard	200-300
Very hard	>300

Hardness ratings are referred from Water Chemistry Text Book using in Chemistry Department of Meiktila University.

3.7 Alkalinity

Alkalinity of water is its quantitative capacity to react with a strong acid to a designate pH. Highly alkaline water is usually unpalatable. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. Alkalinity is significant in many uses and treatments of natural and waste water. Alkalinity measurements are used in the particular way and control of water treatment processes.

3.8 Calcium

Calcium is a major constituent of various types of rock. It is one of the most common constituents present in natural water ranging from zero to several hundred milligrams per liter depending on the source and treatment of the water. Calcium is a cause for hard in water and incrustation in boilers.

3.9 Magnesium

Magnesium is a common constituent in natural water. Chemical softening, reverse osmosis, electro dialysis, or iron exchange reduces the magnesium and associated hardness to acceptable levels.

3.10 Chloride

Chloride is one of the major inorganic anion in water. In portable water, the salty taste which is produced by the chloride concentrations is variable and dependent on the chemical composition. There is no known evidence that chloride any human health hazard.

3.11 Sulphate

The major physiological effects resulting from the ingestion of large quantities of sulfate are catharsis, dehydration and gastrointestinal irritation. Water containing magnesium sulfate at levels above 600 mg/L acts as a purgative in humans. The presence of sulfate in drinking water can also result in a noticeable taste; the lowest taste threshold concentration for sulfate is approximately 250 mg/L as the sodium salt. Sulfate may also contribute to the corrosion of distribution systems.

3.12 Iron

Anaerobic ground water may contain iron at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. Taste is not usually noticeable at iron concentrations below 0.3mg/L, although turbidity and color may develop in piped systems at levels above 0.05 to 0.1 mg/L. Iron is an essential element in human nutrition.

3.13 Biochemical Oxygen Demand (BOD)

BOD is the amount of oxygen consumed by bacteria as they oxidized organic matter in water. It indicates biochemically oxidizable organic matter. Untreated surface water shows 1.0 to 10.0 mg/L or more biochemical oxygen demand. The 5 days BOD of domestic water measured at 20°C should be less than 2 mg/L.

3.14 Dissolved Oxygen (DO)

Dissolved oxygen is the amount of oxygen dissolved in water. DO content indicates whether the water is fresh or not. DO test is one of the most important analysis in determining the quality of natural water.

4. Experimental

4.1 Sampling and Storage

Sample water was collected from 4th Street of South Pyi-Thar-Yar near Myanmar Aerospace Engineering University (MAEU), Meiktila Township in Mandalay Region. The place of sample water collected is shown with the map in the following Figure1. The separation distance of tube-well that sample water was taken from the surrounding areas is also described in the Figure 2. It was stored in clean plastic bottles which had been washed with a detergent and rinsed with tube-well water sample, dilute nitric acid solution, distilled water

and water sample. The bottle were filled completely with sample water and capped tightly.

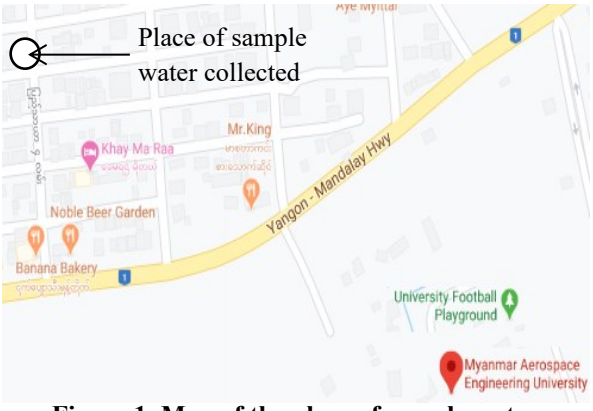

Figure 1. Map of the place of sample water collected

Note: Screenshot from Google Map

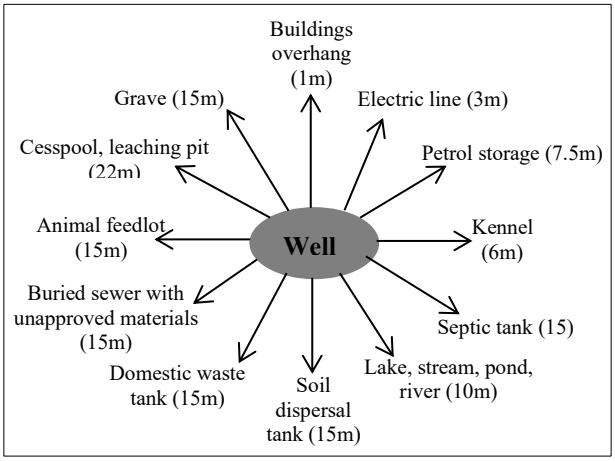

Figure 2. Separation distance of sample water tube-well

Note: Practical measurement by measuring tape

4.2 Methods Used for Analysis

Sample water was analyzed as soon as possible after collection. However, it was stored when decay was unavoidable. The techniques of storage water are different depending on the nature of constituents to be determined. The methods used for analysis of sample water are described in the Table 4.

Table 4. Methods used for analysis of sample water

Parameters	Analytical Technique	Units
Turbidity	Turbidity Meter	NTU
Conductivity	Direct Measurement	μ moh/cm
Temperature (Temp)	Thermometer	°C
pH	pH meter	pH units
Color	Spectrophotometry	Pt-Co unit
Total dissolved solids (TDS)	Evaporation at 180°C/weighing	mg/L
Hardness (Hard)	EDTA Titrimetric	mg/L
Alkalinity	Titrimetric	mg/L
Calcium (Ca)	EDTA Titration	mg/L
Magnesium (Mg)	EDTA Titration	mg/L
Chloride (Cl^-)	Argentometry	mg/L
Sulphate (SO_4^{2-})	Gravimetric	mg/L
Iron (Fe)	Phenanthroline	mg/L
Biochemical Oxygen Demand (BOD)	Iodometric Titration	mg/L
Dissolved Oxygen (DO)	Iodometric Titration	ppm

Methods are referred from practical experiments with Water Chemistry Text Book using in Chemistry Department of Meiktila University.

5. Results and Discussion

5.1 Expression of Results

The results are expressed in mg/L. It is equivalent to parts per million (ppm). The conductivity is expressed in μ mohs/cm and turbidity is expressed in NTU. Color is shown by Pt-Co unit.

5.2 Drinking Water Standard Proposed by World Health Organization

Maximum concentrations of chemical substances in drinking water are proposed by WHO is described in the Table 5. These values are compared with the results of the sample water in the Table and portability of water is determined on the basic of these concentrations.

Table 5. Results of the sample water comparing with standard limits of WHO

Parameters	Results	WHO (1972) Recommendation	
		Desirable	Imperative
Physical Properties			
Appearance	Colorless	-	-
Temperature (°C)	29	-	-
pH (scale)	7.5	7-8.5	6.5-9.2
Color (units)	5	5	50
Turbidity (NTU)	1.34	5	25
Conductivity (μ moh/cm)	560	800	4000
Elemental Properties			
Alkalinity (mg/L)	280	200	500
Hardness (mg/L)	240	100	500

Calcium (mg/L)	56	75	200
Magnesium (mg/L)	24	30	150
Chloride (mg/L)	28	200	600
Sulphate (mg/L)	<200	200	400
Iron (mg/L)	0.01	0.3	1.0
Manganese (mg/L)	0.01	1.0	1.5
Copper (mg/L)	Nil	1.0	1.5
Arsenic (mg/L)	Nil	0	0.05
Biochemical Oxygen Demand (mg/L)	1.3	-	2
Dissolved Oxygen (mg/L)	3	5	5

These data are collected from the testing in Water and Sanitation Department in Mandalay City Development Committee.

Depending on the results of the sample water, its temperature is found to be 29°C and its color is 5 units which are the beyond the maximum acceptable limits of WHO. Its pH is 7.5 which is in the range of 6.5 to 8.5 for drinking water. Turbidity is also less than maximum acceptable limit of 5 NTU and the conductivity is found to be 560μ mho/cm, less than the mandatory health limit of drinking water standard 800μmho/cm.

As per elemental characteristic, the alkalinity of sample water is less than maximum allowable limit and can be indicated that the absence of hydroxyl alkalinity. Its sulphate is also below the limit of WHO drinking water. Its chloride content is lower than the acceptable limit of 200 mg/L by WHO. The value of hardness of sample water is also lower than the maximum desirable limit so it is soft water.

The calcium and magnesium in the sample water are below maximum acceptable limit so it cannot be affected to health. In the sample water, iron and manganese are detected but the toxic elements, arsenic and copper are absent. However, the iron and manganese concentration in sample water are lower than the standard recommendation limit. Therefore, the sample water can be used for drinking.

6. Conclusion

The investigation of physical and elemental parameters is determined in this study of water sample from Southern Pyi-Thar-Yar, Meiktila Township. Based on the observation, the resulting values of sample water are within the range of international standards of drinking water proposed by World Health Organization.

According to the experimental data, the values of the hardness and calcium of sample water do not exceed the maximum limits of WHO. The color value is also lower than the standard limit and the toxic metals arsenic and copper are not detected in the sample water.

Therefore, upon the whole consideration of the various parameters of the sample water in this study, the quality of the tube-well water from South Pyi-Thar-Yar in Meiktila Township can confirm to be fit and suitable for domestic and industrial uses and also for drinking. Thus, the quality of Southern Pyi-Thar-Yar tube-well water is satisfactory.

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