

Determination of Differences in the Quality of Groundwater and Treated Water of Najran City, Kingdom of Saudi Arabia

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Abstract: *This paper aims to find out the major differences in the quality of groundwater and treated water at Najran City which lies in the southern region of Saudi Arabia. Physical and chemical analyses were conducted and used to determine these differences. The study and chemical analysis for groundwater (samples collected from bore holes), and treated water (samples collected from treated water stations), showed that ammonia (NH₃), fluoride (F), and iron (Fe) are not detected in the water samples. The groundwater and surface water quality in the studied area is fit for drinking and other domestic uses as compared with the international drinking water standards. Also the study showed that, the treated water samples are fit for different uses except at Al Mishaliya which shows high nitrates content. Groundwater samples are very hard and high content of nitrates were recorded at Al Hayra.*

Keywords: Ground water, treated water, water quality, Najran, Kingdom of Saudi Arabia

1. Introduction

Water is a ubiquitous chemical substance that is vital for all known forms of life (UNOSIA, 2005). In typical usage, water refers only to its liquid form or state, but the substance also has a solid state, ice, and a gaseous state, water vapor or steam. Water covers 71% of the Earth's surface (FAO, 1997a). There are two main categories of water associated with health hazards are of prime importance: Biological agents transmitted through ingestion of pathogens and chemical and radioactive pollutants (UNEP and WHO, 1988). Driscoll (1986) mentioned that, groundwater is normally more hygienic than surface water, because most groundwater carries no suspended particles and practically no bacteria or organic matter.

The chemical examination of water can indicate the possible past history and whether it has been, or is now polluted (Twort, Law and Crowley, 1987).

Overman (1976), stated that, the maximum permitted concentrations of various substances in public water supply is controlled throughout the world by legislation and varies to some extent from country to country. The United Nations, in collaboration with individual nations, regularly monitors access to water and sanitation. The most recently completed assessment, published in 2000 by the World Health Organization (WHO 2008). Feachem R., Mc Garry and Mara (1977) mentioned that the most difficult to handle, and the largest, of water-related infections in the faecal – oral group because they are all potentially water-borne but can also be transmitted by any other faecal-oral route.

2. Geological Setting, Location and Climate

Najran City is located to the far south-western part of the Kingdom of Saudi Arabia as seen from Figure 1. It is near to the Yemen frontiers.

The study area of Najran City is surrounded by a series of outcrops composed of different geological formation and contains different minerals with wide chemical composition and crystal structures which mainly characterize the acidic igneous rocks such as feldspars, biotite, micas and quartz. They are mainly metavolcanics of pre-cambrian age. Najran area which lies in the south western part of Saudi Arabia, lies within the area of the Great African Rift valley with its simple and complex fault zones which have different trends. The faults have trends north east to south west, or North West to south east. Najran is located in Saudi Arabia, its geographical coordinates are 17°30'20" North, 44°11'3" East and its original name (with diacritics) is Najran. Najran is located in the southwest corner of Saudi Arabia, close to the Yemeni border. It is one of the Kingdom's most modern cities and is also the capital city of Najran province. Najran City is surrounded by orchards and trees, and encircled by outcrops of metamorphosed pre-cambrian rocks.

The climate in Najran is desert climate. There is much less rainfall in winter than in summer. The driest month is June with 0 mm rainfall, and most precipitation falls in March with an average of 59 mm. About 133mm of precipitation falls annually. The average annual temperature in Najran is 23.6°C. The warmest month of the year is July with an average temperature of 29.9°C. In January, the average temperature is 16.6°C. It is the lowest average temperature of the whole year (<http://www.climate.data.org>).



Figure 1: Location map of Najran City within the Kingdom of Saudi Arabia

3. Methodology

Water samples were collected in one liter ethylene plastic bottles, after bottle was washed with soap and then with distilled water and then dried, were then washed each bottle with water well, or treated water plant to be studied. Figures 1 and 2 show some water samples taken from a groundwater well and a treated water station in Najran City. Then the physical parameters were measured in the field (pH, EC, T, TDS) and then take the remainder of the sample to the laboratory to measure the chemical parameters (Na, K, Ca, Mg, Fe, Total hardness, total alkalinity, CL, F, SO₄, NO₂ and NO₃).



Figure 1: Groundwater sample taken from a borehole at Najran City

4. Physical Parameters

PH, Electrical conductivity (EC), Total dissolved Solids (TDS), Turbidity and Dissolved oxygen. The above parameters were measured, on-site immediately after the collection of samples. Measurements of pH in the field were conducted by using an instrument model HANNA HI 8424 pH meter. Turbidity has been measured in the field using a turbidity meter (Lovibond-Turbi Check SN10121759). The total dissolved solids (TDS) has been measured in the field using the instrument Electrical Conductivity TDS meter (SPER SCIENTIFIC, 850038 Pure Water Meter). A dissolved oxygen meter has been used for the measurement of dissolved oxygen in the water samples in the field.



Figure 2: Treated water sample taken from Al Athayba treated water station

5. Results and Discussion

The physical parameters studied and analyzed in the area surveyed and comprise the following: Hydrogen ion concentration (pH), Dissolved oxygen (DO), total dissolved solids (TDS), electrical conductivity (EC) and Turbidity.

Tables 1 and 2 shows the results of physical parameters for water samples collected from water stations and bore holes respectively.

Table 1: Results of physical properties of treated water collected from treated water stations

No.	Locality	pH	DO (mg/l)	TDS (mg/l)	EC (μ S)	Turbidity (NTU)
1	Al Hadan	8.4	0.03	76	151.9	2.33
2	Al Athayba	7.1	0.1	147	293	0.32
3	Al Uraisa	7.2	0.03	1.2	2.4mS	0.30
4	Al Mishaliya	7.5	0.04	86.5	173.5	0.77

Table 2: Results of physical properties of groundwater collected from boreholes

No.	Locality	PH	DO (mg/l)	TDS (mg/l)	EC(μ S)	Turbidity (NTU)
5	Al Hadan	7.4	0.70	183	366	0.46
6	Uraisa Farm	7.6	0.05	41.5	83	0.55
7	Al Shurfa	7.2	0.05	719	1438	0.48
8	Al Hayra	7.4	0.06	909	1817	0.38

6. Chemical Analysis

The chemical analyses had been carried out at the chemical Laboratory of Water Administration at Najran City. They used the classical chemical methods for the investigation of different chemical parameters.

7. Chemical Parameters

The chemical parameters studied and analyzed in the treated water samples and those samples collected from bore holes (Groundwater), comprise the following: The major cations i.e.; Ca (Calcium), Mg (Magnesium), and the major anions which include Nitrite (NO_2), Nitrate (NO_3), Chlorides (CL), Sulfates (SO_4), and fluorides (F), this beside the total hardness, total alkalinity, ammonia (NH_3), iron (Fe) as trace element.

Tables 3 and 4 shows the results of chemical analysis for treated water samples and groundwater samples collected from the study area. As can be seen from tables 3 and 4, chemical analysis for groundwater (samples collected from bore holes), and treated water samples collected from treated water stations, showed that ammonia (NH_3), fluoride (F), and iron (Fe) are not detected in the water samples. It was clear that according to the results of chemical analysis carried out in the study area, groundwater samples showed the water samples are very hard, while water collected from treated water stations are hard.

Also according to the results of chemical analysis done for the treated water samples, nitrates (NO_3) were recorded high at Al Mishaliya (Table 3) while for groundwater samples chemical analysis showed high nitrates amounts at Al Hayra (Table 4).

Table 3: Results of chemical analysis of treated water

No.	Locality	NH_3	NO_2	NO_3	Cl	SO_4	T.H.	Ca Hard.	Mg Hard.	Fe	F	T.Alk.
1	Al Hadan	0.0	0.0	2.3	2.5	10.0	150	120	80	0.12	0.0	100
2	Al athayba	0.0	0.2	12.3	35	38.6	140	110	30	0.0	0.0	90
3	Al Uraisa	0.0	0.0	5.6	25	4.3	120	100	20	0.0	0.0	50
4	Al Mishaliya	0.0	0.51	56.2	50	22.9	150	120	30	0.0	0.0	90

*All units in mg/l

Table 4: Results of chemical analysis of groundwater collected from boreholes

No.	Locality	NH_3	NO_2	NO_3	Cl	SO_4	T.H.	Ca Hard.	Mg Hard.	Fe	F	T.Alk.
5	Al Hadan	0.0	0.0	32.6	35	32.8	200	160	40	0.0	0.0	95
6	Uraisa Farm	0.0	51	29.6	400	205.0	1500	1200	300	0.0	0.0	120
7	Al Shurfa	0.0	0.04	23.2	200	155.7	500	400	100	0.0	0.0	100
8	Al Hayra	0.0	0.2	69.9	300	140.4	1000	800	200	0.0	0.0	90

*All units in mg/l

8. Conclusion and Recommendation

From the work done during the period of this study carried out for the investigation of groundwater (collected from bore holes), and treated water (collected from treated water

stations), quality in Najran town the following can be concluded:

- The groundwater and surface water quality in the studied area is fit for drinking and other domestic uses as compared with the international drinking water standards.

- It can be concluded that the treated water samples are fit for different uses except at Al Mishaliya which shows high nitrates content.
- Groundwater samples are very hard and high content of nitrates were recorded at Al Hayra.

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