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Physical and Chemical Characteristics Comparison of the Drinking Water and Water Produced from the Conventional and Modification Solar Water Distillery

Abstract- *A comparison of the physical and chemical characteristics of water samples produced from the conventional and modification solar water distilleries, and water samples of networks from different regions in Kirkuk were carried out. Two samples of each water type were tested. The study has focused on measuring the total dissolved solids, pH, electrical conductivity, sodium, calcium, potassium, magnesium, sulfate, nitric and chloride. The results show that all tests of distillate water produced from the solar water distillery are within Iraqi and world standards lower than the other samples, but only pH values ranged from 7 to 8.3, which are within the standard specifications.*

Keywords- *Drinking water, Solar Water Distillery, Chemical, Physical, Kirkuk city.*

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1. Introduction

Getting fresh drinking water is very important to health, a basic populace's right and a component of an effective policy of populaces' health protection. Furthermore, potable water is important as health and the development affair at local, national and regional levels. It has been shown that operation of drinking water supply in certain zones can yield a net economic feasibility benefit and the reductions in health insurance and care costs; which overbalance the costs of installing a freshwater solutions system [1]. This is genuine and an effective part of the major strategy, infrastructure investments in water treatment to supply fresh water to homes and save the life of the poor populace in the rural, urban zone or militarism segments on limits of the country (the boundary of the country) [2]. There are beyond a million general populations lack of cleanest drinking water were found by the World Health Association. In addition, most of these populaces are living in the rural, urban zone and on limits of the country where it is challenging to build a cleanest drinking water system [3].

There are many methods for the treatment of raw water. One of the methods, which is simple, lower manufacture, ease of inspection, zero price fuel, ease of cleaning, available, renewable energy and can be used devoid of environmental contamination is a solar water distillery. It produces fresh water from briny water.

A solar water distillery works on essential principles of vaporization and condensation. The contaminated water is subjected to the solar water distillery where the solar rays enter through a glass surface leading to raising the temperature of the water continuously which will evaporate water by the greenhouse effect. The water vapor is shunning all noxious waste and microscopic organism are left behind in the sink. The water vapor condenses on the inside surface of the cover and flows into a collection channel and then into a bounded vessel. At all-time, impure water supplied into the solar water distillery and in the middle period, it blew out concerted waste from the sink of the solar distillery to shun high concentration contamination and waste material. Figure 1 demonstrates a schematic diagram of the energy and mass flow in double slope-type solar distillery [4].

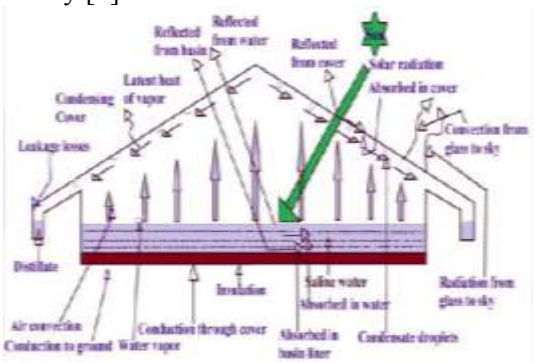

Figure 1: Schematically diagram shows double slope-type solar water distillery [4].

[5] have designed a solar water distillery which converts the muddy and saline water into potable and fresh water using solar energy as a renewable source of energy. The TDS (Total Dissolved Solids) in the portable and fresh water is 81 ppm.

[6] have estimated the quality of the bottled fresh water produced in Al-Najaf, Babylon and Karbala

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towns. The water samples were subjected to physical and chemical tests covering pH, total dissolved solids TDS, Na, Ca, Mg, Cl, and NO_3. The results of the tests were within the Iraqi and the International Bottled Water Association (IBWA) standards, except the pH value where 36% of the tested samples were not satisfied with both specifications. The quality of the tested sample from the same factory differed in various ranges for the samples tested within 31% in general. There was an inconsistency between the factory specifications and the real tested specifications, in different ranges for the samples tested within 52%.

[7] have focused on river water quality as a source of raw water, efficiencies of water treatment plants, the goodness of transporting water pipes of the water networks and drinking water quality as consumed within certain city residential sectors. The water quality parameters tested were: Electrical Conductivity, Turbidity, Cl, and NO_3. They selected four treated water samples from water treatment plants in Mosul city. The results showed that the water quality limits were at most exceed the Iraqi national standard limits and the World Health Organization (WHO) of water quality .

[8] has conducted physical and chemical tests of local and international mineral water products. Results have shown that there were many variations within the water sample means of physical and chemical tests. Some results accord were within the values of national (Central Organization for Standardization and Quality Control) (pH, Ca, Mg, SO_4 & E.C.) but others, where were, have not accorded in some stations.

[9] have carried out the monitoring of water quality of the Tigris River from July to December 2013. They have selected ten sampling sites. A result of raised values of physic-chemical tests due to the contamination of Tigris River as city wastewater, domestic wastes, industrial effluent and agricultural runoff that influence the water quality directly or indirectly. It can be concluded that urbanization, human activates and municipal sewage are the most important reasons for contamination water quality of Tigris River which is increasing in trend from north to south.

[10] have conducted analysis includes several water quality parameters: pH, Temperature, Nitrate, Calcium, Magnesium, Potassium, Sodium, Sulfate, Chloride, Total Dissolved Solids, and Electrical Conductivity. These parameters were recorded at the intakes of five water treatment plants (Al-Kifl, Al-Kufa, Al-Shamiya, Al-Manathera, and Al-Shannafiya) for the years 2015 and 2016. The quality of the river in study region classified as acceptable to severely polluted according to BWQI, good to poor according to CCMEWQI and good to very poor according to WAWQI. It was observed from this study that the impact of human activity, sewage disposal and industrial wastes in the river was severe on most of the parameters.

The Objectives of the Study

The aim of this study is to evaluate the water quality of any sites of the city of Kirkuk (Technical College Kirkuk, Technical Institute Kirkuk and New Tisin Region) and water produced from solar water distilleries (conventional and modification), which includes the following:

a. a. Comparison of the results of tested water samples with the Iraqi and world standards.

b. Comparison of the results of the examination of distillate water samples between the artificial and solar water distillery.

2. Experimental Rig

The experimental work which prepared were the conventional and modification distillery. The conventional and modification distillery was manufactured in order to produce the distillate water. The modification solar water distillery consists of a partly submerged slowly turning hollow cylinder is introduced into the basin water and integrated with flat plate collector work as a water heater unit. These improvements in the modification distillery to boost the productivity of distillate water as shown in Figure 3. The experimental work was carried out on the rooftop of the Technical College of Kirkuk building of Kirkuk situate, Iraq, 2018 on sunny days.

I. Design of the Solar Water Distillery

1. The Conventional Distiller

The basin distiller can be described with dimensions length = 1.32 m, width = 0.78 m and height = 0.15 m. It has insulated by fabric glass with 0.05 m thickness and has an effective basin area of (1 m^2). It is fabricated using galvanized steel material. The glass cover is fixed to the top of the basin water and channel to assemble distillate water to out as illustrated in Figure 2.

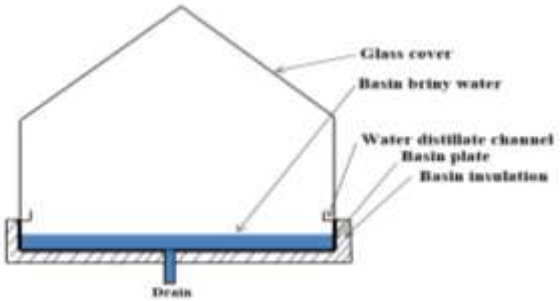

Figure 2: Section side view for the conventional distillery apparatus.

II. The Modification Distiller

Basin water and the glass cover of the modification distiller were chosen identical to the conventional distiller. A partly submerged slowly turning hollow-cylinder is introduced into basin water in order to confirm the maximum productivity. As it turns, a thin layer of water is formed around both the internal and external surfaces and this layer easily evaporates due to the low thickness and the high temperature of the hollow cylinder surfaces. The hollow cylinder was chosen with dimensions diameter = 0.66 m, length = 1.22 m and 0.001 m thickness, which is fabricated from the Aluminum sheet. The hollow cylinder was fixed and turning by shaft and mounting between two general bearings. The pulley was fixed at the end of the rotating shaft which has driven by DC motor. The DC motor has powered by a photovoltaic board as shown in Figure 3.

Fig. 3: Photo of the conventional and modification solar water distillery apparatus.

4. Materials and Methods

I. Collection of samples

The samples of water were taken from tap water of several sites of Kirkuk city which were Technical College Kirkuk, Technical Institute Kirkuk and New Tisin Region, and distillate water produced from the artificial (available in the market) and the solar water distilleries (conventional and modification). All water samples were collected by two replicates of each type to avoid changes due to storage and temperature fluctuations. The chemical and physical tests were carried out in the Technical College Kirkuk and Technical Institute Kirkuk by their laboratory staff have the same devices .

II. The measurement methods were done as follows:

1. Total Dissolved Solids (TDS) and PH meter: The tests were carried out by the OAKION module PH/CON 510 Series.
2. Electrical conductivity**:** The test was carried out by the JENWAY module 4520 Conductivity Meter.
3. Sodium (Na), Calcium (Ca) and Potassium (K)**:** The tests were carried out by the JENWAY module Flame Photometer PFP7.
4. Sulfate **(SO_4):** The test was carried out by the WTW module Photometer 6000 Series.
5. Nitric (NO_3): The test was carried out by the Spectrophotometer.
6. Chloride (CL)**:** The tests were carried out in the EUTECH INSTRUMENTS module Ion 2700.

For the purpose of comparing the examination, was adopted by the WHO [11, 14] and Iraqi [12, 13]standards. Physical and chemical tests were adopted to Iraqi standard (bottled water) No. 417 of 2001 issued by the Central Organization for Standardization and Quality Control [13]. Table 1 shows the highest permissible values for WHO and Iraqi standards.

Table 1: It shows the highest permissible values for WHO and Iraqi standards.

Seq.	Varieties	Unit	Standards	
			Iraqi	WHO
1	TDS	ppm	1000	500
2	pH	-----	6.5-8.5	6.5-8.5
3	Electric conductivity	µs/cm	1000	1000
4	Na	ppm	200	200
5	Ca	ppm	50	200
6	K	ppm	200	200
7	Mg	ppm	50	50
8	SO_4	ppm	250	200
9	NO_3	ppm	50	50
10	CL	ppm	250	200

Figure 4: A map showing the sites of the Technical College Kirkuk, Technical Institute of Kirkuk and New Tisin Region, which were studied.

5. Results and Discussion

The physical and chemical properties are important in determining the validity of water, whether drinking water or fresh water produced from the solar water distillery. The physical and chemical factors of water are particularly important in determining the suitability for human use. Each variable was compared with the approved specifications Table 1 as follows:

1. Total Dissolved Solids (TDS)

Figure 5 shows the results of the total dissolved solids test in the following:-

- Concentration values of TDS of all examined water samples were found to range from 2.5 to 709 ppm.
- Distillate water produced from the solar water distillery gives the best results among all the tested samples.
- Samples of water of Technical College Kirkuk and Technical Institute Kirkuk were out of the world standards (500 ppm). This is abnormal which contains excess salts which may negatively affect the human body through the formation of stones and drought, and it leads to the emergence of calcification in water networks and industrial boilers.
- The difference between the two samples of the distillate water from the solar water distillery and artificial ranged between 34.1 ppm.

2. pH values ranged between 7 and 8.3 as shown in Figure 6. The results are in accordance with the standard specifications, which are suitable for all water characteristics such as density, viscosity, etc. However, the modification of solar water distillery gave the best results.

3. Figure 7 indicates that the electrical conductivity of Technical Institute Kirkuk was (1104 µs / cm) and such value does not conform to the Iraqi standard [13]. Water samples of the solar water distilleries (modification and conventional) had values of 8.22 and 12.95 µs / cm respectively. This is due to the better water treatment system.

4. Figure 8 shows the results of sodium concentration and the following was observed:-

- The sodium concentration values in this study ranged from (0-512 ppm). It is apparent that water samples of Technical College Kirkuk and Technical Institute Kirkuk were out of both Iraqi and world standards, but other samples are okay. Because the tap water of Technical College Kirkuk and Technical Institute Kirkuk were supplied from the well water without treatment.
- The increased concentration of sodium in the water leads to elevated blood pressure. The doctors advise people with heart disease not to drink water if they contain high concentrations of sodium.

5. Calcium concentration values for the study samples are illustrated in Figure 9 and it was observed the following:

- The calcium concentration values in the study samples ranged from (0-98ppm). It is apparent that water samples of Technical College Kirkuk

and Technical Institute Kirkuk were out of the Iraqi standard while other samples were not.

- An increase in the concentration of calcium affects the work of washing machines and cleaning powders, and it leads to the emergence of calcification in the water networks, boiling vessels and industrial boilers.

6. Figure 10 illustrates the results of the potassium concentration test of the water samples and it is observed the following:-

- The concentration of potassium in the samples examined ranged from (0-3.6 ppm). It is apparent that all samples of water are within the Iraqi and world standard.
- The effect of the problem of increasing potassium concentration like that of sodium.

7. Figure 11 illustrates the results of the magnesium concentration test of the water samples and it is observed the following:-

- The concentration of magnesium in the samples examined ranged from (0-82 ppm). It is apparent that water samples of Technical College Kirkuk, Technical Institute Kirkuk and New Tisin Region were out of the Iraqi and world standards.
- It is like calcium cause water turbidity. Because it has low relatively concentrations in the water, there is little interest in causing side effects or potential damage.

8. Figure 12 illustrates the results of the sulfate concentration test of the water samples and it is observed that the concentration of sulfate in the samples ranged from (0-723 ppm). It is apparent that water samples of Technical College Kirkuk and Technical Institute Kirkuk were out of the in Iraqi and world standard but other samples were not.

9. Figure 13 illustrates the results of the nitric concentration test of the water samples where it is observed that the concentration of nitric in the samples examined ranged from (0-111 ppm). It is apparent that water samples of Technical College Kirkuk and Technical Institute Kirkuk were out of the Iraqi and world standard while other samples were not.

10. Figure 14 illustrates the results of the chloride concentration test of the water samples it is observed that the concentration of chloride in the samples examined ranged from (0.7-140 ppm). All water samples were within the Iraqi and world standards.

6. Conclusion

1. All the tests of (TDS, pH, electrical conductivity, calcium, magnesium, nitrite, etc.) for the distillate water produced from solar water distillery have given the best results.
2. pH values ranged between 7 and 8.3 are in accordance with the standard specifications.
3. Some samples of water (Technical College Kirkuk and Technical Institute Kirkuk were out of the Iraqi and world standards.

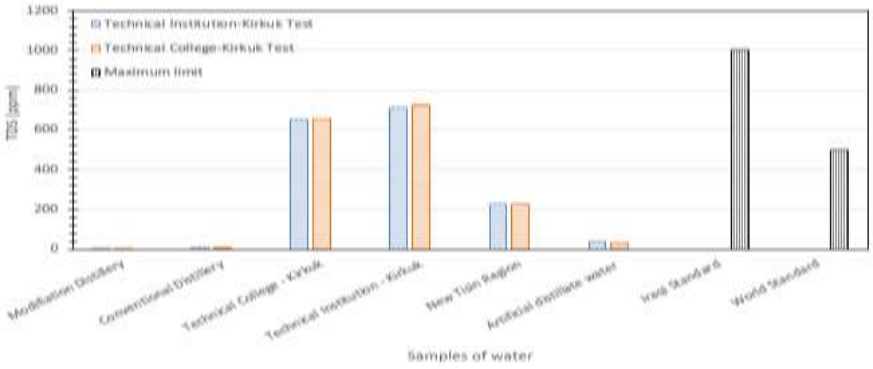

Figure 5: A compression of total dissolved solids (TDS) content in different water samples in Kirkuk, 2018.

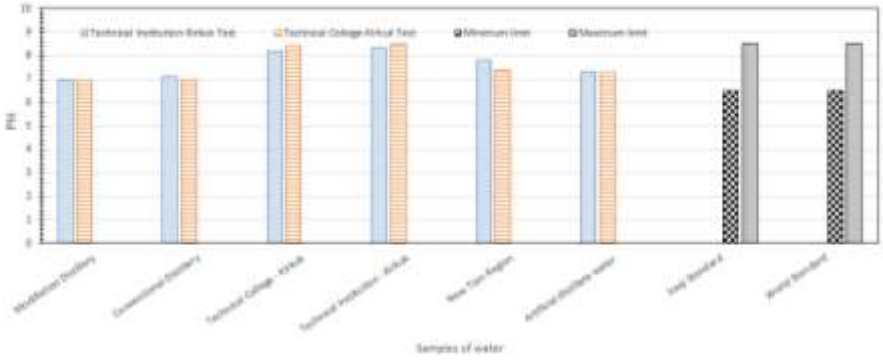

Figure 6: A compression of pH values of different water samples in Kirkuk, 2018.

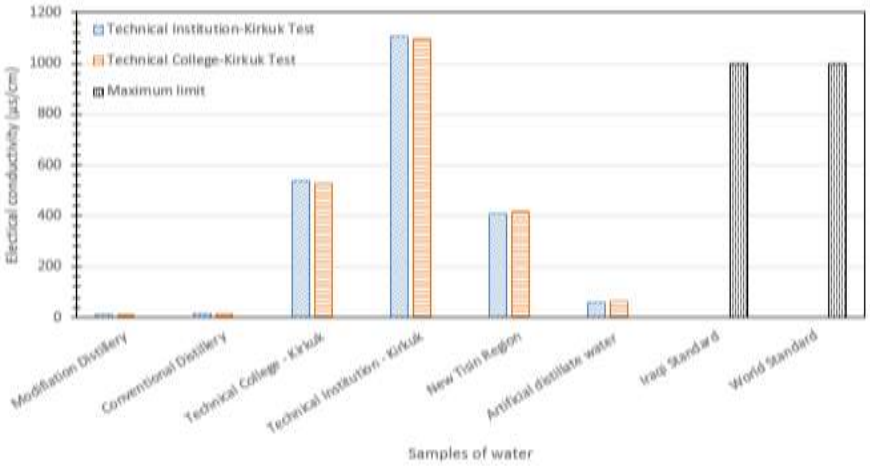

Figure 7: A compression of Electrical conductivity (EC) of different water samples in Kirkuk, 2018.

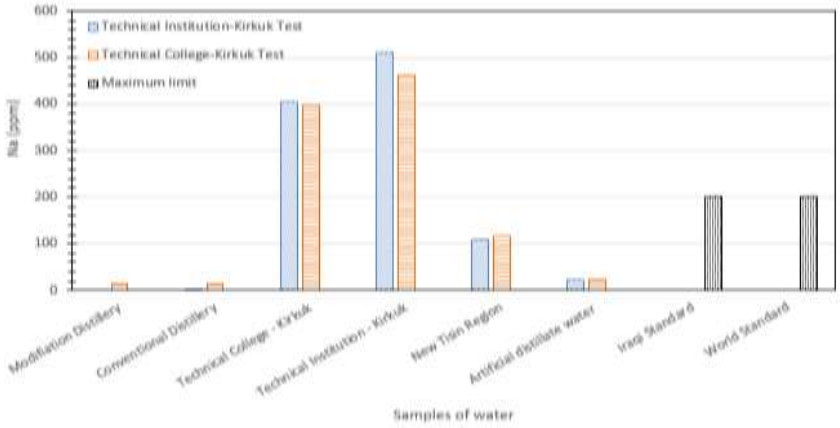

Figure 8: A compression of Sodium (Na) ions content in different water samples in Kirkuk, 2018.

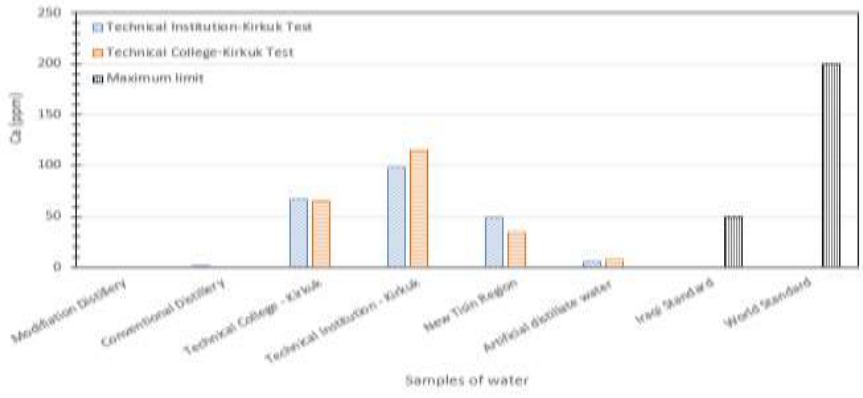

Figure 9: A compression of Calcium (Ca) ions content in different water samples in Kirkuk, 2018.

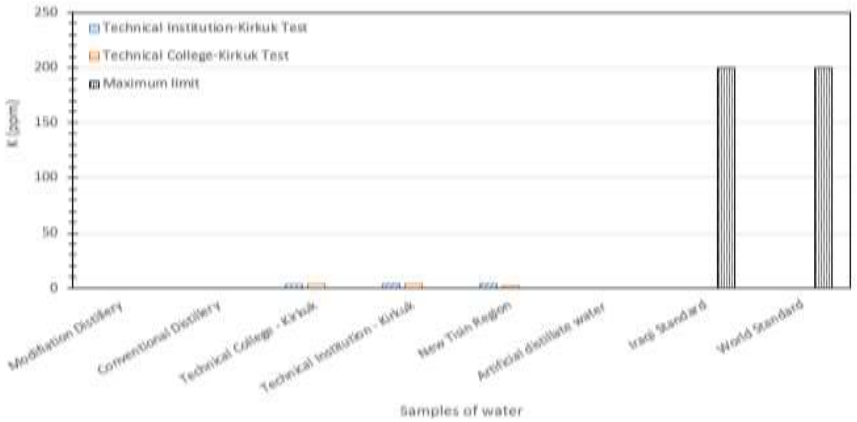

Figure 10: A compression of Potassium (K) ions content in different water samples in Kirkuk, 2018.

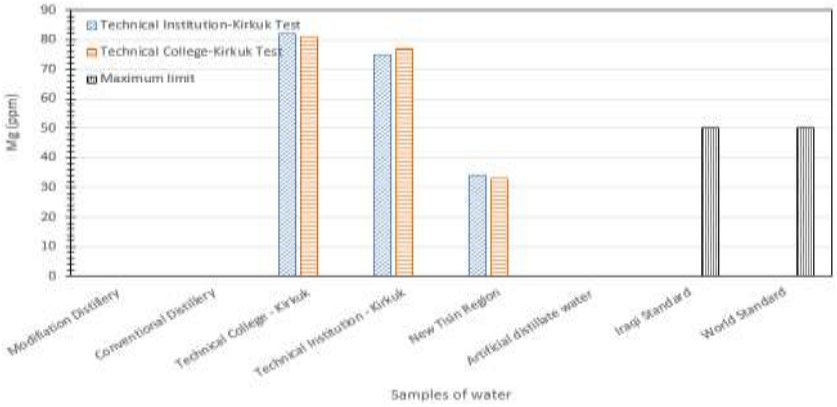

Figure 11: A compression of Magnesium (Mg) ions content in different water samples in Kirkuk, 2018.

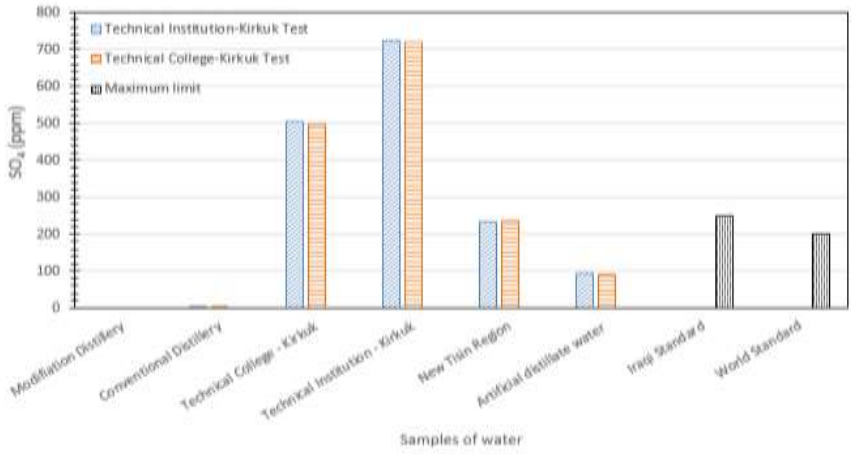

Figure 12: A compression of Sulfate (SO_4) ions content in different water samples in Kirkuk, 2018.

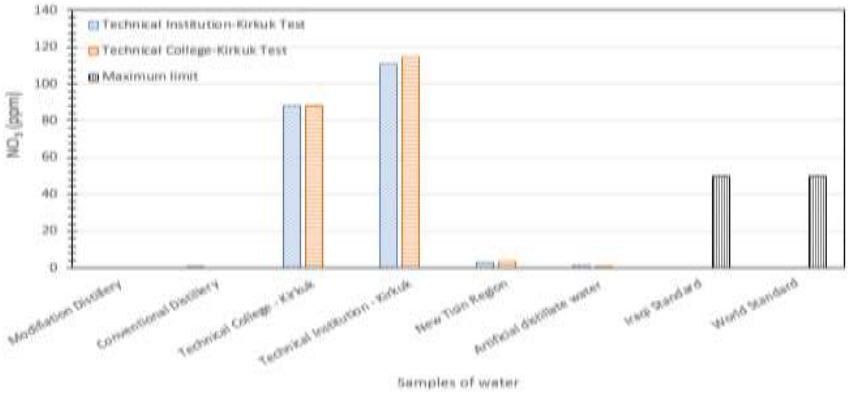

Figure 13: A compression of Nitric (NO_3) ions content in different water samples in Kirkuk, 2018.

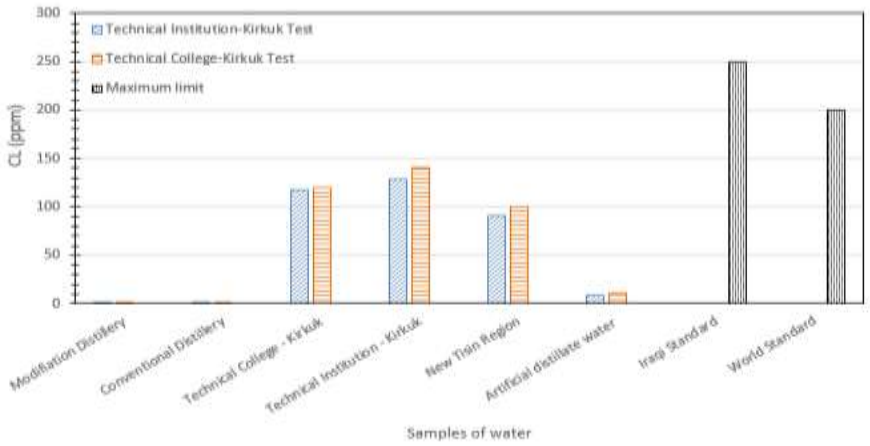

Figure 14: A compression of Chloride (Cl) ions content in different water samples in Kirkuk, 2018.

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