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# Evaluate the Levels of Some Physical and Chemical Factors in Wastewater from Some Companies and Kirkuk General Hospital in Kirkuk City

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***Abstract:** The current study aimed to evaluate the levels of some physical and chemical factors in wastewater from some companies and Kirkuk General Hospital in the city of Kirkuk. Water samples were collected from study sites, from North Oil Company, North Gas Company, Kirkuk cement plant and Kirkuk General Hospital, and for six months from September of the year (2023) AD, until February 2024, using containers Poly Athelin is 2.0 liters tight, the containers were shoved with sample water twice. Where, EC was 64600, and Salinity was 29.8 in water of North Oil Company, while TDS was 44000 in water of North Gas Company. For chemical factors, North Gas Company was the most chemically polluted compared to the rest of the samples. Where, pH was 3.67, PO4 was 36.5 ppm and NO3 was 18.6 ppm. While, highest valve of SO4 showed in water of North Oil Company and it was 1267 ppm. It is noted that the water samples collected from North Oil Company contained the highest concentration of cadmium (11.334), lead (10.355), nickel (1.356) and copper (1.579), while the water sample collected from North Gas Company contained the highest Concentration of iron (9.047) and cobalt (0.881). It's included that the water collected from some companies and the hospital in the city of Kirkuk showed high physical and chemical contamination of wastewater, especially the northern oil and gas companies.*

***Keywords:** Wastewater, Physical Properties, Chemical Properties, TDS.*

## 1. INTRODUCTION

Any water whose quality has been negatively impacted by human activity is considered wastewater. It includes liquid waste that is released from residential, commercial, industrial, and agricultural sources. It can include a variety of possible contaminants and concentrations.

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[1] Because industrial water introduces heavy metals and other toxins into soil and water resources, it produces wastewater that poses a risk to the environment [2]. One of the biggest problems is water pollution, which can be caused by a wide range of materials, such as urban wastewater, agricultural effluent, and industrial discharges. It has been established that there is significant pollution in half of the world's rivers, resulting in a drop in water levels [3–4]. The water is contaminated if the levels of certain elements (nitrates 50 mg/L, calcium 300 mg/L, sodium 200 mg/L, magnesium 300 mg/L, chloride 200 mg/L, sulphates 250 mg/L, total dissolved solids 600 mg/L, and potassium 12 mg/L) exceed the standard limit [5]. Water pollution comes from two different sources [6]: point and nonpoint sources. Point sources, which include oil spills from tankers, factory igniters, and wastewater flowing, are easily recognized. Runoff is the term used to describe precipitation or snowmelt that travels from land to water. Water runoff originates from nonpoint sources and may contain bacteria, soil, oil, grease, trash, animal waste, and chemical pollutants such fertilizers, metals, and pesticides [7]. The process of cleaning wastewater is known as wastewater treatment. Because certain toxins or pollutants are hard to control after they are released from point sources of pollution into habitats, this procedure is crucial [8]. The three steps of a traditional wastewater treatment procedure are primary, secondary, and tertiary [9]. Numerous heavy metals are responsible for contaminating water. It has been shown in several research that elements can be categorized into three groups based on the ratios of their soluble forms: high (manganese, zinc, and lead), moderate (nickel and copper), and insoluble (aluminum, iron, and titanium) [10–11]. Therefore, the current study aimed to evaluate the levels of some physical and chemical factors in wastewater from some companies and Kirkuk General Hospital in the city of Kirkuk.

## 2. RELATED WORKS

In study of [12], indicated that the Dissolved Oxygen (DO) content near factories revealed contaminated water that was dangerous to consume and required expensive treatment. A crucial component of irrigation is sodium concentration, which is represented by SAR and SSP. SSP levels above 75.73% in the water close to these factories have the potential to degrade soil structure and harm agricultural areas. Fish and other aquatic life may be at risk due to the elevated levels of BOD5 and COD. Because the Shatt Al-Arab River is used for a variety of purposes, the study's findings indicated that the water surrounding industrial regions was contaminated. In research of [13], referred that the study of the Kufa sewage treatment plant's quality is known to measure the ratios of oxygen chemical (COD) absorbed and oxygen vital (DO) uptake. Indicators have also been studied and mentioned, including pH, electrical conductivity, E.C., salts dissolved total TDS, materials stuck total T.S.S., BOD, chlorides, nitrates, oil and grease, phosphates, and temperature.

## 3. METHODOLOGY

### Sampling Methods

Water samples were collected from study sites, North Oil Company, North Gas Company, Kirkuk cement plant and Kirkuk General Hospital, and for 6 months from September 2023 to

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February 2024, using containers Poly Athelin is 2.0 liters tight, and containers have been cleaned with diluted nitric acid, After eliminating organic materials and contaminants, thoroughly wash them with high-quality distilled water. After that, it was filled with distilled water until the sample arrived, at which point the containers were twice pushed full of sample water. Prior to sampling in each field model, glass 300 ml containers were used. Each site was modeled both before and after processing by holding the container from below and filling it with water up to a depth of nearly 30 cm, leaving the nozzle pointing toward the stream of water. Next, the cover was removed to fill the container with water, closing it immediately after. Finally, the bottles were instructed regarding the date of taking the models. Additionally, during the modeling process, all additional data and the containers were kept in fiber boxes with ice until they were moved to the lab. The samples were maintained at a certain temperature in the refrigerator. On samples for analysis (sulfate, phosphate, nitrate, TDS, EC, salinity, pH, temperature), this was done at (4.0 $^0$C). The 150 ml of samples that were meant to be used in the heavy element analysis were taken as soon as the laboratory was back in operation. After filtering the samples, a few drops of strong nitric acid (HNO3) were added to acidify them.

## Physical Tests of Water

### Temperature

A conventional mercury emitter was used to monitor the water's temperature, which ranged from (100.0 - 0.0) °C to (0.1 ° C).

### Electric Conductivity- (EC)

Specific Electrical Connectivity Using HANNA Model (EC- meter) Device H.199301 Microcosmenise/CM Unit.

### Salinity

Salinity was calculated based on electrical conductivity values, as described in the method as shown in the following formula:

$$Salinity\,\%_o = \frac{Electrical\,Conductivity - 14.78}{1589.08} \quad -------- Where\ EC\ in\ \mu S/cm$$

Units Part per Thousand (Part Per thousand %) E Unit (g/L).

### Total Dissolved Solid (T.D.S)

Total dissolved solids in milligrams per liter (mg/L) using the HANNA model type device H.199301 standard (2000.0-0.0).

## Chemical Tests of Water

PH Meter The pH of the samples was measured using a pH meter made by HANNA (Microprocessor HI 9321).

### Sulphate Ion Estimation

The spectral method (Turbidity metric method) known as the APHA method [14], as reported by Agha [15], was utilized to estimate the sulfate ion.

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### Nitrate Ion Estimation

The APHA method [15, 16] for nitrate ion is a spectral method that uses a Spectrophotometer at a wavelength of (270nm, 220nm).

### Phosphate Ion Estimation

Using the spectral method, Abbas detailed the phosphorus using APHA method and for the wavelength (700nm).

## 4. RESULTS AND DISCUSSIONS

### Physical Factors

Table 1 shows the physical factors of the water collected from different locations, it is noted that North Oil Company and North Gas Company was the most physically polluted compared to the rest of the samples. Where, EC was 64600, and Salinity was 29.8 in water of North Oil Company, while TDS was 44000 in water of North Gas Company.

Table 1 Physical tests of water

| Factors Location | EC (ms/cm) | T.D.S (ppm) | Temperature ($^0$C) | Salinity (ppm) |
|---|---|---|---|---|
| A1 | 43100 b | 21100 c | 25.2 b | 18.7 b |
| A2 | 64600 a | 31700 b | 25.9 a | 29.8 a |
| B1 | 38300 b | 1880 e | 25.4 b | 0.8 d |
| B2 | 26200 c | 22100 c | 26 a | 0.4 e |
| B3 | 21500 c | 44000 a | 25.9 a | 18 b |
| C | 1200 e | 1000 f | 26 a | 0.3 e |
| H | 4210 d | 3360 d | 25.5 b | 1.6 c |

A1, A2: North Oil Company B1, B2, B3: North Gas Company C: Kirkuk cement plant H: Kirkuk General Hospital
Vertically similar letters mean that there is no significant difference in the probability level ($P<0.05$).

The salinity values of the water's thickness are retrieved from the measurement of the electrical conductivity of water bodies, which serves as an indicator of the ions present in the water [17]. Table 1 shows a discernible rise in the research sites' electrical conductivity values. The TDS levels in the water clearly increased along with this increase in electrical conductivity, with North Gas Company having the highest value at 44,000 ppm. Reduced water levels, more nutrients, and an accelerated evaporation process are the causes of this. Large amounts of laboratory and hospital trash are fed into it throughout the course of the study's months, making it challenging to dilute because of the water's slow circulation [18]. The amount of dissolved solids in a body of water, fertilizer runoff, wastewater and septic effluent, soil erosion, decomposing plants and animals, and local geological features are all impacted by the rising dissolved salt levels in businesses and hospitals in the current study as a result of the rising water temperature [19].

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**Chemical Factors**

Table 2 shows the chemical factors of the water collected from different locations, it is noted that North Gas Company was the most chemically polluted compared to the rest of the samples. Where, pH was 3.67, $PO_4$ was 36.5 ppm and $NO_3$ was 18.6 ppm. While, highest valve of $SO_4$ showed in water of North Oil Company and it was 1267 ppm.

Table 2 chemical factors of water wastes

| Factors Location | pH | $PO_4$ (ppm) | $SO_4$ (ppm) | $NO_3$ (ppm) |
|---|---|---|---|---|
| A1 | 6.48 b | 5.66 b | 1267 a | 6.88 d |
| A2 | 6.64 b | 3.16 c | 900 b | 9.77 c |
| B1 | 6.83 b | 0.696 e | 198 d | 1.105 f |
| B2 | 3.67 c | 2.31 d | 162.5 d | 2 e |
| B3 | 7.27 a | 36.5 a | 72.4 e | 18.6 a |
| C | 8.33 a | 2.25 d | 178 d | 15 b |
| H | 6.68 b | 6.35 b | 413 c | 2.2 e |

A1, A2: North Oil Company B1, B2, B3: North Gas Company C: Kirkuk cement plant H: Kirkuk General Hospital
Vertically similar letters mean that there is no significant difference in the probability level ($P<0.05$).

The relevance of pH is emphasized by general environmental sources and water contamination. According to Ruttener [20], pH impacts the nature of the ecosystem and many living organism kinds. The variations in pH values between the study sites are displayed in Table 2, these values were towards acidity and varied from 3.67-8.33. This is because the wastewater from the hospital increases the amount of organic molecules in the water, which encourages microbial organisms to take up oxygen in order to break down organic materials [21]. Certain cleaning detergents included chemicals called polyphosphates. The issue of phosphorus entering detergents seems to be more complicated because the way detergents are used varies depending on the nation. Eutrophication is the process whereby an abundance of phosphorus in receiving waters causes a large-scale development of algae. Only 0.005 to 0.05 mg/l of phosphorus is needed in an aquatic environment to support algal blooms [22], and the values of every sample site were high enough to cause the eutrophication phenomenon. Lower values may be caused by the presence of CO2, salts, sulphates, nitrates, and chlorides. The effect of alkaline cleaning agents on the alkaline material is responsible for the increase in the relative values of pH, PO4, and SO4 during specific times [23]. Kirkuk General Hospital's pH never dropped below 7. In a similar vein, an investigation into Iranian hospitals revealed that the average pH of their raw wastewater was 7.5 across all hospitals under investigation [24].

**Heavy Metals**

Table 3 shows the heavy metals found in water collected from different locations, it is noted that the water samples collected from North Oil Company contained the highest concentration of cadmium (11.334), lead (10.355), nickel (1.356) and copper (1.579), while the water sample collected from North Gas Company contained the highest Concentration of iron (9.047) and cobalt (0.881).

Table 3 Concentration of some heavy Metals in Water

| Sites / Metals | A1 | A2 | B1 | B2 | B3 | H | C |
|---|---|---|---|---|---|---|---|
| Cd | 9.280 a | 11.334 a | 3.806 b | 8.512 a | 9.824 a | 2.143 b | 0.712 c |
| Pb | 6.115 c | 10.355 a | 8.622 b | 5.166 c | 8.133 b | 1.150 d | 1.200 d |
| Fe | 5.447 c | 4.844 c | 9.047 a | 7.124 b | 2.011 d | 2.474 d | 1.001 e |
| Co | 0.520 d | 0.754 b | 0.881 a | 0.793 b | 0.624 c | 0.312 e | 0.433 d |
| Ni | 1.356 a | 0.929 c | 1.247 a | 1.320 a | 1.110 b | 0.588 d | 0.310 e |
| Cu | 1.579 a | 1.240 b | 0.517 d | 1.285 b | 1.521 a | 0.644 c | 0.213 e |

A1, A2: North Oil Company B1, B2, B3: North Gas Company C: Kirkuk cement plant H: Kirkuk General Hospital
Horizontally similar letters mean that there is no significant difference in the probability level ($P<0.05$).

The concentration of all dissolved heavy metals in the river water is very high. The research area's industrial and human activity can be blamed for the elevated amounts of heavy metals. The waste from rubber and textile companies limits industrial activity. The low solubility of the heavy metals in the water is caused by their tendency to adsorb to the suspended particles, which causes precipitation in the pool bed. Additionally, water alkalinity accelerates the adsorption process and reduces the solubility of heavy metals [25–26]. Hospitals and oil and gas companies are thought to be potential sources of the metal since they release untreated waste into the water [27–29]. Even though lead (Pb) adsorbs strongly on sediment particles [30], the high amounts of Pb in the water under study may mean that Pb was present in excess of most other heavy metals and exceeded Iraqi and WHO criteria in the summer, fall, and spring. Cobalt and chromium just barely surpassed these requirements. The discharge velocity and water current are significant factors that affect how the amounts of heavy metals vary. A rise in current velocity causes turbulence in the water column, whilst an increase in discharges helps to dilute metal levels. Because of the mixing process with the bottom sediments, it helps to raise the concentrations of heavy metals in water [31].

## 5. CONCLUSIONS

The results of the current study showed that the water collected from some companies and the hospital in the city of Kirkuk showed high physical and chemical contamination of wastewater, especially the northern oil and gas companies.

 

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