Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Physical and Chemical Research (EJPCR)

ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

EVALUATION AND STUDY OF SOME CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF INDUSTRIAL WATER WASTE FROM THREE OIL COMPANIES

Khairallah Mohammed Abdullah Al-Obaidy[1]
Mohammed Y. Najmuldeen[2]
[1]Petroleum Training Institute - Refining Department – Iraq
[2]Petroleum Engineering Department, College of Engineering, University of Kirkuk, Kirkuk, Iraq
Corresponding author: Khairallah Mohammed Abdullah Al-Obaidy
Khery0121@gmail.com

Abstract

This study included an assessment of the quality of liquid industrial waste from three oil companies: Baiji Refineries Company (A) near Tikrit, the North Oil Company inside the city of Kirkuk (B), and the North Gas Company outside the city of Kirkuk (C), where samples were collected at regular monthly intervals for a period of six months, from September 2022 until February 2025 the study focused on a set of measurements that included alkalinity in terms of calcium carbonate, ammonia, with an estimate of the amount of nutrients (nitrite, nitrate, and phosphate), as well as potassium ions, aluminum, and some of biological pollution, including BOD and COD, as well as E.coli bacteria, total coliform bacteria, yeasts and molds, as they were all exceeding the standard specifications, except for ammonia and nitrite,

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

which were within the limits, as they showed a variation in medium basicity between the three companies, as the highest value was (467.01) for Company (A), and the lowest value was (25.03), with slight differences. As for nitrate, the results were between (3.9-50.9) mg/L. The average phosphate values exceeded the permissible limits of the Iraqi standards (3.0 mg/L), as they ranged between (1.7-7.9 mg/L), while the ammonia values ranged (0.07-79 mg/L) and the lowest rate for potassium was (2.1 mg/L) and the highest rate was (60.5 mg/L). As for aluminum, it ranged between (0.08-0.29 mg/L). The BOD_5 values also showed a high concentration of organic matter in industrial waste water, which varied between (102.0-117.2 mg/L). The results of the study showed a difference in the numbers of E. coli bacteria between the months of the study, as the highest value was recorded during the month of September, which was 760,000 cells/100 ml.

Keywords: Chemical characteristics - microbiological characteristics - industrial water - oil companies.

1- Introduction

Pollution is one of the challenges facing water at the present time, as most of the world's rivers suffer from severe pollution and a decline in the level of their water [1]. Pollution means causing damage (a defect in the water system) that leads to reducing its ability to perform its role, as it becomes harmful when used [2]. Discharging industrial water into rivers, with or without treatment, causes enormous damage to the aquatic environment because the water contains high concentrations of harmful environmental determinants. The increase in the metabolic process carried out by the algae leads to their proliferation, which activates the bacteria and increases the process of

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

biological decomposition of the algae, which leads to a decrease in the percentage of dissolved oxygen in the water, and this leads to the mass destruction of fish and other aquatic organisms. The water rots, emits unpleasant odors, and becomes suitable for the reproduction of insects as a result of the release of organic pollutants in large quantities [3].

1-2 Objective of the research

1- A qualitative study of industrial water waste (for three companies that differ in location, quantity of production, and the source of water they use, with a monthly comparison between the elements studied.
2- Evaluation and study of some of the chemical and biological characteristics of industrial water waste from three oil companies.

2- Practical part

2-1 Devices and tools used

A set of chemical and biological tests were conducted based on internationally approved standard methods [12], where nitrite (NO^{-1}) and nitrate (NO_3^{-1}) were measured using a spectrophotometer at wavelengths (220 nm and 275 nm), and phosphate (PO_4^{-3}) at a wavelength of 700 nm. The biological oxygen demand (BOD_5) was measured using a dissolved oxygen measuring device (Oxi Top/WTW) with an incubator at a temperature of (20) °C for a period of five days, and the chemical oxygen demand (COD) was measured using ($K_2Cr_2O_7$).

2-2 Sample area

Samples were collected and analyzed monthly for three oil companies: Baiji Refineries Company (A), North Oil Company (B), and North Gas Company

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

(C). The samples were collected in special plastic containers for preserving water, with a container capacity of (1.5) liters, they were transported directly to the laboratories. Work continued in this manner throughout the period of conducting qualitative examinations and analyses, which extended from September 2022 until February 2023, when samples were collected at regular monthly intervals for a period of six months. The company's locations have been changed to have more diversity regarding water and air.

3- Results and discussion

3-1 Basicity in terms of $CaCO_3$

The monthly fluctuations in total alkalinity rates may be attributed to conventional filtration processes and to not adding sufficient alum, as adding 1 mg/L of alum consumes 0.5 mg/L of the alkalinity of drinking water in terms of $CaCO_3$, and the reason for the decrease may be due to the consumption of dissolved CO_2 and bicarbonate ions as a source of inorganic carbons for the photosynthesis processes of aquatic plants and algae [4].

These results were close to the values recorded by Al-Hamdany [5], when he studied industrial waste, as they ranged between (82-420) mg/L, while they were lower than those of the liquid industrial waste of the city of Mosul, which reached (2125-2592) mg/L, respectively, Al-Aryani [6].

Figure (1) shows the variation in alkalinity averages between the three companies, where the highest value (467.01 mg/L) was recorded for Company (A) and the lowest value was (25.03 mg/L) with slight differences because Company (A) uses water from the Tigris River near the refinery, which is usually alkaline, and this matches what Al-Saffawi found [4], which ranged between (89-445 mg/L).

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

3-2 Nitrate ion (NO_3^{-1})

The results varied between (3.9-50.9 mg/L), and the reason for the increase in nitrate ion concentrations is the amount of polluted liquid waste released by companies, represented by industrial wastewater, which contains large quantities of protein substances that are decomposed by microorganisms into nitrogenous compounds. As for the decline in anoxic conditions, nitrates often turn into nitrite and nitrogen oxides, or even into free nitrogen [7].

Nitrates are primarily sourced from nitrite (NO_2), which is formed from ammonia due to the activity of aerobic bacteria, as in the following equations [8]:

NH_3 + Oxygen → NO_2 + energy

NO_2 + Oxygen → NO_3 + energy

The reason is due to the oxidation process of nitrogenous compounds available in water. Nitrates alone do not pose a danger to living organisms, but the danger lies in their derivatives that are produced by microorganisms available in the digestive tract (stomach), which cause stomach cancer and also hydroxylamine, which is produced by some types of bacteria, which are active on nitrates and cause genetic mutations [9].

3-3 Nitrite (NO_2)

Nitrite concentrations were low, as they were transformed by oxidation into nitrate, reaching (430 mg/L). The increase in nitrite concentration is attributed to the effect of industrial waste generated by companies as a result of the use of some chemical additives on the nitrite ion in production processes, which is what was concluded by [10] when evaluating and treating factory waste in the city of Hilla.

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

Nitrite is the intermediate state of oxidation of organic nitrogenous substances, and there are two main sources of dissolved nitrite: the first is from ammonia, as some nitrifying bacteria convert ammonia to nitrite, and the second is from reducing nitrate to nitrite. The US Environmental Protection Agency has determined its concentration not to exceed (1) mg/L (EPA, 2004) [11]. This is consistent with the current study, as the recorded nitrite values ranged between (0.0496-0.43) micrograms of nitrogen atom-nitrite/liter.

3-4 Phosphate

Phosphorus is an important nutrient for aquatic plants, which makes them grow in an unusual way. Then, their death and exposure to biological decomposition processes leads to the depletion of dissolved oxygen in the water and thus has a negative impact on aquatic life [12]. Phosphate concentrations have an important role in determining primary productivity, as they are an important element for the growth of phytoplankton, because the main source of phosphate in waste water is chemical additives such as antioxidants and antifreezes, which contain the activated phosphorus (builder), the most common of these stimulants is sodium tri-poly phosphate (STPP) ($Na_5P_3O_{10}$) which hydrolyzes quickly into simple components [13], which are shown in the following equations:

$$Na_5P_3O_{10} + 2H_2O \rightarrow 2Na_2HP_4 + NaH_2PO_4$$

$$NaH_2PO_4 \rightarrow Na^+ + H_2PO_4$$

This decrease in phosphate values (Table 4) may have resulted from the lack of excreted pollutants or due to the consumption of phosphate by plants and aquatic organisms. The high phosphate concentrations during the winter months may be attributed to the rise in water levels that lead to the washing away of plant nutrients and fertilizers added to the agricultural lands adjacent

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

to the river, as well as the decomposition of organic materials by bacteria to form phosphate [14].

Organic Comp. + O_2 → PO_4^{-3} + H_2O + CO_2

The average phosphate values exceeded the permissible limits of Iraqi standards, which were set at (3.0 mg/L). These results agreed with the results of other studies [14].

3-5 Ammonia

The results of the study showed a difference in ammonia values between the months of study for industrial waste water (Figure 5), as the highest value of ammonia was recorded in December and January (0.36, 0.79, 0.35) mg/L, respectively.

The results of the study showed that ammonia concentrations increased in the winter and decreased in the fall, as the results of the statistical analysis indicated that there were significant differences between the rainy seasons. This behavior of ammonia puts it in direct proportion to nitrates, and the rise in ammonia rates coincides during the winter and spring seasons as a result of rainfall, and the washing away of the nitrogenous compounds formed and accumulated in the soil from fertilizers and animal pollutants, which excrete nitrogen in the form of various nitrogenous compounds such as: ammonia and urea, in addition to what bacteria and fungi do to break down the proteins present in the dead plants and animals to convert the nitrogen into amino acids, then into ammonia, which quickly turns into nitrate, in addition to the role of industrial pollutants excreted from factories near the sites, and the drift of algae consuming nitrogen reduces its consumption, and then its percentage increases in winter [15].

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

3-6 Potassium ion (K^+)

Potassium ion concentrations from the study area were characterized by differences as in Figure (6), with the lowest rate being (2.1 mg/L) and the highest rate (60.5 mg/L).

Potassium concentrations in the Makhmour Basin, southeast of the study area, reached 100 mg/L (Abdul Hussein, 2008) [16]. The reason for this is due to the intense fertilization in those areas.

3-7 Aluminum:

Aluminum is found in most industrial waters in a dissolved or insoluble form, as the main reason for the presence of aluminum in drinking water is alum ($Al_2(SO_4)_3$), which is used in water liquefaction projects, as it is one of the most important compounds that cause agglomeration in the sedimentation process [16].

It was found that when adding alum in quantities greater or less than the amount required to treat the specific turbidity, it leads to an increase in the concentration of aluminum in the water because the excess alum does not bind with the turbid particles in the case of an increase and because the small amount of alum is not able to ferment with the turbid particles in the case of a decrease, and this was confirmed by [17].

Most of the results for aluminum concentrations in drinking water agreed when measured by the Iraqi standards of 0.25 mg/L (Standard No. 417 for drinking water of 1989) and the international standards [18], except for some that increased at different times than the specified percentage (Table 7).

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

3-8 Chemical Oxygen Demand (COD)

It was found that there is a noticeable increase in the values of COD in waste water. This confirms that the water contains large quantities of organic materials, which are difficult to decompose biologically. The value of COD is often higher than the values of BOD, because it expresses the amount Oxygen consumed in the oxidation of chemically and biologically oxidizable substances [19].

3-9 Biological oxygen demand BOD_5

The results in Table (9) showed: an increase in the concentration of organic materials in industrial waste water, which varied between (102.0-117.2 mg/L). The reason for the increase is that it contains large quantities of organic waste and industrial waste, which negatively affects the concentration of dissolved oxygen, then the occurrence of anoxic degradation of organic materials and sulfide compounds (H_2S) and ammonia gas (NH_3), and the emission of unpleasant and annoying odors, which are harmful products to the aquatic environment, according to what is stated in the following equations [20]:

$$4CH_3H_7O_2NS + 8H_2O \rightarrow 4CH_3COOH + 4NH_3 + 4H_2S$$

$$4CH_3COOH + 8H \rightarrow 5CH_4 + 3CO_2 + 2H_2O$$

3-10 E.coli bacteria

This test is an indicator of the presence of types of disease-causing microorganisms, such as viruses and protozoa that are resistant to disinfectants.

The results of the study showed a difference in the numbers of E.coli bacteria between the months of the study (Table 10), as the highest value was recorded in September and was 760,000 cells/100 ml, while the lowest number of E.coli

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

bacteria was recorded in December. This was confirmed by (Al-Azzawi, 2010) [21], and this result was consistent with (Al-Fatlawi, 2007) [22].

3-11 Total coliform bacteria (TC)

The results of the current study showed high monthly rates of TC numbers. This is due to several reasons that may be related to the quality of the water prepared for the production line, as the bacterial content varies depending on the source [23]. The surface water sources on which bottled water depend, and natural filtration, as well as the quality of disinfection processes in production lines, and the lack of control over the ozone dosages or the wavelength of U.V. rays necessary to ensure a successful disinfection process [24], Table (11).

3-12 Yeasts and molds

Molds are characterized as mycelium and one thread is called hypha. Some hypha threads grow submerged in food, while others grow in the air (aerial) at a temperature of (25-30°C) and are called mesophiles, and others grow at a temperature slightly above the freezing point and are called psychrophiles, and some of them grow at temperatures lower than freezing, while some of them grow at temperatures (37-50°C) and are called thermophiles.

As for yeasts, they are eumycetes, ascomycetes, unicellular, oval or spherical. They reproduce either asexually by buds or sexually by forming spores [25].

Most of the water is not considered to meet the standards, the reason is due to water pollution, the lack of careful sterilization processes, and the contamination of samples during preparation processes, in addition to water pollution caused by workers in factories, the excessive release of H_2S, and the

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

age of the machines used in it, as the acidic environment is considered suitable for the growth and reproduction of fungi and molds (Al-Mayali, 2008) [26].

Conclusions

1- High concentration and values of physical, chemical and biological tests for industrial water waste, as most of the tests appeared not to conform to Iraqi and international water standards, which increased the severity of the effects of pollution on the governorate's environment.

2- Industrial water and its wastes affected the aquatic environment according to the type of product and the amount of pollutants released.

3- Using industrial waste water for irrigation may lead to (eutrophication), i.e. increasing production, but the accumulation of these minerals in the long term.

4- The lack of commitment of some industrial establishments to using modern methods to avoid the harmful effects of pollution resulting from their industrial waste.

References

1. Al-Samalouti, Nabil. (2003). The problem of environment and development in the Islamic world. Conference on Ijtihad on Environment and Urban Issues. Jordan.
2. Al-Omair, Mohammed bin Abdul Rahman. (2001). Environmental pollution - A vision through the Prophet's hadiths. International Symposium on Islamic Sharia and Contemporary Society Issues. Morocco.
3. W.J. Hammer. (2008). Water and Wastewater. Technology, 6th Ed.
4. Al-Saffawi, Abdul Aziz Younis Tali'. (2007). A study of the quantity and quality of liquid waste discharged from the city of Mosul and its impact

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
Eureka Journal of Physical and Chemical Research (EJPCR)
ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

on the water quality of the Tigris River. Proceedings of the first scientific conference of the Center for Environmental Research and Pollution Control. University of Mosul-Iraq, June 5-6, pp. 1.

5. Al-Hamdany, Ali Ahmed Jassim. (2009). Removing pollutants from some of the city of Mosul's sewage water using some aquatic plants. Master's thesis, College of Science/University of Mosul.
6. Al-Aryani, Adil Qaed Ali. (2005). Estimating the qualitative characteristics and trace and heavy elements in the soil and sewage water of the city of Mosul and in the plants irrigated therein and determining the efficiency of Helianthus annuus L. in removing them. PhD thesis / College of Science - University of Mosul.
7. I.O. Asia, and E.E. Akporhonor. (2007). International Journal of Physical Sciences. Vol. 2, No. 3, pp: 61-67.
8. Elia, Hala Nabil. (2010). Physicochemical treatment of hospital complex wastewater in Mosul. Al-Rafidain Science Magazine. 18(3): 13-24.
9. Basil Abdul-Jabbar Latif. (1990). Environmental pollution and its control. Baghdad: Dar Al-Hikma Printing, pp. 51.
10. Hashimi, Mohammed Ali. (2000). An evaluation of the treatment of industrial waste from Hilla Textile Factory to Shatt Al-Hilla. Department of Building and Construction, University of Technology - Baghdad. pp. 3-27.
11. Lawrence, Michael C., et al. "Structure of the haemagglutinin-neuraminidase from human".
12. Lee, J.A., Cho, K.J., Kwon, O.S. and Chung, I.K. (1993). A study on the environmental factors in Nektons estuarine ecosystem. The Kor. J. Phycol., 8(1): 29-36.

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Physical and Chemical Research (EJPCR)

ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

13. Ali, Latif Hameed. (1991). Industrial Pollution, University of Mosul / Iraq.
14. Salim Dhiaa Al-Din Hassan, Mohannad Hadi Issa, Ali Radi and Ali Fahim Abd. (2009). A study of some determinants of pollution in Najaf Al-Ashraf. Journal of Geographical Research. Issue (11): 215-232.
15. Al-Saadi, Hussein Ali, Al-Daham, Najm Omar, and Abdel-Jalil, Laith. (1986). Aquatic Ecology, University of Basra, Basra.
16. Habayeb Abd Al-Hussein Majeed. (2008). Determining the conformity of industrial wastewater specifications. Technical Magazine, Volume 21, Issue 4.
17. Kleihues, Paul, Peter C. Burger, and Bernd W. Scheithauer. (1993). The new WHO classification of brain tumors. Brain pathology. 3(3): 255-268.
18. Al-Anazi, Majida Sabah. Akbar, Manal Mohammed. Abdel-Sahib, Ibtisam Mahdi. (2014). Evaluating the efficiency of the Hamdan Industrial Water Treatment Plant in Basra Governorate. Dhi Qar Science Journal. 5(1): 2-8.
19. Al-Saffawi, Abdul Aziz Yunis Tali' and Al-Ta'i, Nour Dhiaa Salih. (2013). Environmental and bacteriological study of liquid waste from hospitals in the city of Mosul. Tikrit Journal of Pure Sciences, 18(4): 86-97.
20. Al-Anazi, Majida Sabah. Akbar, Manal Mohammed. And Abdel-Sahib, Ibtisam Mahdi. (2014). Evaluating the efficiency of the Hamdan Industrial Water Treatment Plant in Basra Governorate. Dhi Qar Science Journal. 5(1): 2-8.
21. Al-Azzawi, Israa Salman Dillis. (2010). Environmental and bacteriological study of the Al-Alam irrigation project in Salah Al-Din Governorate, Master's thesis, College of Science/Tikrit University.

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
OPEN ACCESS JOURNALS

Eureka Journal of Physical and Chemical Research (EJPCR)

ISSN 2760-490X (Online) Volume 2, Issue 7, July 2026

https://eurekaoa.com/index.php/1

22. Al-Fatlawi, Ya'rub Faleh Khalaf. (2007). Study of drinking water quality for some Baghdad water liquefaction projects. PhD thesis, College of Science, University of Baghdad.
23. EPA. (2005). Water Health Series: Bottled Water Basics. US. Environmental Protection Agency (EPA). 10.
24. Razouki, Sarab Mohammed Mahmoud. (2008). Study of the reality of the bottled drinking water industry in Iraq between the years 1995-2008. The first scientific conference: Public health is an investment for a better life, Ministry of Health.
25. LODDER, Jacomina. (1970). General classification of the yeasts. The Yeasts, a Taxonomic Study, 1-33.
26. Ethar Kamil Al-Mayali. (2008). Evaluation of the microbial quality of drinking water distributed from the Al-Fath Al-Mubin complex. Al-Mustansiriya Science Journal, 19(2): 36.