Data Article

Anomalies in industrial wastewater quality data in Kuwait

Adel Al-haddad, Mohd Elmuntasir Ahmed, Hussain Abdullah, Rashed Al-Yaseen

Kuwait Institute for Scientific Research, P. O. Box 24885, Safat 13109, Kuwait

A R T I C L E   I N F O

Article history:
Received 14 January 2021
Revised 3 March 2021
Accepted 4 March 2021
Available online 5 March 2021

Keywords:
Industrial wastewater
Categorization
Field survey
Database
Quality control
Wastewater treatment

A B S T R A C T

Data was collected on the quality and quantity of wastewater discharged from different petroleum and nonpetroleum industrial sources in Kuwait over a period of one year. A field survey included 75 factories distributed in three industrial areas (Sabhan, Kuwait City, and Shuaiba). Among the industries contacted only 41 agreed to participate in field measurements and wastewater sampling campaign. The questionnaire feedback obtained indicated that the activities of these industries can be categorized into 20 categories including 4 and 37 petroleum and nonpetroleum industries, respectively. The mean quality of wastewater generated in Sabhan industrial area were found to be higher than those of Kuwait City and Shuaiba areas. The inorganic results indicated that high values of total suspended solids (TSS), total dissolved solids (TDS), sulfide, free chlorine, and fluoride were observed in the wastewater of petroleum factories of Shuaiba, while high values of total phosphate, ammonia, total Kjeldahl nitrogen, total nitrogen, and floatables were observed in the wastewater of nonpetroleum factories of Kuwait City. Additionally, organic results indicated that high values of chemical oxygen demand (COD), biochemical oxygen demand (BOD), oil and grease, and total petroleum hydrocarbons (TPHs) were observed in the wastewater of petroleum factories of Shuaiba area. GIS maps were generated for 25 wastewater parameters for the participating 41 factories using ArcView GIS software.

* Corresponding author.
E-mail address: miahmed@kisr.edu.kw (R. Al-Yaseen).

https://doi.org/10.1016/j.dib.2021.106945
2352-3409/© 2021 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
### Specifications Table

| Subject       | Environmental Engineering |
|---------------|---------------------------|
| Specific subject area | The data deals with wastewater quantity and quality which is important for designing wastewater treatment and management interventions and pollution control. Additionally, wastewater treatment is one environmental engineering subject area which contribute to treated effluent reuse and augmentation of water resources. |
| Type of data  | Figure |
| How data were acquired | The data were acquired: using Thermometer, pH Meter, EC Meter, DO Meter, Filtration Assembly, Analytical Balance, Oven, Imhoff Cone, Hach UV–Vis Spectrophotometer (DR. 6000), BOD Measurement System, BOD Incubator |
| Data format   | Raw |
| Parameters for data collection | Data was acquired through field measurement of field parameters and sample collection. The collected samples were preserved and analysed in KISR laboratories for inorganics, organics, and microbial parameters. The field measurements and sampling were conducted at 41 industrial facilities in Kuwait. The field measurements and sampling was conducted on biweekly bases with some exceptions. |
| Description of data collection | Based on agreement between the owners of factories and the project team, a total of 41 factories were included in this data survey (14, 10, and 17 for Sabhan, Kuwait City, and Shuaiba industrial areas, respectively). Shuaiba industrial area represents factories of petroleum wastewater origin, while the other sites (Kuwait City and Sabhan) represent factories of nonpetroleum wastewater origin. The field measurements and sampling started for all factories in mid-December 2018 on a biweekly basis except for factories in Sabhan industrial area where the sampling started on a monthly basis during the period between mid-December 2018 and end of April 2019, as instructed by the owners of factories, followed by biweekly sampling during June–July 2019. The wastewater sampling was stopped during May 2019, resumed in June 2019, and was completed by the end of July 2019. Also, wastewater was not collected, especially when the wastewater collection points were dry during the visit of the field team to the factory. |
| Data source location | Institution: Kuwait Institute for Scientific Research |
|                   | City/Town/Region: Kuwait City |
|                   | Country: Kuwait |
| Data accessibility | Mendeley |
|                   | [https://data.mendeley.com/datasets/9zbf28fgmn/1](http://creativecommons.org/licenses/by-nc-nd/4.0/) |

### Value of the Data

- Wastewater quality data are useful in deciding wastewater management alternatives in the industrial sector. Also, these data are useful to design best collection and treatment systems, reuse alternatives, and environmental management actions.
- The data on wastewater quantity and quality is of utmost benefit to government institutions, private sector wastewater companies, and international community.
- This data set is useful to build on to further investigate environmental impacts of industrial wastewater and its specific pollution characteristics including trace contaminants, contaminants of emerging concern, and toxicity.

### 1. Data Description

In this section, the changes in wastewater quality with respect to the field parameters, inorganic, organic, and microbial parameters of the wastewater for the three industrial areas
A. Al-haddad, M.E. Ahmed and H. Abdullah et al. / Data in Brief 35 (2021) 106945

Fig. 1. Distribution map of average values of temperature (°C) in wastewater for various industries in Kuwait.

(Sabhan, Kuwait City, and Shuaiba) are presented. Shuaiba area consists of both nonpetroleum and petroleum factories, while the other industrial areas consist only of nonpetroleum factories (Sabhan and Kuwait City).

1.1. Field parameters

Temperature. The average values of wastewater temperature for the three industrial areas are shown in Fig. 1. In this figure, the highest values of wastewater temperature were obtained in Shuaiba area compared to the other two areas. Also, the wastewater temperature was found to be higher in nonpetroleum factories than in petroleum factories in the same area. This might be due to the nature of industrial activities for nonpetroleum factories.

pH. The average values of wastewater pH for the three industrial areas are shown in Fig. 2. From this figure, it is clear that the highest values (that is, alkaline media) of wastewater pH was obtained in Shuaiba area compared to the lowest pH values (acidic media) of the wastewater obtained from Sabhan area. Also, the wastewater pH was found to be higher in petroleum factories than in nonpetroleum factories in the same area. In general, the pH values of the wastewater for all industrial areas were below the maximum limit set by KEPA for irrigation water.

EC. The average values of EC of wastewater for the three industrial areas are shown in Fig. 3. The highest values (that is, brackish water type) of EC of wastewater was obtained in Shuaiba area compared to the lowest EC values (that is, freshwater type) of the wastewater obtained from Sabhan area. Also, the EC value of wastewater was found to be higher in nonpetroleum factories than in petroleum factories in the same area.

ORP. The average values of ORP of wastewater for the three industrial areas are shown in Fig. 4. From this figure, it is clear that the highest values (that is, low reduced zone) of EC of wastewater were obtained in Shuaiba area compared to the lowest EC values (that is, high reduced zone) of the wastewater obtained from Sabhan area. Also, the EC value of wastewater was found to be higher in nonpetroleum factories than in petroleum factories of the same area.
Fig. 2. Distribution map of average values of pH in wastewater for various industries in Kuwait.

DO. The average values of DO of wastewater for the three industrial areas are shown in Fig. 5. The highest values (that is, high oxidized zone) of EC of wastewater were obtained in Shuaiba area compared to the lowest EC values (that is, low oxidized zone) of the wastewater obtained from Sabhan area. Also, the DO values of wastewater were found to be higher in nonpetroleum factories than in petroleum factories of the same area.

1.2. Inorganic parameters

The average values of TSS of wastewater for the three industrial areas are shown in Fig. 6. From this figure, it is clear that factories of Shuaiba area produce higher values of TSS compared to other two areas.

The average values of TDS of wastewater for the three industrial areas are shown in Fig. 7. From this figure, it is clear that factories of Shuaiba area produce higher values of TDS compared to other two areas with the exception of one factory in Kuwait City.

The average values of TP of wastewater for the three industrial areas are shown in Fig. 8. TP produced from factories in Sabhan and Kuwait City is higher than that of Shuaiba area. This observation applies to ammonia (Fig. 9), Kjeldahl nitrogen (Fig. 10), and TN (Fig. 11) with few exceptions.

The average values sulfide, free chlorine, and fluoride are shown in Figs. 12, 13, and 14, respectively. Highest averages of sulfide were found in Shuaiba and Kuwait City, for chlorine in Shuaiba and Sabhan, and for fluorides the average concentrations are similar in the three areas. Floatables average concentrations are shown in Fig. 15 which shows that the highest average floatable concentrations were observed in Sabhan area.

From these Figures (6–15), it is clear that petroleum factories of Shuaiba area produce high values of wastewater parameters, including TSS, TDS, sulfide, free chlorine, and fluoride compared to the other factories, while nonpetroleum factories of Kuwait City and Sabhan areas produce high values of wastewater parameters, including total phosphate, ammonia, TKN, TN, and floatables, compared to the other factories.
1.3. Organic parameters

The average values of organic wastewater parameters for the three industrial areas are shown in Figs. 16, 17, 18, 19, 20 for O and G, TOC, TPH, COD, and BOD, respectively. From these figures, it is clear that petroleum factories of Shuaiba area produce high values of organic wastewater parameters, including O and G, TOC, TPH, COD, and BOD compared to the other areas.

1.4. Microbial parameters

The average values of microbial parameters for the wastewater of three industrial areas are shown in Figs. 21, 22, 23, 24, and 25 for TC, FC, E. coli, salmonella, and fungi, respectively. It is evident from this figure that the nonpetroleum factories of Kuwait City area produce high counts of microbial wastewater parameters, including total coliform, FC, E. coli, salmonella, and fungi compared to the other areas. Coliphage viruses, enterococci, and parasites were not detected in the three areas.

2. Experimental Design, Materials and Methods

The industries in Kuwait are mainly distributed in three areas, namely, Kuwait City, Sabhan, and Shuaiba industrial areas. Based on agreement between the owners of factories and the project team, a total of 41 factories were included in this data survey (14, 10, and 17 for Sabhan, Kuwait City, and Shuaiba industrial areas, respectively). Shuaiba industrial area represents factories of petroleum wastewater origin, while the other sites (Kuwait City and Sabhan) represent factories of nonpetroleum wastewater origin.

The measurements and sampling started for all factories in mid-December 2018 on a bi-weekly basis except for factories in Sabhan industrial area where the sampling started on a
monthly basis during the period between mid-December 2018 and end of April 2019, as instructed by the owners of factories, followed by biweekly sampling during June–July 2019. The wastewater sampling was stopped during May 2019, resumed in June 2019, and was completed by the end of July 2019. Also, wastewater was not collected, especially when the wastewater collection points were dry during the visit of the field team to the factory.

The laboratory results of industrial wastewater were grouped into four groups including field parameters, inorganic parameters, organic parameters, and microbial parameters. Field parameters consisted of five parameters including temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), and oxidation–reduction potential (ORP). The inorganic parameters consisted of ten parameters including total suspended solids (TSS), total dissolved solids (TDS), total phosphate (TPO$_4$), ammonia (NH$_3$), total Kjeldahl nitrogen (TKN), total nitrogen (TN), sulfide (S$^{-2}$), free chlorine (F-Cl$_2$), floatables, and fluoride (F). The organic results consisted of five parameters including chemical oxygen demand (COD), biochemical oxygen demand (BOD), total organic carbon (TOC), oil and grease (O and G), total petroleum hydrocarbon (TPH). The microbial parameters consisted of nine parameters including total coliform (TC), fecal coliform (FC), E. coli, enterococci, salmonella bacteria, fungi, coliphage virus, and parasites. In general, the wastewater parameters were analysed for 41 factories distributed in three industrial areas on a biweekly basis for seven months.

The wastewater field measurements, sampling, and laboratory analysis activities were carried out according to the Standard Method for Water and Wastewater Examination, American Public Health Association (APHA) [1].

Excel spreadsheet was prepared as a database in which values of wastewater quality parameters were regularly for each location. The Excel database was then converted into a GIS database, using ArcGIS software (version 10.4). From the GIS database, GIS maps for each wastewater quality parameter were generated to reflect the spatial distribution of the quality of the raw wastewater produced by the various industrial facilities studied.
Fig. 5. Distribution map of average values of dissolved oxygen (mg/l) in wastewater for various industries in Kuwait.

Fig. 6. Distribution map of average values of total suspended solids (mg/l) in wastewater for various industries in Kuwait.
Fig. 7. Distribution map of average values of total dissolved solids (mg/l) in wastewater for various industries in Kuwait.

Fig. 8. Distribution map of average values of total phosphate (mg/l) in wastewater for various industries in Kuwait.
Fig. 9. Distribution map of average values of ammonia nitrogen (mg/l) in wastewater for various industries in Kuwait.

Fig. 10. Distribution map of average values of total Kjeldahl nitrogen (mg/l) in wastewater for various industries in Kuwait.
**Fig. 11.** Distribution map of average values of total nitrogen (mg/l) in wastewater for various industries in Kuwait.

**Fig. 12.** Distribution map of average values of sulfide (mg/l) in wastewater for various industries in Kuwait.
Fig. 13. Distribution map of average values of free chlorine (mg/l) in wastewater for various industries in Kuwait.

Fig. 14. Distribution map of average values of fluoride (mg/l) in wastewater for various industries in Kuwait.
Fig. 15. Distribution map of average values of floatables (mg/l) in wastewater for various industries in Kuwait.

Fig. 16. Distribution map of average values of oil and grease (mg/l) in wastewater for various industries in Kuwait.
Fig. 17. Distribution map of average values of total organic carbon (mg/l) in wastewater for various industries in Kuwait.

Fig. 18. Distribution map of average values of total petroleum hydrocarbon (mg/l) in wastewater for various industries in Kuwait.
Fig. 19. Distribution map of average values of chemical oxygen demand (mg/l) in wastewater for various industries in Kuwait.

Fig. 20. Distribution map of average values of biochemical oxygen demand (mg/l) in wastewater for various industries in Kuwait.
Fig. 21. Distribution map of average values of total coliform bacteria counts (mpn/100 ml) in wastewater for various industries in Kuwait.

Fig. 22. Distribution map of average values of fecal coliform bacteria counts (cfu/100 ml) in wastewater for various industries in Kuwait.
**Fig. 23.** Distribution map of average values of E. coli bacteria counts (mpn/100 ml) in wastewater for various industries in Kuwait.

**Fig. 24.** Distribution map of average values of salmonella bacteria counts (cfu/100 ml) in wastewater for various industries in Kuwait.
Fig. 25. Distribution map of average values of fungi counts (cfu/100 ml) in wastewater for various industries in Kuwait.

CRediT Author Statement

Adel Al-Haddad: Project leader, sampling plan and analysis methodology and project execution; Mohd Elmuntasir Ahmed: Data analysis, Writing the Original draft, Reviewing and Editing corresponding author; Hussain Abdullah: sample collection, laboratory analysis, and tabulation; Rashed Al-Yaseen: data analysis and software.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

Acknowledgments

The Author would like to thank the Kuwait Foundation for the Advancement of Sciences (KFAS) and Kuwait Institute for Scientific Research (KISR) for the financial funding of this research.

Reference

[1] APHAStandard Method for the Examination of Water and Wastewater, American Public Health Association, Washington, D.C., USA, 2017.