Studying the optimal techniques for removing the organic load from wastewater of hospitals laboratories

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Abstract

Hospital wastewater poses a strong threat to human health security as it contains a variety of difficult-to-degrade organic compounds, active pharmaceutical compounds, multiple inorganic pollutants, etc., causing complex pollution in water resources and ecosystems.

Aim of this study to treatment wastewater resulting from analysis laboratories in the hospital.

waste water was treated using several techniques, including biological treatment using the rotating biological tablets (RBC) method, adsorption with Syrian natural pollutants, coagulation with aluminum sulphate, advanced oxidation with ultrasound, and dual treatment using natural pollutants with ultrasound waves. The effectiveness of organic load removal was determined after each treatment and by applying different treatment conditions.

results showed the effectiveness of the treatment methods used, the best way to treat the studied water sample was treatment using natural pollutants with ultrasound waves. Water suitable for irrigation was obtained according to the Syrian standard when adding natural pollutants at a concentration of 1gr per liter of polluted water and applying ultrasound waves at a high frequency. 40kHz for 30 minutes, where the COD value reached 212 mg/l with a removal rate 94%, and the BOD value reached 82 mg/l with a removal rate 87%.

Keywords: Wastewater, Coagulation, Adsorption, Ultrasound, Biological Treatment, Chemical Treatment

DOI: 10.7176/CMR/17-1-03

Publication date: January 31st 2025

1. Introduction

Medical and solid waste from hospitals and the environmental pollution that destroys it are among the most important topics that must be undertaken seriously by others, because they have the greatest catastrophic impact on humans, soil, and water sources if they are not disposed of in the correct ways [1].

Most hospitals, if we do not say one, do not have plants in them that handle waste, and as for those optional wastes, as they are, with all the danger they carry, either to the public garden, or to the rivers, and in the end the crops that we eat are irrigated with them.

He studied many sewage units belonging to distinguished hospitals. The distinguished one in this field is Beryl's study, which determines the specifications of fresh water drains from the hospital laboratory in Gaziantep. The final result, which is the search for effective water for the hospital laboratory, contains some polluting elements that are above The required limits are required globally so this water is necessary [2].

It contains many polluting sources resulting from its large activities. These are excreted in the high turquoise acid of luxury cars, chemical compounds, radioactive isotopes, viruses that cause viruses, and viruses resulting from the various units in the hospital, especially the laboratory unit, which contains multiple types of laboratories, including (chemicals laboratory, hematology laboratory, Bacterial laboratory, vitamin laboratory, PCR laboratory, testing laboratory, serology laboratory, electrolytes laboratory, PT laboratory) [3,4].

Certainly, these many laboratories are conducted in which various chemical materials and compounds are used, the most important of which are (cyanide, phenol, mercury, bromine, formaldehyde, chromium, and zinc). These compounds are used through the network to the general stream to detect and affect the qualitative profits in it and are disposed of as they are with all It is carried by blood [3,4].

Next, a clear and bacteriological film of hospital wastewater demonstrates the presence of a wide range of hazardous chemical compounds and their residues, including scents, hormones, smoke, disinfectants, dyes, cytotoxins, and visible isotopes. It is characterized by hospital wastewater and the complexity of BOD, COD, TDS, TSS, TS, TOC, TN, nitrite, nitrate. Drainage water also creates high concentrations of harmful bacteria and

drug-resistant bacteria, therefore, it remains essential for the environment.
The percentage of sewage resulting from laboratories in the hospital represents about 7-20% of the sewage of the hospital college. [5,6]
After wastewater treatment by WWTPs, the particle removal for small and minor PC steps is 20-50%, 30-70%, and > 90%, respectively. Conventional viral treatment; Bagdad Bioactives, multi-organism-activated treatment, and filtrate, are present (<80%) in BOD, COD, and TSS but are ineffective in removing combinations of mild discrimination, psychiatric drugs, and antibiotic resistance. Advanced industry needs such as advanced refrigerator, ozone refrigerator, Fenton oxidation, nano-regeneration, and hybrid technologies for comprehensive study of complete fungi removal. The ozonation cell removes up to 93% of the various active substances present in the wastewater. Just as modern AOPs remove a significant amount of antibiotics and antibiotics from hospital wastewater, it has been shown that MBR reactors in conjunction with urbanization with advanced readiness AOPs are not successful in discharging hospital wastewater on a full scale [5,7,8].
Aleppo University Hospital was chosen in this research because it is considered one of the most important vital and strategic departments because of the free medical services it provides in general. For this reason, the idea is based on draining water from the hospital laboratories using chemical research techniques, including coagulation, adsorption, advanced treatment, and advanced oxidation with ultraviolet waves and then electricity to begin. Later for the new generation.

2. Materials and work methods

Water samples were collected from wastewater produced by Aleppo University Hospital laboratories, then mixed to form a composite sample and stored in tightly sealed polyethylene containers at low temperature. The specifications of raw and treated wastewater in the hospital were determined according to standard methods [9].
To study the effectiveness of biological treatment of the water sample, the RBC method of rotating biological discs was used. To study the effectiveness of chemical adsorption treatment, natural clay with the chemical composition shown in Table No. (3) was used, which is from the Tal Ajar area in the countryside of the city of Aleppo in Syria. To study the effectiveness of coagulation treatment The chemist used hydrated aluminum sulphate, $Al_2(SO_4)_3.18H_2O$, with a purity of 98%, produced by Sigma-Aldrich. To study the effectiveness of ultrasonic treatment, an ultrasonic wave generating device, model WUC-D 3.3, with a high frequency of 40 kHz, produced by witeg, was used. Labortechnik GmbH. To conduct bacterial tests for the water sample before and after treatment, the Total Count Plate (TPC) method was used, and each of the following media was used:
General counting medium: (Oxoid) plate count agar was used to enumerate the germs in the studied sample
MacConkey Agar: (HIMEDIA) MacConkey agar was used to detect the presence of Enterobacteriaceae bacteria.
2.1. Biological treatment of aqueous sample
In order to conduct biological treatment of the aqueous sample, the RBC rotary disk reactor was designed, which consists of a cylindrical treatment basin with a length of 1m and a diameter of 55cm, with a capacity of 80 litres. It contains 18 disks, the diameter of each disk is 45cm, the spacing between the disks is 1cm, the thickness of the disk is 3mm, and the length of the axis is 1m, where the horizontal distance of the first disk is approximately The inlet is 38cm, and the horizontal distance of the last disc from the exit is 38cm, as shown in Figure (1). The number of cycles is controlled and the disc immersion rate is 35%. There is a sedimentation basin after the treatment basin.

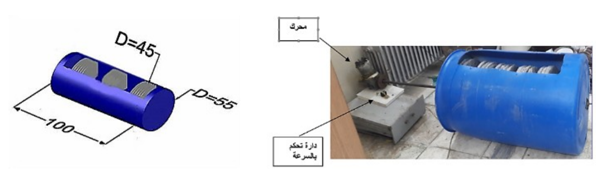


Figure (1): RBC rotary disk biological reactor

The reactor was operated at a laboratory temperature of (25±2) ºC, where a sample of wastewater resulting from the hospital was added daily in order to grow bacteria on the surface of the discs. The development process took 35 days until the biological layer was formed on the surface of the discs, and the thickness of the biological membrane layer was 0.5. Approximately mm, and then processing experiments were conducted on it. Table (1) shows the results of the experiments conducted in the reactor start-up phase.

Table (1): Results of experiments conducted in the reactor start-up phase

start-up (day)	COD (mg/l)
0	3600
5	1523
10	1342
15	924
20	575
25	437
30	263
32	251
33	245
35	240

We note from Table No. (1) that as the take-off time increased, the efficiency of COD removal improved due to the increasing growth of biomass that was feeding on organic materials and breaking them down to obtain the energy needed for growth and construction.

After the completion of the reactor start-up process (biological membrane development), treatment was carried out by adding the water sample to be treated to the treatment basin in batches at a flow rate of 2 L/h, using a rotation speed equivalent to 6 rpm. Samples were taken from the sedimentation basin after the treatment basin, after different times h. (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) Chemical analyzes were conducted to determine the extent to which the treatment effectiveness is affected by time, as in Table No. (2). It can be observed that as the treatment time increases, it decreases. The COD value reached the value of 147 mg/l at a treatment time of 12 hours and also at a time of 10 hours. The Syrian standard for irrigation of agricultural lands No. 2752 of 2008 was reached, where the COD concentration decreased to 294 mg/l. The results also indicated that with increasing treatment time, it decreased. The BOD value reached 124 mg/l at a time of 12 hours, and also at a residence time of 10 hours. The Syrian standard for irrigation of agricultural lands was reached, as the BOD concentration decreased to 135 mg/l, which indicates that the ideal treatment time to obtain water suitable for irrigation is 10 hours.

2.2. Treating the aqueous sample with natural clay

Use natural clay with the following chemical composition: SiO_2 (47.44%), Al_2O_3 (19.25%), Fe_2O_3(8.5%), MgO (1.79%), CaO (6.18%), Na_2O (0.19%), K_2O (2.35%), SO_3(0.97%), L.O.I (13.05%).

Eight samples of the studied water, each with a volume of 1 liter, were taken, and carbohydrates were added to them in different quantities, granular sizes, and different treatment times according to the following:

- Sample (A): amount of clay 0.5gr, particle size 500µm, processing time 30min
- Sample (B): The amount of clay is 1gr, the particle size is 500µm, the processing time is 30min.
- Sample (C): Amount of clay 2gr, particle size 500µm, processing time 30min
- Sample (D): Amount of clay 3gr, particle size 500µm, processing time 30min
- Sample (E): The amount of clay is 2gr, the granular size of the clay is 300µm, the processing time is 30min.
- Sample (F): The amount of clay is 2gr, the granular size of the clay is 100µm, the processing time is 30min.
- Sample (G): Amount of clay 2gr, particle size 100µm, processing time 60min
- Sample (H): amount of clay 2gr, granular size of clay 100µm, processing time 120min

-Chemical analyzes of water samples were conducted before and after treatment with lime, and the results were presented in Table (2), which shows the following points:

-The effectiveness of treatment increases with the amount of added pollutants, and the best amount is 2 gramper liter of polluted water. Adding a larger amount does not give a clear increase in the effectiveness of treatment.

-The effectiveness of the treatment increases with the decrease in the granular size of the clay used as a result of the increase in the specific surface. We note that the size of 100 microns was the best and we did not study the size less than 100 because there is difficulty in grinding and a high cost to reach smaller sizes.

-The effectiveness of treatment increases with increasing treatment time, and the best time is 120 minutes. 60 minutes can be sufficient if the goal is to dispose of water into sewage.

2.3. Treatment with aluminum sulphate

Treatment was carried out using aluminum sulphate by coagulation by adjusting the acidity of the medium at pH=7 using a diluted solution of sodium hydroxide and a diluted solution of hydrochloric acid until the required value was reached, which is the appropriate value for aluminum sulphate to work as a coagulant. The treatment conditions were according to Table. (3).

Table (2) shows the results of the analysis of the samples after this treatment. The results of the analysis showed that the effectiveness of treatment with aluminum sulphate is less than the effectiveness of treatment with adsorption agents. The explanation for this result is due to the type of pollutant materials accompanying the studied water, where their ability to aggregate and settle is weak and their solubility is high. Therefore, adsorption is considered to be of high quality. Better effectiveness in capturing and collecting these organic pollutants.

2.4. Treatment by Ultrasound

The effect of the effectiveness of ultrasound waves, frequency, and exposure time in reducing organic pollutants present in the water sample was studied, where the applied frequency was kHz (20, 30, 40), and the exposure time was min (15, 30, 45). Each test was repeated 3 times, then the COD and BOD were measured after treatment, and the results were placed in Table No. (2), where the results of the analysis indicate that the effectiveness of the treatment increases with the increase in the applied frequency and the frequency application time, and that the treatment is greatly affected by the increase in frequency. It is more than affected by the time of applying the frequency, so it can be concluded that treatment at a frequency of 40 kHz for 30 minutes is sufficient to obtain water with an organic content acceptable for use in irrigating crops.

Treatment with clay and ultrasound

In order to reduce the amount of dirt required for treatment and to give good results during a short treatment period, the treatment was carried out with dirt and in the presence of ultrasound waves. The sample was coded with the symbol AU and stirred by a mechanical motor. The following conditions were applied:

- The amount of added vegetables is 0.5gr
- The granular size of the clay is 500µm
- Processing time 30 minutes
- Frequency 40 kHz

A chemical and bacterial analysis of the treated sample was conducted according to the previous conditions, and the results were presented in Table. (2).

Table (2): Organic load after treatment with different techniques

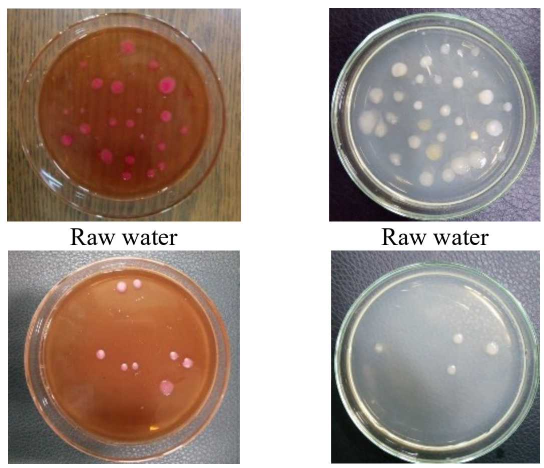
type Treatment	Water sample		COD (mg/l)	BOD (mg/l)
Biological treatment	Raw water		3600	635
	1h		2683	530
	2h		2119	466
	3h		1709	326
	4h		1366	301
	5h		1095	278
	6h		894	251
	7h		724	231
	8h		528	227
	9h		388	206
	10h		294	191
	11h		186	135
	12h		147	124
Treatment with natural clay	A		610	225
	B		436	198
	C		410	172
	D		380	150
	E		312	131
	F		277	112
	G		252	91
	H		240	85
Treatment with aluminum sulphate	A0.5		2198	379
	A1		1755	341
	A1.5		1689	330
	A2		1630	310
Ultrasound treatment	kHz	min		
	20	15	3120	592
	20	30	2833	500
	20	45	2773	432
	30	15	2688	401
	30	30	2430	344
	30	45	2332	312
	40	15	2312	378
	40	30	1934	284
	40	45	1885	255
with clay and ultrasound	AU		212	82

The results indicated the great effectiveness of the double treatment method applied using ultrasound waves (advanced oxidation) with adsorption with natural dirt, as following this technique resulted in obtaining a low

organic content. It is suitable for use for irrigation with a relatively short treatment time and low soil content compared to other experiments in which natural soil alone was used in this research.
As for bacterial analyzes, they were conducted on the final treated sample by planting 1 ml of the sample by spreading it on both types of medium and incubating at a temperature of 37 degrees Celsius for 48 hours. The number of bacteria in 1 ml of the sample was calculated after developing colonies and applying the counting law by multiplying the number of growing colonies by the reciprocal of the dilution. The number of bacterial colonies in the mother (untreated) sample reached 3100 cfu/ml on plate count agar and 2200 cfu/ml on MacConkey agar. This number decreased significantly in the treated sample, as the number of bacterial colonies reached 80 cfu/ml on plate count agar.
plate count agar and 40cfu/ml on MacConkey medium as in Figure No. (2), which indicates the efficiency of the double treatment process applied.

Table 3: Conditions applied for aluminum sulphate treatment.

sample	Aluminum sulphate gr	Treatment time min
A0.5	0.5	120
A1	1	120
A1.5	1.5	120
A2	2	120



Raw water | Raw water
The treated sample MacConkey agar | The treated sample plate count agar

Figure. (2) Results of bacterial analysis of the raw sample treated with natural clay and ultrasound

3. Conclusions

After a series of experiments and tests conducted in this research, the following was revealed:
When treating laboratory wastewater resulting from Aleppo University Hospital using the rotating biological disk method, it was found that treatment for 10 hours an hour is sufficient to obtain water suitable for irrigation according to Syrian Standard No. 2752 of 2008, where the concentration of COD decreased to 294 mg/l, as well as the BOD to 135 mg/l.
The best conditions for treating the studied polluted water sample using the natural dirt adsorption technique were 2gr of natural dirt with a granular size smaller than 100 microns per liter of polluted water, for a period of 120 minutes to use the water for irrigation, and 60 minutes to throw the water into the public sewer.
The effectiveness of treating the studied contaminated water sample with aluminum sulphate is less than the effectiveness of treatment with adsorption agents. The explanation for this result is due to the type of contaminated materials accompanying the studied water, where their ability to collect and settle is weak. Therefore, adsorption is considered to be more effective in capturing and collecting these organic pollutants.
The best way to treat the studied water sample was by adding natural clay at a concentration of 1gr per liter of polluted water and applying ultrasound waves at a frequency of 40kHz for 30 minutes, where the COD value reached 212 mg/l with a removal rate of 94% and the BOD value reached 82 mg/l with a removal rate of 87%. %.

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