

The Use of Chemical and Physical Treatment to Remove Pollutants from Car Wash Stations Water and Reuse

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Abstract

The research aims to study the chemical and physical properties of water drained from car wash stations and treat it and reuse it, to reduce fresh water consumption and remove pollutants. Water samples were collected from three car wash stations in Baghdad, the concentration of pollutants was estimated, based on these results treatment systems was designed. The results indicated that there is a variation in water properties between the three car wash stations. The values Turbidity, Total Dissolved Solids, Chemical Oxygen Demands and Oils were ranged (118-349 NTU), (693-954 ppm), (95-292 ppm) and (13-70 ppm) respectively. The discharged water was treated using a mixture of lime, soda ash and alum. Turbidity, Total Dissolved Solids, Chemical Oxygen Demands and Oils were decreased by (96.5%), (51.2%), (88.6%) and (93.8%) respectively.

Keywords: Car Wash Stations, Water Pollution and Waste Water Treatment of Car Wash Stations.

استخدام المعالجة الكيميائية والفيزيائية لإزالة الملوثات من مياه محطات غسيل السيارات

وإعادة استخدامها

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هيئة البحث العلمي / مركز بحوث وتكنولوجيا البيئة والمياه والطاقات المتجددة - بغداد - العراق

الخلاصة

يهدف البحث إلى دراسة الخواص الكيميائية والفيزيائية للمياه المصروفة من محطات غسيل السيارات ومعالجتها وإعادة استخدامها لتقليل استهلاك المياه العذبة وإزالة الملوثات. جمعت نماذج المياه من ثلاث محطات لغسيل السيارات في مدينة بغداد وتم تقدير تركيز الملوثات وعلى أساسها صممت منظومة المعالجة. أشارت النتائج إلى قيم العكارة، المواد الصلبة الذائبة، المتطلب الكيميائي للأوكسجين والزيت وتراوح (118-349 NTU)، (693-954 ppm)، (95-292 ppm) و (13-70 ppm) على التوالي. تمت معالجة المياه المصروفة باستخدام خليط من اللايم ورماد الصودا والشب. انخفضت العكارة، المواد الصلبة الذائبة، المتطلب الكيميائي للأوكسجين والزيت بنسبة (96.5%) و (51.2%) و (88.6%) و (93.8%) على التوالي.

الكلمات المفتاحية: محطات غسيل السيارات، تلوث المياه ومعالجة مياه الصرف لمحطات غسيل السيارات.

Introduction

Car wash stations have become very popular and have become an additional threat to environment, especially the water resources, which necessitated many researchers to conduct studies on waste water treatment for car wash stations and reuse them to reduce waste in the consumption of fresh water. (Boussu, *et al.*, 2007)

Vehicles can be divided into large vehicles and small vehicles. Large vehicles travel great distances and carry petroleum or oils and coal, and these pollutants go to the body of the car and drain into the waste water when washing the car (Lau, *et al.*, 2013) and (Torkashvand, *et al.*, 2021).

The water drained from car wash stations often contains many organic and inorganic pollutants, such as oils, grease and some heavy elements, which discharged without treatment. Therefore, it is necessary to have a separate water treatment plant in car wash centers (Zaneti, 2009) and (Mandac, *et al.*, 2014)

Wastewater can be recycled and reused for car wash plants by adding appropriate chemicals and by using sedimentation methods for treatment, recycling and use it again (Metacalf, *et al.*, 2006).

The concept of water recycling and reuse is known as wastewater treatment, removal of impurities and pollutants and use it again is known as water reclamation (Mandac, *et al.*, 2014).

There are many benefits to water recycling and reuse, including: (Al-Gheethi, *et al.*, 2013)

- Water recycling can reduce the discharge of effluents that may harm and pollute ecosystems.
- Water recycling saves resources and financial resources.

water recycling systems had become a critical component of car wash centers and it may be easier and more efficient to treat the waste water at the beginning of discharge than by collecting it in one treatment plant (Al-Gheethi, *et al.*, 2015 and Shahid, *et al.*, 2021).

wastewater from car washes with high turbidity can be treated using coagulation and flocculation and reuse it again (Khamis, 2010) and (Kumar, 2018).

Many chemicals can be used in the coagulation and flocculation process. Also included the use of low-cost natural materials as coagulants to improve water quality characteristics (Firdaus, 2013 and Jangkarn, *et al.*, 2014).

The use of *M.oleifera* and *S. botatorium*, contains natural coagulants compared to common synthetic coagulants for car wash wastewater treatment capable of removing Turbidity, Chemical Oxygen Demand (COD), Bio Oxygen Demand (BOD) and total suspended solids (TSS) (Mohamed, 2014) and (Suhartini, *et al.*, 2013).

In this study, a simple treatment system was designed for car wash waste water, and the treatment process was enhanced with a system that includes filtration, coagulation, flocculation and sedimentation units by using chemicals such as alum, lime, and soda ash in addition to natural materials, cellulose fibers (Sawdust).

The aim of the study is to use chemical and physical methods to remove pollutants from the water of car wash stations and reuse it.

Materials and Methods

Sample Collection

Water samples were collected from car wash stations and subjected to chemical and physical analyses using the approved methods. Three types of car

wash stations were chosen for the study, depending on the type of vehicles to be washed and the method of washing, as follows:

- 1- An automatic car wash station for small cars A.
- 2- A manual car wash station for small cars B.
- 3- A manual car wash station for large cars and trucks C.

Water samples were taken from car wash stations and it were two types:

First: raw water (Water Samples were Collected from the Storage Basin Located at the Entrance of the Car Wash Station). This water is pumped by pumps to be used for washing.

The second: Wastewater (Which is Obtained after Washing Cars through Outlets and Drains that Flow into the Sewers).

Chemical Tests

Water samples were collected from car wash stations and analyzes were carried out using approved methods. Tests (Tur, pH, TDS, CO_3 , HCO_3 , Ca, Na, Cl, Mg, T.H, Oil, TOC, and COD) were used to show the difference in chemical and physical properties. On this basis, the treatment system is designed (APHA, 2012).

Design of the Processing Unit

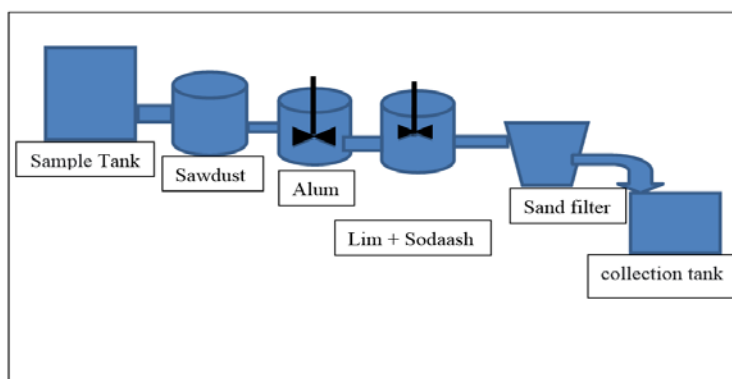


Figure (1) Schematic Diagram of the Treatment System.

There is a wide range of treatment technologies that can be applied, it depends largely on the amount of pollutants produced by each car wash station to obtain suitable water quality with lower operating and maintenance costs. The proposed treatment unit was designed in a laboratory (Lab Scale). The water moves from tank to another by gravity only, without using pumps. Figure (1) shows a Schematic diagram of the proposed treatment system.

Processing Steps

The treatment system was designed in a laboratory to reduce the concentration of pollutants in the water and to reuse and recycle the water. The water samples of the third type car wash station (Station C) were selected for treatment due to the large pollution they contain comparing to other stations. The steps for treating the water of car wash stations as follows:

1-Sampl collection: collecting the water from the car wash station by using (50) liter tank.

2-Screening: (Removal of Large and Floating Particles). Sawdust was used and also the ability of cellulose to absorb hydrocarbon compounds and reduce COD.

3- Chemical treatment: It consists of two stages:

First - Sedimentation: Alum has been added to tank (20) liter to reduce turbidity through the process of coagulation, flocculation and pH balancing.

Second - removing hardness: lime, Ca(OH)_2 , and soda ash. $\text{Na}_2\text{(CO}_3\text{)}$ had been added to the treatment tank (20) liter with stirring to reduce dissolved salts and reduce COD.

4-Filtration: used Sand at diameter (0.3-0.6 mm) and gravel (10-20 mm), also remove Oil and reduce COD.

5-Final collection tank: The treated water had been collected in tank (50) liter and can be used again.

Chemical and physical procedures were used to analyze water samples of car wash stations to determine the concentration of pollutants.

Results and Discussion

Chemical and physical analyzes were conducted on the water samples of the three car wash stations distributed in the city of Baghdad two stations in (Al-Rasheed) and one in (Al-Dora). The quantity and size of pollutants in the water sample were determined before it was discharged to the sewage network and used in the design of the treatment system.

Table (1) shows the physical and chemical properties of water samples for car wash stations.

The results showed that there is a variation in the physical and chemical properties of the water between the three car wash stations where the values ranged from the Turbidity TUR (118-349 NTU), the Total Dissolved Solids TDS (693-954 ppm), the Chemical Oxygen Demand COD (95-292 ppm), the Oil concentration (13-70 ppm) and the Total Hardness T.H (38-388 ppm). There is a slight variation in the concentration of

some heavy metals related to iron and copper; Where the car wash station C recorded the highest values of pollutants and is dedicated to washing trucks, followed by station A dedicated to washing small cars and operates manually, and then station B which is dedicated to washing small cars and works automatically and is the least polluted. The reason is believed to be due to the large amount of water spent in washing the car compared to washing manual.

Table (2) shows the differences in water quality between the raw water and the water discharged from Station C. The highest concentration of pollution was found in station C, because it used to wash large trucks. The nature of its work carries many pollutants such as oils, chemicals and industrial materials or derivatives Oil in addition to other pollutants, these pollutants flow into the wastewater during washing.

The treatment was carried out on the water samples of Station C (The Truck Wash Station) because the water sample was highly contaminated. The treatment process focused on reducing turbidity, Total dissolved Solids, Chemical Oxygen Demand and Oils. Different doses of lime and soda ash (0.2, 0.4, 0.6, and 0.8) mg/L (0.3, 0.5, 0.7, and 0.9) mg/L, respectively were used. Table (3) shows the characteristics of the treated water to show its impact on the Efficiency of the treatment System.

Through the results shown in Table (3), it was found that the addition of lime with soda ash reduced the turbidity to (47.8%), Total Dissolved Solids decreased to (45%), Chemical Oxygen Demands decreased to (83%), and the Oils decreased to (90.7%). Figure (2) shows the relationship between the treatment efficiency of the system at

different concentrations of lime and soda ash in reducing the (COD, Oil, Tur and TDS) in the water of car wash stations.

Table (1) Physical and Chemical Properties of Water for The Three Car Wash Stations (A, B and C).

Test	Station A Small Car	Station B Small Car	Station C Big Truck
	Manual	Automatic	Manually
Tur NTU	133	118	349
EC US/Cm	1345	1240	1832
TDS mg/l	767	693	954
pH	7.1	7.2	7.6
CL mg/l	83	74	253
CO ₃ mg/l	32	25	133
HCO ₃ mg/l	128	72	160
Na mg/l	68.2	56	148.5
K mg/l	4.5	4.1	7.0
T.H mg/l	121	68	388
Ca mg/l	180	54	280
Mg mg/l	65	39	114
Oil mg/l	25	13	70
COD mg/l	141	95	272
TOC mg/l	89	51	144
CU mg/l	0.04	0.03	0.06
Fe mg/l	0.2	0.14	0.3

Table (2) Comparing the Properties of Water Samples for Car Wash Station C with Raw Water and Increased Pollution

Test	Raw Water	Station C Big Truck	Increased pollution
Tur NTU	3.0	349	Increased by 346
EC US/Cm	794	1832	Increased by 1038
TDS mg/l	446	954	Increased by 568
pH	7.1	7.6	Increased by 0.5
CL mg/l	14	253	Increased by 139
CO ₃ mg/l	0.0	133	Increased by 133
HCO ₃ mg/l	65	160	Increased by 95
Na mg/l	40	148.5	Increased by 108.5
K mg/l	3.3	7.0	Increased by 3.7
T.H mg/l	28	388	Increased by 360
Ca mg/l	101	280	Increased by 179
Mg mg/l	36	114	Increased by 78
Oil mg/l	-	70	Increased by 70
COD mg/l	4	272	Increased by 268
TOC mg/l	1.2	144	Increased by 142.8
CU mg/l	0.01	0.06	Increased by 0.05
Fe mg/l	0.03	0.3	Increased by 0.27

Table (3) Characteristics of Treated Water Using Different Doses of Lime and Soda Ash in the Treatment System.

Dos of Lim + Soda Ash mg/l	Tur NTU	TDS mg/l	COD mg/l	Oil mg/l	pH
0	349	954	272	70	7.1
C1= 0.2+0.3	273	765	158	52	7.8
C2= 0.4+0.5	216	623	95	39	8.2
C3= 0.6+0.7	183	521	45	6.5	8.6
C4= 0.8+0.9	195	534	56	9.8	9.0
Efficiency %	47.8	45.0	83	90.7	

Table (4) Characteristics of Treated Water by Adding Alum with Lime and Soda Ash in the Treatment System.

Dos of Lim + Soda Ash mg/l	Tur NTU	TDS mg/l	COD mg/l	Oil mg/l	pH
0	349	954	272	70	7.1
C1= 0.5+0.2+ 0.3	85	655	110	39	7.6
C2= 0.7+0.4+ 0.5	32	541	76	11	7.4
C3= 1.0+0.6+ 0.7	12	465	31	4.3	7.3
C4= 1.5+0.8+ 0.9	28	487	35	4.4	6.8
Efficiency %	96.5	51.2	88.6	93.8	

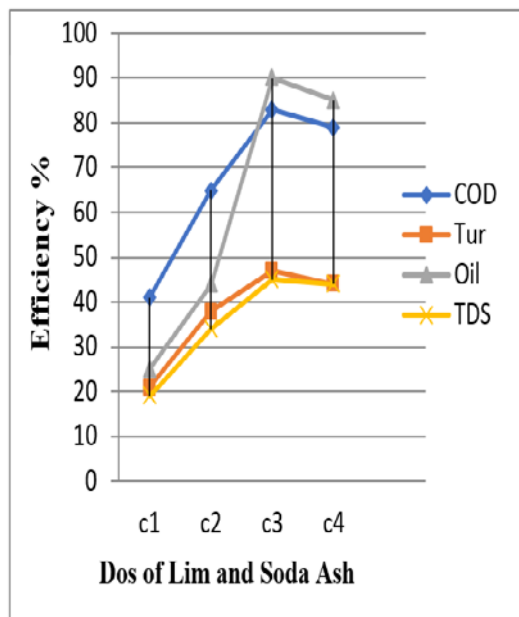


Figure (2) Relationship between the Treatment Efficiency of the System with Different Concentrations of Lime and Soda Ash.

The increase in pH from (7.1) to (9.0) was found to be due to the alkalinity of the lime and soda compound, while the turbidity still needs to be reduced. Therefore, alum was used in different doses ranging from (0.5-1.5) mg/l with lime and soda ash to increase sedimentation efficiency and reduce acidity (pH) as shown in Table (4).

The addition of alum reduced each of (Turbidity, Total Dissolved Solids, Chemical Oxygen Demands and Oils) to (96.5%, 51.2%, 88.6%, and 93.8%), respectively, as well as pH decreased to 7.3. Addition of alum increased sedimentation efficiency and reduced the turbidity, this led to a decrease in TDS and COD. Figure (3) shows the relationship between the treatment efficiency at different doses of Alum with Lime and Soda Ash.

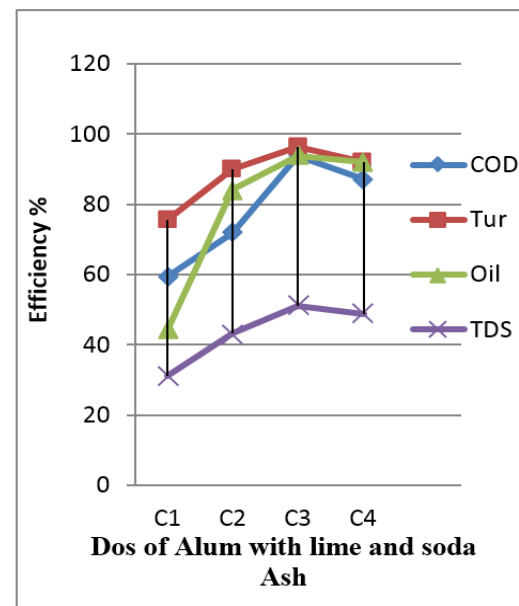


Figure (3) Relationship between the Treatment Efficiency with Different Concentrations of Alum with Lime and Soda Ash.

Conclusions

From this study, the coming points can be concluded:

- the third station(C) used truck washing have the highest values of pollutants and High concentration of COD and Oil in water samples, the reason is the large amount of pollutants and organic materials carried by these trucks that transport oil derivatives, which flow into the wastewater during washing.
- The second station, which operates automatically, recorded the lowest percentage of pollutants due to the large amount of water used for washing, which leads to a high dilution of pollutants.
- The results showed low concentrations of heavy metals in the water samples of the three car wash stations.
- The treatment system has achieved a good percentage of pollutant removal, and this water can be reused in car washing.

Recommendations

Car wash stations in Baghdad use fresh water and this negatively affects the amount of water for people, especially in the summer. The results obtained may help in the future in organizing the safe reclamation of wastewater and in the recycling of water in car wash stations. Establishing a system for treating waste water in car wash station and recycling this give economic benefit and protecting the environment.

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