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MODERN SOLUTIONS FOR CLEANING WASTEWATER FROM CAR WASHES

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ABSTRACT

The research conducted examined the ecological aspects of washing cars, the levels and characteristics of washing detergents used, and their impact on polluting natural waters. The results of disposing of wastewater generated from washing cars were presented. The necessity of using water recycling systems was identified and substantiated, along with aspects that need to be considered in their use.

Key words: car maintenance service, car wash station, chemical analysis of samples, concentration of pollutants, water recycling systems.

INTRODUCTION

In recent years, it has been noted that the number of used vehicles in the Republic of Uzbekistan has increased significantly. In the last 20 years, the number of used trucks has increased by 3.2 times, and the number of light vehicles has increased by 4.6 times. One of the problems associated with the use of vehicles is keeping them clean, which is carried out by car wash stations [1].

The rational organization of car washing aims to minimize water usage and maximize the mechanization of the process. However, washing cars causes significant environmental damage. This situation is explained by the presence of oil residues, suspended solids, and various heavy metals in the wastewater, as their

discharge into the sewage system or open water bodies without primary treatment is prohibited [5,6].

Organizing the reuse of water for car washing is deemed appropriate, i.e., the used water is processed through special purification devices and cleaned for reuse. However, setting up this system also presents certain difficulties and leads to problems in its use [4,7].

The development of science and technology has led to the emergence of many beneficial inventions that are indispensable for modern life. A bright example of this is automobiles. They have already deeply and extensively penetrated our lives. According to statistics, every fourth person in Uzbekistan owns a car [1].

With the increase in the number of cars, the service sector for them is also expanding, i.e., auto services, technical maintenance stations, and car washing services are among these [2]. The more cars there are on the streets, the higher the demand for services to keep them clean. Where and how a car is washed varies according to each individual's preference level, but the impact of the wastewater generated from car washing on nature and environmental factors remains an open issue [3].

Research materials and methods.

In conducting scientific research, the short analyses of the sanitary-chemical and organoleptic indicators of wastewater generated from washing vehicles at the SEW of Tashkent city and the PHC's sanitary-chemical and bacteriological laboratories were studied. The purpose of studying the quality indicators of wastewater from sedimentation tanks and sand traps, which are underground structures at the vehicle wash station's cleaning facility, was to determine the efficiency indicator of the cleaning facility. For this purpose, samples for organoleptic and chemical analysis were taken from the wastewater generated from washing vehicles. The sampling was based on the "single stream principle," meaning that the focus was on taking the sample from the same portion of wastewater entering the sedimentation tank and sand trap from the exit points of these facilities. This ensures the reliability of the indicators in the samples obtained. The samples were tested at the SEW of Tashkent city and the PHC's sanitary-chemical laboratory for organoleptic (turbidity, suspended solids, color indicator, clarity) and chemical indicators (iron content, pH, residue on evaporation, chlorides, sulfates, and SSAA), as well as for a range of heavy metal salts and petroleum residues. The samples were collected over the course of a shift, thoroughly mixed after the shift, and taken in a volume of 1 liter.

Research results. Sharp increase in the number of vehicles leads to an increase in the types of services provided for them, including various methods, devices, and reagents used. Currently, one of these service types is car wash stations. Various methods are available for washing cars, including traditional hand washing with buckets, foamy solutions, sponge fabrics, and high-pressure water devices. In contactless washing, the car is cleaned under high pressure, where the cleaning agent is sprayed onto the car through a special nozzle, and then rinsed off with water under pressure. Automatic washing is divided into portal and tunnel types. In the portal method, the vehicle remains stationary while brushes move along the car body, and in the tunnel method, the car moves along a conveyor. First, a high-foam composition is applied to the car, then the dirt is washed off with pressurized water using rotating brushes, and finally, the car is dried with an air stream. Each method of washing cars has its advantages and disadvantages. The automatic method is the fastest, while the contactless method is considered the most careful. However, each uses different chemical reagents in the washing process. The composition of wastewater from car wash stations contains gasoline, rubber particles, bitumen, used reagents, and synthetic surfactants. These substances belong to the second class of harmfulness, indicating that they cannot be discharged directly into open water bodies or sewage systems without treatment.

Wastewater from any type of car wash must be cleaned according to the Sanitary Rules and Norms № 0318-15 "Hygienic and anti-epidemic requirements aimed at protecting water bodies in the territory of the Republic of Uzbekistan" before being discharged into open water bodies or the sewage network. The wastewater treatment system is a multi-stage structure capable of removing 90% of pollutants from the wastewater. Such a high degree of purification allows the treated wastewater to be discharged into the urban sewage network and also enables car wash stations to reuse this water.

Methods such as ozonation and ultrafiltration are used alongside traditional methods like filtration and subsequent filtration with reagent addition, gravitational, and flotation processing to enhance the effectiveness of these traditional methods. Ozonation of wastewater or reused water accelerates the formation of flocs and enhances coagulation efficiency. In some cases, ozonation enables the effective coagulation of substances that would not coagulate without ozone treatment. Following the use of coagulants, water is mechanically cleaned using ultrafiltration membranes, which is considered the most reliable and simple method to filter flocs resulting from coagulation. This method is more effective than sedimentation, filtration, or contact coagulation, as the filtered particles are

several times smaller. A similar situation is observed with efficient flotation methods, where suspended, colloidal, and dissolved organic substances are cleaned by attaching to gas bubbles. Bubbles formed by the release of dissolved gas and the oxidation of dissolved organic compounds with ozone, along with adsorbed additives, are easily retained in the membrane.

To study the ecological aspects of pollution of open water sources by wastewater generated from washing vehicles, we selected a large car wash complex located on the Katta Halqa Yoli street in Tashkent city and small wash stations in Zangiota district, Tashkent region, on A.Temur street, to investigate the operation of car wash stations using both contact and contactless methods, their technological processes, and the stages of wastewater treatment.

Currently, 224 car wash stations operate in Tashkent city. The majority of them – 65% – use contact methods, while the remaining 35% use contactless methods. Considering that an average of 700 liters of water is used per car wash, calculating the amount of wastewater generated in large wash stations per day is not difficult. Therefore, large wash stations must necessarily have wastewater treatment facilities. The first object selected for our research is a self-service station located in the Olmazor district of Tashkent city. The main reason for selecting this station was the presence of wastewater treatment facilities, its location near the busy Katta Halqa Yoli, and its service to 250-300 vehicles per day. The station covers an area of 1 hectare and has 10 cells for washing cars using the contact method. The station's territory is landscaped, but the level of greening is 25% (the standard is 45%). The wastewater treatment facilities are divided into underground and aboveground parts. The underground part includes a sand trap and horizontal sedimentation tank, automated pump devices, while the aboveground part includes a flotator, granular load filters, a clean water storage tank, a hydrogen peroxide dosing device, an ultraviolet disinfection unit, and bag-type dewatering devices. To determine the efficiency of the existing purification facility at the car wash station, samples of wastewater generated from washing vehicles were taken for organoleptic and chemical analysis. The samples were collected during a shift, thoroughly mixed after the shift, and taken in a volume of 1 liter for analysis at the sanitary-chemical laboratory of Tashkent city SES and SSC, where they were tested to determine organoleptic and chemical indicators, a series of heavy metal salts, and oil residues.

Table 1

Local cleaning device efficiency indicators

№	Indicators	Unit	Amount in wastewater	Indicator after cleaning	Norm
1	Hanging substances	Mg / l	8,2	6,5	7,5
2	Petroleum products	Mg / l	2,5	0,2	0,35
3	SSAA	Mg / l	5,0	1,8	2,9
4	Phosphates	Mg / l	3,8	1,6	2,0

This purification facility operates based on a reagent usage scheme, where the main cleaning process occurs in a flotator, and the water requiring purification is disinfected with ultraviolet rays in a reservoir. It is evident from the data presented in the table that after the cleaning device, the amount of the most common pollutants in the wastewater—suspended solids, petroleum products, synthetic surface-active agents (SSAA), and phosphates—showed results below standard indicators. This implies that the treated wastewater can be redirected into the water reuse system and reused for washing vehicles. According to regulatory legal documents, the concentration of pollutants in wastewater to be discharged into the sewage system should not exceed 3000 mg/L, and the amount of oil residues should not exceed 300 mg/L. While large car wash facilities in the city of Tashkent have wastewater purification installations, smaller stations often lack such facilities, which managers attribute to the high cost of cleaning installations. The car wash station under our supervision has a local purification facility, and the water used there is intended for reuse. The general principle of the water reuse system is as follows: after washing the cars, the rinse water falls into a collection tray located on the floor, from which it is collected in a settling tank called a caisson. There, it is thoroughly cleaned and returned to the system for reuse. Then, the vehicle is rinsed with clean water. A standard cleaning device allows for up to 50 times reuse of water, after which the water is disposed of.

Figure 1. Appearance of the wastewater generated at the car wash station before and after treatment.

The second object under supervision is located in Amir Temur Street, Zangiota District, Tashkent Region. The inspection of this facility revealed that the total area of the car wash station is 0.6 hectares, the area is landscaped, and the level of greenery is 30% (the standard is 45%). The organoleptic indicators of the wastewater generated by the station include: very high turbidity (1200 mg/L), and the water is heavily polluted with oil residues and synthetic detergents. There is a layer of foam 8-10 cm high on the water surface, with a foul odor due to the presence of oil residues, and residues of oily or greasy substances can be seen floating on the water surface. After the organoleptic examination of the wastewater from the car wash station, the chemical indicators of the wastewater were tested, and the presence of heavy metal salts in the wastewater composition was studied. For this purpose, the wastewater was passed through a paper filter three times, leaving a distinctive black sediment, but filtration did not clarify the water. After that, the filtrate was centrifuged in a laboratory centrifuge and tested for iron, lead, cadmium, and nickel substances.

Table 2

Composition of Untreated Wastewater Generated from the Car Wash Station

№	Indicators	Unit	Inspection results	Norm
1	SSAA	Mg/l	7,0	0,1
2	Petroleum products	Mg/l	25	0,1
3	Iron	Mg/l	1,5	0,3
4	Tin	Mg/l	0,2	0,03
5	Cadmium	Mg/l	0,03	0,001
6	Nickel	µg/l	40	1,0

It is evident from the provided table that the chemical indicators of wastewater generated from the car wash station are several times higher than the regulatory standards, indicating the essential need to construct local purification facilities. The second car wash station we selected showed the presence of nickel ions, copper ions, and lead in the wastewater composition. Even with a relatively simple testing method, it was determined that the wastewater generated from the car wash station poses a danger to the hydrosphere. At the same time, it is necessary to note that several problems have arisen in reusing the wastewater generated at the car wash station. Firstly, when reusing the water, a foul odor develops, and the more the water is reused and the longer it stays in the settling tank, the intensity of this unpleasant odor increases. Secondly, various difficulties arise in using the washing equipment since the recycled water does not always reach the quality level of tap water. As a result, customer complaints about the quality of the water have emerged. Therefore, recent observations have revealed instances where the car wash station under our supervision does not regularly use the purification facility. They use clean tap water for washing vehicles. There is a hidden drain valve in the settling tank, through which they dispose of the used water directly into open water bodies without any reuse, always using clean water instead.

Conclusion. The increasing pollution of open water bodies and underground water sources with wastewater year by year affects humans through water, altering the internal environment of a person and leading to various dangerous diseases. Unfortunately, the number of stations with purification systems is insufficient, and the efficiency of these purification devices often does not meet hygienic standards (SRN №0318-15). This necessitates further in-depth study of this issue. One of the primary problems for current environmental protection organizations is the operation of car wash stations without purification facilities or those operating illegally. Their danger lies in the fact that they discharge their wastewater directly into the ground or the sewage system without any treatment. At aeration stations, there are no facilities to neutralize the petroleum residues or heavy metal salts contained in such wastewater. This significantly reduces the efficiency of the biological treatment stage, leading to an increase in water-related diseases among the population, negatively affecting people's lifestyles, and degrading the quality of life.

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