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Evaluation of carwashes in Kermanshah metro-city with regard to water resources, consumption, and existence of treatment facility

Hiwa Hossaini^{a*}, Shoeib Rahimi^a, Shahram Usefi^a

^a Department of Environmental Health engineering, School of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran.

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Corresponding author

Hiwa Hossaini

Email: hiwa_hossaini@yahoo.com

Tel: +98-38264165

ABSTRACT

In this study, the amount of water consumed in the carwashes of Kermanshah city was evaluated according to the type of water source used. Also, the existence of preliminary and primary wastewater treatment facilities was investigated. The most important type of detergents used was also determined. The results indicated that 77% of carwashes used municipal water distribution system as the water source and remaining used well water. The average water consumption in the surveyed carwashes was 195.4 liter per day per light vehicle. There is lack of full wastewater treatment facility in all the carwashes, and the only observed wastewater treatment facility was bar screen that was seen in 91.6% of the carwash units.

Introduction

Industrial developments, as well as industrial corporation states, have many economic and social advantages for communities. In order to achieve sustainable development conditions with long-term benefits for humankind and future generations, aligning industrial development with environmental development is inevitable. One of the most important environmental issues in the metro-towns is the water supply for industries and the entry of industrial pollutants into surface water and underground water resources. The construction of appropriate wastewater treatment systems will prevent water and environmental pollution, and will also provide a new source of water for reuse [1]. With rising awareness about environmental issues and enforcement of environmental laws, the need for the existence of wastewater treatment plant is obvious [2-4]. From the point of view of environmental protection and efficient use of water resources, reuse of carwash water is one of the most important issues around

the world. In many parts of the world, water used in carwashes is treated and recycled or directed to the sewers, rivers, or other surface water resources. The purification methods include sand filtration [5]; adsorption [6]; ozonation [7]; biological [8], electrochemical [9], and membrane processes. Carwashes should be subject to special supervision because they are located outside the industrial corporation states. High water consumption and discharge of various pollutants such as detergents, fats, oils, and granular materials are among the most important issues of carwash units [10]. Carwash units with high freshwater consumption are ideal candidates for inclusion in a recycling program. Due to the increasing number of vehicles and everyday contamination, most people tend to wash cars regularly; so carwash units are growing rapidly [11]. In order to better manage the carwash wastewater and plan for treating and recycling it, correct estimation of the amount of water used is the first step. Since 1990, the International Carwash Association has conducted numerous

studies to determine the amount of water needed to wash a car as well as the characteristics of discharged wastewater^[12] and water conservation and rescue techniques^[13] in the carwash industry. According to the available reports, the average water consumption for each vehicle^[14] is 57 liters; 129 liters and 163 liters for self-service conveyor belts and washes, respectively. Rosenblum (2001) reported an average water consumption of 177 liters per vehicle in urban carwashes. Isolation of water and oil leakage has been introduced as the best practices in carwash water management^[15]. There is no comprehensive data on water consumption in carwashes in Iran and Kermanshah. Therefore, this study aimed to determine the type and amount of water consumed in carwashes in Kermanshah city and the fate of the produced wastewater from these units in the June of 2015.

Material and Methods

This descriptive cross-sectional study was carried out in the Kermanshah carwashes in the June of 2015. At first, a list of all the active carwashes in Kermanshah metro-city was obtained from the carwashes association. Then, Kermanshah city was divided into three zones, and using the Morgan table, 16 carwashes in each zone were randomly assigned for further evaluation. In order to determine the characteristics of the selected carwashes, a checklist was prepared to obtain information about the kind of water source used, the type of detergent, the number of active spray guns, the type of services in light and heavy car, the existence of treatment like screening and grit removal, etc. In order to determine the amount of water consumed, at first, the time required for washing each vehicle was recorded using a timer; then, by measuring the discharge rate of each nozzle, water consumption for light vehicles was determined using equation 1.

$$Q_T = N \times (T_i \times Q_i \times 60) \quad (1)$$

where, Q_T is the daily water consumption of each carwash, L , N is the mean number of cars washed per day, is the mean time required to wash each car in minutes, and Q_i is the mean discharge rate

of each nozzle in liters per second.

Results and discussion

In this study, the amount of water consumed in carwashes in Kermanshah metro-city at June of 2015 was investigated.

In Fig. 1, the water resources in each distinct zone are shown. As observed from Fig. 1, well water comprised of 12.5%, 18.75%, and 37.5% of total water resources used in zone 1, 2, and 3, respectively. On the other hand, the majority of carwash water, 87.5%, 81.25%, and 62.5% in zone 1, 2, and 3, respectively, was supplied from the municipal water distribution systems that provide potable water for the whole city.

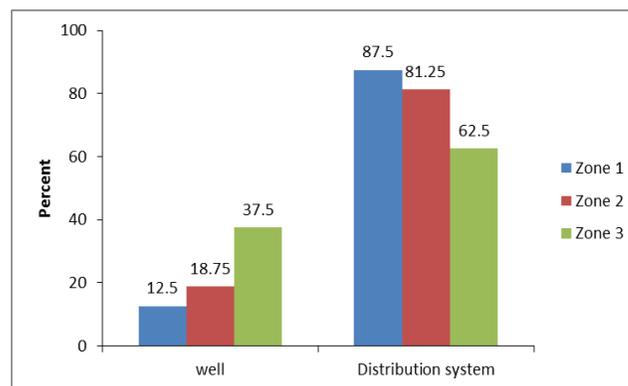


Figure 1. Water resource in each distinct zone

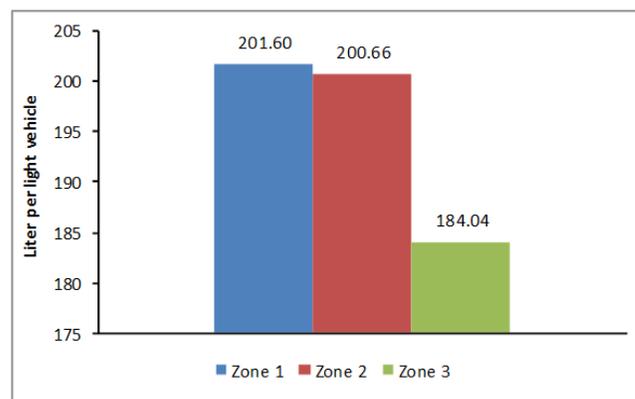


Figure 2. Mean Consumed water per car

As shown in Fig. 2, the amount of water consumed in zone 1, 2, and 3 are 201.6 ± 40 , 200.7 ± 67.7 and 184 ± 15 liters, respectively, for each light car. Accordingly, the average total water

consumption in the selected carwashes in zone 1 was 3494 liters per day, zone 2 3328 liters per day, and zone 3 3828 liters per day. It should be noted that 56.2% carwashes in zone 1, 62.5% in zone 2, and 93.7% in zone 3 used cold water, and the other carwashes used warmed water. The amount and type of detergents used in carwashes in Kermanshah were estimated considering that these are important factors in effluent pollution strength. Accordingly, as shown in Fig. 3, the dominant type of detergent used in the studied zones was liquid dishwater. Due to the discharge of various pollutants, especially grit materials, detergents, oil and grease, fine and large solids, rags, and debris, the existence of treatment facility at the studied carwashes was determined. As shown in Figures 4 and 5, none of the carwashes were equipped with an approved treatment plant, as a complete package or constructed treatment plant, but more than 80% of the studied carwashes were fitted with screening units, and only 30% had grit removal facility. It should be mentioned that none of the selected carwashes had implemented the recycling and reuse program, and the produced wastewater was discharged into the municipal sewerage system without any specific treatment. According to the study results, all the carwash units in Kermanshah are hand-operated, and most of the water used in the carwashes is supplied from high-quality water sources such as the municipal distribution system or groundwater wells. In zone 2, due to the higher welfare level in relation to others, the amount of water consumed by each machine was more than the other zones. The results of the study showed that the use of non-specific detergents in washing machines in the studied areas is common, which is reducing the cleaning efficacy, resulting in more water being used to clean the machine, and consequently, leading to more environmental pollution. According to estimates, at least 50 countries including Iran will face freshwater scarcity by 2050. The per capita domestic water consumption in all household, agricultural, and industrial sectors is higher in Iran compared with the global standards; for example, domestic water consumption in Iran is 220 liters per day while the world standard is only 75 liters per day [16].

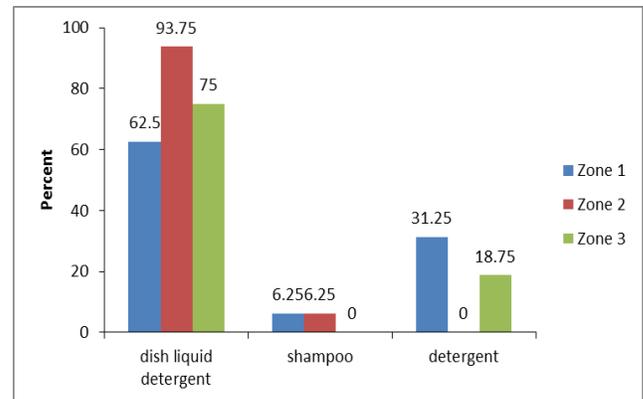


Figure 3. Dominant Type of detergent used

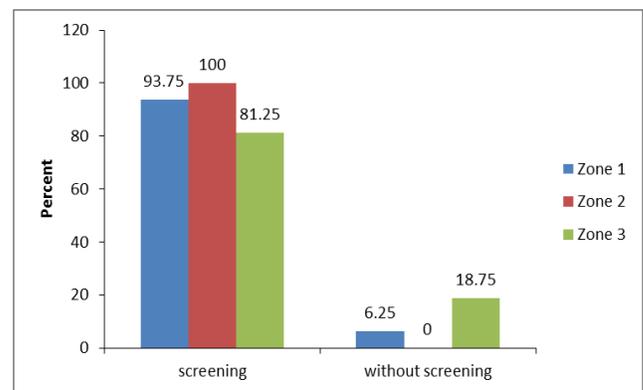


Figure 4. Existence of screening unit

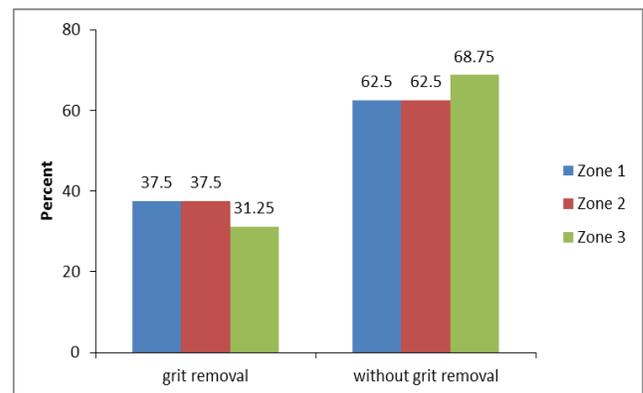


Figure 5. Existence of grit removal unit

Freshwater is one of the vital natural resources that its scarcity is full-fledged. Iran is a dry country with a lot of restrictions on water resources. The water scarcity is more severe in arid and semiarid regions. The industrial sector is one of the main consumers of water resources in the country, and the proper determination of the water demand of the industries is one of the most important priorities to be evolved. In addition to saving water, the needs of the industry are also to be considered [17]. Carwash wastewater consists mainly of particles such as sand and grit, oily materials such as mineral oil and waxes, and surfactants. In order to remove these materials and achieve high purification efficiency, different treatment processes like filtration, ozonation, adsorption, and membrane processes were developed. Among these processes, ultra-filtration and activated carbon treatment followed by microfiltration and reverse osmosis showed higher efficiency. However, it is difficult to remove all the ingredients and surfactants [18]. With increasing scarcity of fresh water and the cost of clean water production, any attempt to reduce water consumption and related costs seems to be a strategic goal to reduce pollution and increase water resources. Comparing the per capita water consumption of each car in Kermanshah with that reported by International Carwash Association showed that consumption in Kermanshah is closer to that reported by the International Carwash Association and less than that in Kuwait (50–100 gallons). Various studies have shown that more than 75% of water can be recycled and used again in carwashes [19]. Water recycling and reuse is important considering that the carwashes in the city of Kermanshah drain their wastewater without any treatment into the sewage system.

Conclusion

In this study, the amount of water consumed in the carwashes of Kermanshah city was evaluated according to the type of water source used. Also, the existence of preliminary and primary wastewater treatment facilities was investigated. The most important type of detergents used was also determined. The results indicated that 77% of carwashes used municipal water distribution system as the water source and remaining used

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