IMPACT ASSESSMENT OF AUTOMOBILE SERVICE STATIONS EFFLUENT OF KARACHI CITY

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خلاصہ

گذشتہ تین دہائیوں سے میگا سٹی کراچی میں آٹو موبائل سروس اسٹیشنوں کی ایک نمایاں تعداد میں اضافہ ہوا ہے اور گندے پانی کی آلودگی کا مسئلہ پیدا ہو رہا ہے۔ ایک اندازے کے مطابق ایک گاڑی (کار) کو دھونے کے دوران تقریبا 255 لیٹر پانی کھایا گیا تھا۔ ایک اسٹیشن پر روزانہ اوسطا 20-25 گاڑیاں دھوئیں جاتے ہیں جو ایک اسٹیشن پر روزانہ 5610 لیٹر پانی استعمال کرتے ہیں۔ کراچی شہر کے ہر ضلع کے دس مختلف اسٹیشنوں (چھ اضلاع کے کل ساٹھ نمونے) سے گندے پانی کے بہاؤ کے نمونے جمع کیے گئے، اوسطا تازہ پانی کی کھپت اور ان کے گندے پانی میں مختلف خطرناک آلودگیوں کے حراستی کا حساب لگانا اور ان نتائج کا موازنہ سندھ ماحولیاتی تحفظ ایجنسی (BOD 80 ،SEQS) COD 150 تیل اور چکنائی 10 اور TSS 200 کی حد سے کرنا۔ کراچی شہر کے وسطی علاقے میں بی او ڈی، سی او ڈی، تیل اور چکنائی، اور ٹی ایس ایس کی حراستی 86.2، 90.9، 91.1 اور 77.21٪ تھی۔ یہ اعلی اقدار سنجیدہ ماحولیاتی آلودگی جیسے فوٹو سنتھیسس میں استحکام، تحلیل آکسیجن کی کمی، آبی حیات کی زندگی میں خلل، گٹر کے نظام کو نقصان پہنچانے، انسانی اور آبی وسائل پر زہریلے اثرات کا باعث بن سکتی ہیں۔ آبادی اور گاڑیوں کی وجہ سے دیگر اضلاع کے مقابلے میں ضلعی مرکزی قدریں سب سے زیادہ ہیں۔ مجموعی طور پر، اس مطالعے میں کراچی کے وہیکل سروس اسٹیشنوں پر روشنی ڈالی گئی ہے، ان کے پانی کی کھپت، علاج معالجے اور ماحولیات پر منفی اثرات کے بارے میں۔

Abstract

Since last three decades a significant number of automobiles service stations have been increased creating waste water contamination problem in the mega City Karachi. It was estimated that approximately 255 liters of water was consumed while washing one vehicle (car). An average of 20-25 vehicles was washed on a station every day consuming 5610 liter of water per day at one station. Waste water effluent samples were collected from ten different stations of each district (South, East, Central, North, Malir and Korangi; total sixty samples from six districts) of Karachi city, to calculate the average fresh water consumption and the concentration of different hazardous pollutants in their wastewater and compare these results with Sindh Environmental Protection Agency (SEQS) limits for BOD 80, COD 150 Oil and grease 10 and TSS 200. The obtained results revealed that the concentration of BOD, COD, Oil and Grease, and TSS was 86.2, 90.9, 91.1 and 77.21% in the central area of Karachi city. These higher values may cause serious environmental pollution like stultification in photosynthesis, depletion of dissolved oxygen, disturbance of aquatic life, damaging of sewer system, toxic effects on human and water resources. District central values were highest as compared to other districts due to high population and vehicles. Overall, this study highlights the vehicle service stations of Karachi, about their water consumption, treatment practices and negative impacts on environment.

Keywords: Automobile, Service station, Effluent, Water consumption, Karachi city

Introduction

Service stations are imperative to keep the vehicle clean and in a good condition, but in a big city Karachi which is facing a shortfall in water supply the number of vehicles has drastically increased due to the population, which means the number of stations have also increased to a great extent (Ashraf *et al*., 2020). Different researches have been carried out worldwide and including Pakistan (Yasin *et al*., 2012; Memon, 2016) and it seems in every research effluent values were higher than acceptable level and have the potential to harm the environment, including air, soil/ground water quality and ultimately the water resources (Yasin *et al*., 2012; Mazumder and Mukherjee 2011).

Furthermore, one of the main sources of wastewater is vehicle wash service station (Monney *et al*., 2020). The pollution caused by vehicle wash service stations of Karachi has not been taken into consideration yet. Beside water, these stations also use kerosene, diesel and used-lubricant oil. After the car-wash activity, these

petroleum products, grease, lubricants and heavy metals pollute the environment and contribute as hazardous components in the effluent water. Mainly they contribute to increase the concentration of COD, BOD, oil & grease and suspended solids. Fumes of Diesel / Petrol, VOCs are also very dangerous and cause air pollution as well (Yasin *et al*., 2012; Memon, 2016).

In addition to the usage of petroleum products, the automobile service stations also use detergents, cleaning solutions for washing. These stations also apply diesel, wax and use lubricants to create a protective layer over the vehicles bodies as an after-wash to avoid further corrosion (Powell *et al.,* 2005). Ashraf *et al.* (2020) reported that most of the automobile factories in several places in Pakistan are situated near the residential areas and can release toxic metals harmful for living beings. Till date no information is available to investigate the BOD, COD, Oil and Grease pollution problem in waste water in the automobile stations of South, East, Central, North, Malir and Korangi at Karachi. The main aim of the study was to collect the water samples from ten different busy stations of each district of Karachi city, and by analysis determine the concentration of hazardous compounds present in the effluent of vehicle wash stations to compare with the SEQS limits. Water consumption on different vehicles was calculated and also possible solutions, treatment and precautions were laid down to save the environment and water.

Methodology

The methodology for waste water testing was designed to obtain the representative samples of discharge water from car wash service station. Most of the samples were collected at evening time when the number of vehicles visiting the stations is more. As per plan samples were collected from ten different busy stations of each district of Karachi City; (South, East, Central, North, Malir and Korangi; Fig. 1) so total sixty samples were collected for the analysis of wastewater in the laboratory.

The technique used to collect the sample was grab. It is the technique in which a single sample or measurement is taken at a specific feasible time. It was collected carefully, so that they show the representation of the water as a whole (Gilbert 1987). In some stations we have to wait for a while as the grab sample was collected when the operational flow shows the average flow rate. Samples were collected in one-liter glass bottle. During analysis 2 replicates sample for each parameter was analyzed to confirm the sample result, accuracy and repeatability, also CRM was used (Uriano *et al.,* 1977), for method verification. All the samples were tested by APHA and USEPA methods (APHA 18th Edition (APHA 1992).

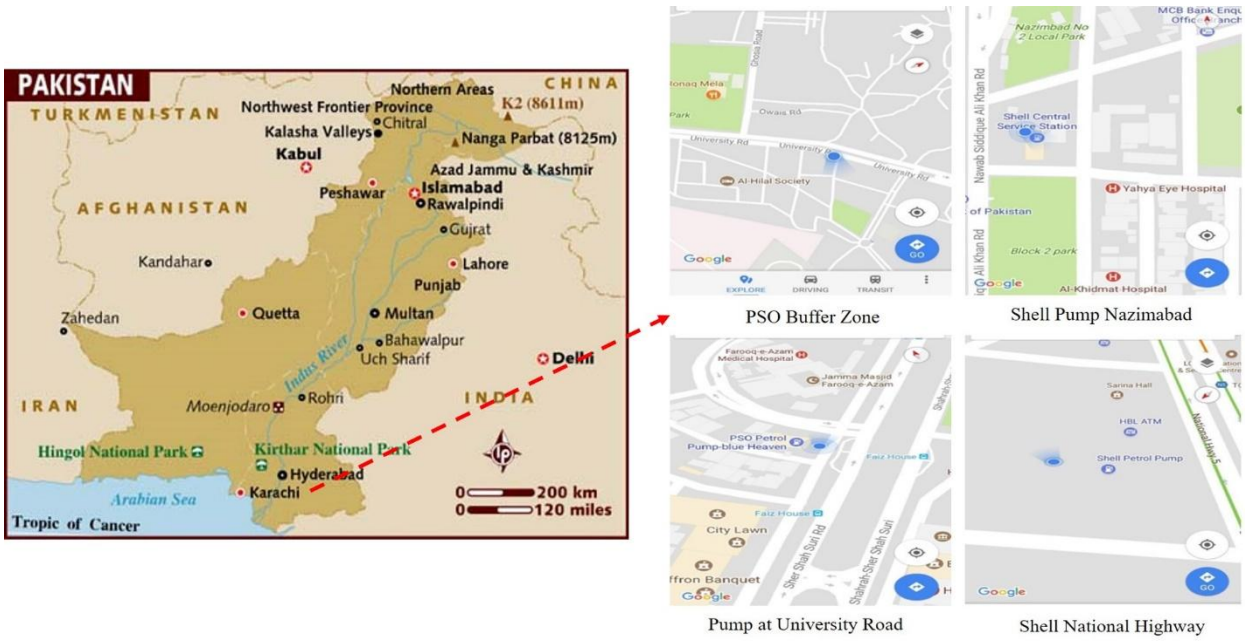

Fig.1. Selected sample collection from South, East, Central, North, Malir and Korangi at Karachi.

Data collection and survey shows, an average of twenty to twenty-five vehicles and twenty to thirty bikes were washed per day at every service station. On weekends this figure exceeded by more than fifty percent. The water was collected from washing spray gun (used in a service station for washing) in known volume container with time taken to fill the container using a stopwatch. A glass bottle of 500 ml and Liter volume was used for this activity. Also, the time was calculated for complete washing of vehicles (outside and inside body) to know the exact water consumption on each vehicle.

Table 1. Water consumption calculation

S. No.	Vehicle Type	Time Consumed			Time required to fill one-liter bottle	Total Water Consumption
		Outside Body Wash	Inside Body Wash	Final Washing		
1	Small Truck / Suzuki	22 min	20 min	20 min	4 sec	930
2	Rickshaw	4 min	3 min	5 min	4 sec	180
3	Car	7 min	5 min	5 min	4 sec	255
4	Bike	3 min	-	4 min	4 sec	105

It was estimated that approximately 255 liters of water was consumed, while washing one vehicle (car). An average of 20-25 vehicles were washed on a station every day consuming 22x255 = 5610 liter of water per day at one station. Operating hours of every station were 12 hrs. i.e. from 8 am to 8 pm. It is the huge amount of water consumption, which can't be neglected.

Statistical analysis

The data was subject to analysis by using Excel 2013 and Statistic (ver. 8.1). In addition, all the graphs were made by using Origin Pro software (version 16).

Results and discussion

As shown in (Table 1) the maximum concentration of Chloride(Cl) was observed by 711.5mg/Lin central district, while the minimum amount of Cl was detected by 214.25 (mg/L) in Malir district of Karachi as compared with SEQS values (1000). The highest content of sulphate (S) in central district was found by 95.44 mg/L, but the lowest S value was found up to 95.44 (mg/L) in Malir district of Karachi rather than SEQS values (600). The maximum total phosphorus (P) content in East district was observed by 3.14 (mg/L), whereas the minimum P concentration in West and Korangi districts was observed by 2.63 mg/L. The greatest pH value in South district was noted by 8.03, on the other hand the lowest pH value in Malir district was received by 7.60, as compared to SEQS limits (6-9). The maximum chromium (Cr) content in central district was detected by 0.67 mg/L, but the minimum Cr content in Malir district was found 0.30 mg/L in respect with SEQS limits (1). The highest iron (Fe) amount in Malir district was 4.80 mg/L, nevertheless the lowest content of Fe in East district was noted by 3.94 mg/L as compared to SEQS standards (8).

The main task was to monitor the organic pollutants like biological oxygen demand (BOD), chemical oxygen demand (COD), oil and grease (O and G) and total soluble salts (TSS), because they can disturb the oxygen level of water reservoirs, which leads to environmental disasters (Laitinen 1960; Rana 2006). These parameters were considerably high as compared to the SEQS limits, experimental results showed that the BOD values varied between 397 to 583 mg/L i.e. 80% to 86% more than limits. Diesel, gasoline, emulsions and waste engine oil in the effluent of car wash stations contributed to higher levels of BOD. Detergents or shampoo used to wash vehicles also contributed to increase the BOD (Fig 2a). The data in (Fig 2b) revealed that the COD values were in the range of 1140 to 1694 mg/L i.e. 86% to 91% higher. Petroleum products like gasoline, diesel, used lubricants and engine oils etc. contained in the wastewater of service station contributed to high levels of COD. The higher COD means a greater amount of oxidizable organic matter in the sample, which will reduce the dissolved oxygen (DO) contents. A reduction in DO leads to anaerobic conditions, harmful to aquatic life (Inyinbor *et al.,* 2016). Measured average values of Oil and Grease were between 44 to 112 mg/L i.e. 77% to 91% higher. Used black engine oil and diesel was sprayed at the bottom of the car to avoid corrosion, this could spill on the floor and move to sewer system. TSS average values were 147 to 702 mg/L i.e. 71% higher (Fig 2c). The data in (Fig 2d) showed that the TSS could block the sun light to reach water body slowing down photosynthesis process and affecting aquatic animal and plants which ultimately could lead to low oxygen level (Sluiter *et al.,* 2008). Rest of the parameters was within the limits as compared to above discussed parameters.

Table 2. Average values of parameters from 6 districts of Karachi. 10 samples from each district and calculated the average values.

Parameters	South	West	East	Central	Korangi	Malir	SEQS Limits
Chloride (mg/L)	557.3	477.1	384.1	711.5	356.95	214.25	1000
Sulphate (mg/L)	240.5	213.15	185.4	339.5	162.95	95.44	600
Total Phosphorus (mg/L)	2.79	2.63	3.14	3.09	2.63	3.97	-
pH	8.03	7.7	7.84	7.69	7.62	7.60	6-9
Chromium (mg/L)	0.37	0.49	0.42	0.67	0.38	0.30	1
Iron (mg/L)	4.06	4.64	3.94	4.71	4.44	4.80	8

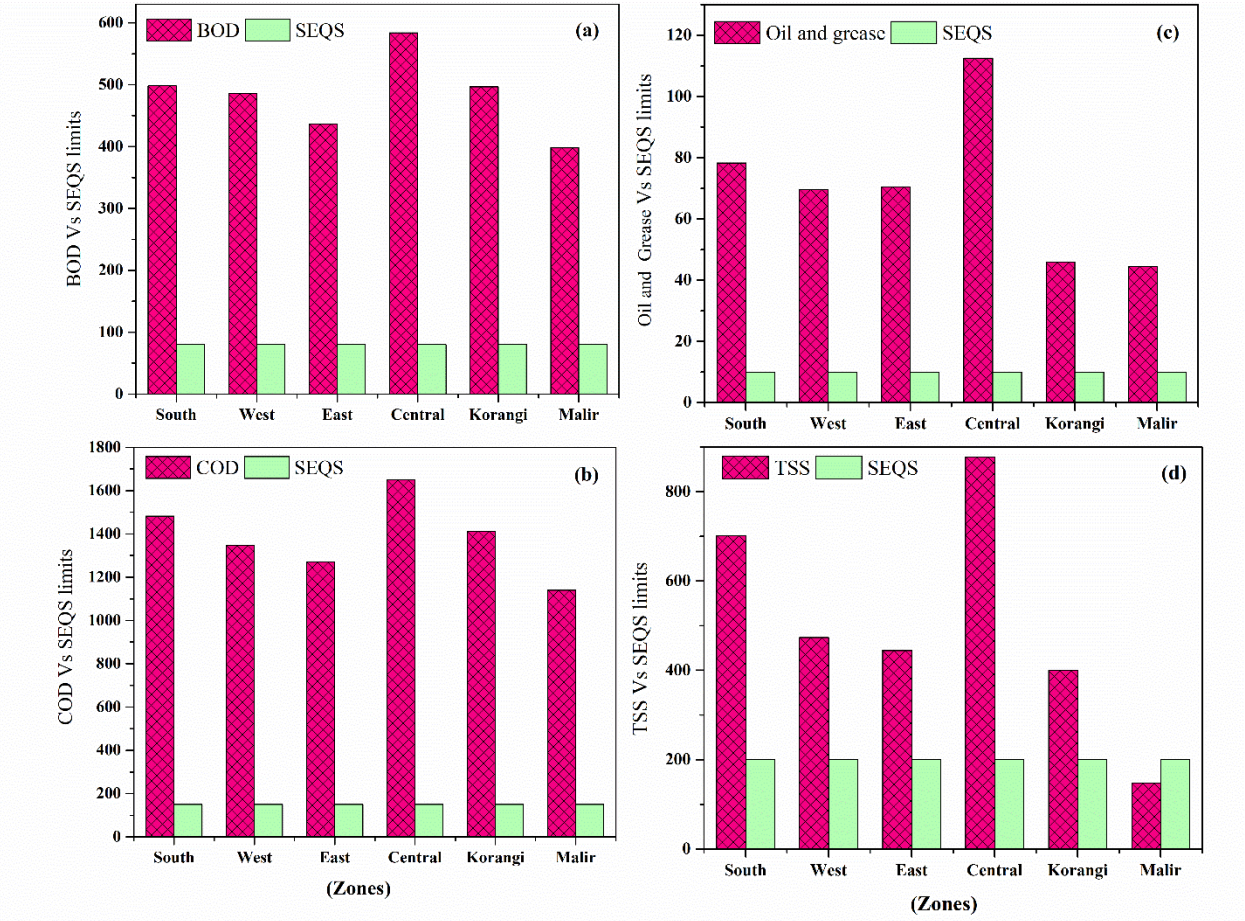

Fig 2. Assessments of BOD Vs SEQS limit (a), COD Vs SEQS Limit (b), Oil and Grease Vs SEQS limit (c), and TSS Vs SEQS Limit (d) from South, East, Central, North, Malir and Korangi zones at Karachi.

Conclusion

Effluent from car wash service stations causes damage to the environment. In our study, samples of car wash from all areas of Karachi (district wise) were collected, measured and analyzed. The effluent was found to be highly polluted especially organic pollutants BOD, COD and Oil and Grease are very high and these three parameters could mainly disturb the aquatic life including depletion of oxygen, retardation in photosynthesis and other environmental hazards. District Central values were highest as compared to others districts, as the number of people visiting service stations for the car wash were more as compared to other districts as measured in this study. The usage of used black engine oils, detergents, shampoo, gasoline and diesel while washing and cleaning the vehicle at service stations directly contributed to increase in the pollutants values. It is concluded

that these car wash service stations are not only polluting the environment but also consuming large amount of fresh water i.e. approximately 5600 liter of fresh water per day at one station only, this is alarming and a big challenge to overcome regarding current water crisis in Karachi. It is suggested to install mini treatment facilities at least at district levels for combine car wash waste water treatment and reclamation of water may apply to those service stations which have more vehicle wash customers.

Other recommendations include that all vehicle wash service stations, should implement the best practices of washing, handling and disposing the waste. The wastewater should be first subjected to treatment, both chemical and physical (Al-Odwani *et al*., 2007; Boussu *et al*., 2008; Hamada and Miyazaki 2015), so as to minimize the hazard towards the environment. Every service station should work on reclamation and waster reuse (Zaneti *et al*., 2011 and 2012). The employees should be well aware of both the short and long term health and safety hazards. The employees should be provided with proper PPEs (Personal Protective Equipment) and cover-all for performing the job. Random third party audits should be conducted during any time of the year to check whether or not best practices are employed at the vehicle water wash stations. All vehicle wash stations owner can contribute to build a proper treatment facility at least at district level in Karachi. Finally, EPA Pakistan should conduct random audits, either by itself or third party, round the year randomly, to ensure fulfillment of best practices at the service stations.

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