Original Research Article

Determination of Seasonal Variation of Volume of Vehicle Wash Waste water in the Shrigonda Town

Abstract

This empirical study estimated fresh groundwater utilized to clean various types of vehicle and the amount of wastewater generated. Thirteen vehicle wash centers were observed during the dry and wet seasons to estimate seasonal variation in the water used to wash three vehicle types. A one-way ANOVA test has been applied to test seasonal variation using MS Excel software. During a week, observations of washing centers in dry and wet seasons involved 762 and 982 vehicles, respectively. The result shows that in the dry season, the mean water used to wash motorbikes was (95.83L), cars (219.62L), light motor vehicles (235.64L) and heavy transport vehicles (300.79L). On the other hand, during the wet season, mean water volume ~~was~~ used to wash motorbikes was (128.28L), cars (258.79), light motor vehicles (290.89) and heavy transport vehicles (415.40). During the dry season, 102301 liters per day, and in the wet season, 168114 liters per day of fresh water was used at the ~~,~~ vehicle washing centers in Shrgonda town ~~use fresh water~~ and discharged wastewater into the sewer system. This investigation suggests to the Municipality that~~,~~ aspirant of startup of the washing centers must fulfill the criteria like authorization by Municipality, site suitability, recycling mechanism, rainwater harvesting against wastewater generated and tax as per daily groundwater pumping.

Keywords: Washing centers, Wastewater, Seasonal variation, ANOVA

1.Introduction:-The variety of vehicle washing facilities is rapidly growing with the growing number of automobiles. Washing is essential for maintaining the vehicles in good condition. The washing of vehicles needs a huge quantity of water. After washing, it releases dangerous chemical compounds due to the use of the cleansing solution in the surrounding through the release of unprocessed wastewater: solvent-based chemicals, oil, grease, and detergent harm living organisms. The properties of effluent water are also greatly affected by soil on a vehicle (Ghaly, et al., 2021). All vehicle washing centers in Shrigonda town discharge effluent to the sewer system without any treatment. The local Municipality has no guidelines, regulations or monitoring mechanisms for effluent discharge in a sewer system.

About 150 to 350 liters/day/vehicle of wastewater is generated from vehicle washing. All this untreated wastewater is discarded into a sewer system. Therefore, it is dangerous to aquatic and terrestrial ecosystems. The pollution level in vehicle washing waste water is lower than wastewater from industrial wastewater. However, direct discharge of sewage holding soil and sand particles, grease and oil, chemical agents, washing powder, hydrofluoric acid and phosphates is boosting the level of pollution (Mujumdar, Rajagolkar, & Jadhav, 2020). The treatment of wastewater is an easier procedure and can be treated efficiently with minimum efforts at the source site rather than released into a sewer and treated together. However, a large volume of wastewater is generated after every vehicle wash, and potable water is turned into mostly contaminated water, which ultimately adds to natural waterways. In addition, the discharge of

vehicle wastewater into waterbodies, the washing powder containing wastewater creates foams, which diminish amount of oxygen and demolish fish mucus covering (Aboulhassan, Souabi, Yaacoubi, & M., 2006).

Non-judicious use of water by vehicle washing centers endangers the health of an urban ecosystem and decreases water security. In the case of this context, policymakers in developed countries have imposed regulations to address these issues. Germany and Austria have made mandatory recycling of wastewater generated~~of theirs,~~ whereas, in Belgium, 15% of vehicle wash centers recycle their wastewater (K. Boussu, C. Kindts, C. Vandecasteele, & B. Van der Bruggen, 2007). The Netherlands and Scandinavian countries have imposed restrictions on water use for vehicle wash. (K. Boussu, C. Kindts, C. Vandecasteele, & B. Van der Bruggen,2007). Brazil also has implemented strict environmental regulations for recycling vehicle-wash wastewater. In developing counties, few initiatives have been taken for policy action and regulations to control wasteful water use. In India, according to the prevention and control of pollution act 1974 (amended 1988), before the discharge of effluent into a sewer or natural stream content checking is necessary (PCP, 1974,1988). The Maharashtra pollution control board warned service centers for violating environmental norms (Times of India, 2017). Pune Municipal Corporation has imposed a total ban on potable and groundwater or vehicle washing (News18, 2012). Still, it seems that laws and orders are not implemented, and there is no monitoring mechanism for observing these activities.

Deep bore wells are being used illegally by the vehicle washing industry to extract groundwater for vehicle cleaning. Consequently, the volume of water is turned to polluted water. The Shrigonda Municipality does not regulate the exploitation of groundwater for commercial use and the discharge of effluent.

This study provides the municipality authorities with a compressive analysis of the wastewater produced in Shrigonda town. Making policies to conserve water resources will benefit it as well. From this investigation, effluent emission standards and a strategy for recycling wastewater can be developed.

2.Material and Method

2.1 Study Area:-Shrigonda town, the present study area, is located at 18^0 36' 48" North latitude and 74^0 42' 00" East Longitude with an average altitude of 552 meters and comprises 9 wards covering 79 square kilometer area including ~~of~~ *Gavthan (*old town), the suburb area (Yellow Zone), and the green zone. It accommodates 32000 populations as per the 2001 census and 6000 constructions (residential, commercial) as per google images data of 2019. It is a drought-prone area of Maharashtra located south of Ahmednagar city. It has developed as a residential town. The town depends on surface and groundwater for domestic and commercial use. But these sources of water decrease rapidly in the summer season. There are thirteen vehicle washing centers in Shrigonda town. Due to the scarcity of tar and concert roads, vehicle owners need to wash vehicles frequently, and the frequency of washing increases in the monsoon season due to muddy roads.

2.2 Status of water resources of Shrigonda Town

Shrigonda town lies in the drought-prone area of Maharashtra, India, to the south of Ahmednagar district. It receives 447 mm (IMD) average annual rainfall. Shrigonda Municipality constructed a water treatment plant (WTP) in 2018 under

the Urban Infrastructure Development Scheme for Small and Medium Towns by investing 4595.63 lakhs (SMC, 2017) for supplying domestic, drinking and commercial use. The WTPs water purification capacity is 11 MLD/day. The water lifted through the pipeline from Ghod Dam is transferred to WTPs built near Shrigonda town for treatment.

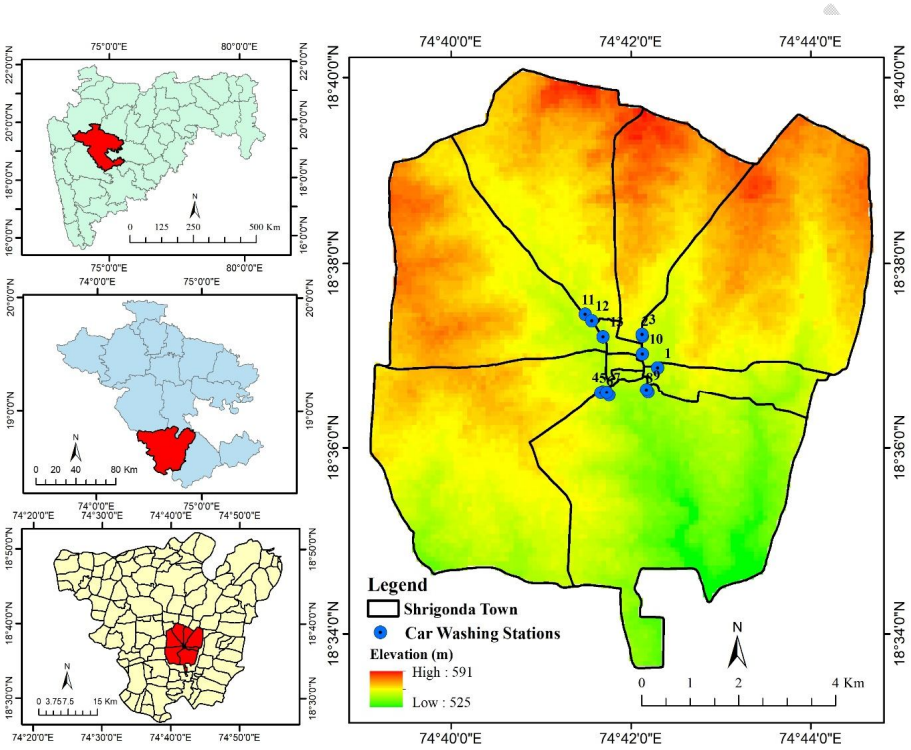

Figure 1. Location map of washing centers in Shrigonda Town

The treated water is then distributed and stored in different overhead water storage tanks constructed across the other parts of the town. The Municipality supplies water for commercial purposes by a separate connection, but vehicle washing centers are not availing connection due to freely available groundwater. The amount and frequency of water supply decrease in summer due to drying up the surface water bodies. Almost all washing centers uses groundwater for their commercial activities. In the summer season, water yield from the bore well also decreases. There are two small-sized surface water tanks adjacent to Shrigonda town, but water from these tanks is not directly utilized for commercial and domestic purposes. No single-vehicle washing center has taken Municipality's water supply connections for washing vehicles.

2.3 Fieled Survey

Field observations were carried out with field inventory to determine the water requirement for vehicle washing and the volume of wastewater generation of vehicle wash centers in Shrigonda town. Thirteen Vehicle wash centers were observed during the field survey. The collected data included locations, sources of water, type of vehicle washed, the time required for vehicle wash, number of vehicles washed, types of washing surface and types of vehicle. All vehicle washing centers were observed daily (7 am-6 pm) during dry and wet seasons for a week (7 days), including Sunday, to get the maximum number. The per day number of vehicle washed and the amount of water used to wash different vehicles was obtained from all thirteen car wash centers. Vehicle washing centers were observed during the dry and wet seasons because during the wet season number of vehicles washed per day increases rapidly owing to muddy roads.

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2.4. Types of vehicle and method of wash

Field observation shows vehicles are categorized into two-wheelers and four-wheelers. Two-wheelers included motorbikes, and four-wheelers included cars, light motor transport vehicles and heavy transport vehicles. Very few heavy transport vehicles are washed at the washing centers. Primarily cars and motorbikes are washed all over the vehicle washing centers in Shrigonda town. All vehicle washing centers use the semi-manual method of washing. It refers to hand-held spray with the spray gun and hand washes with brush,cotton cloth and foam making detergent solution. A plastic bucket is used to make foam.

2.5. Amount of water used to wash per vehicle was computed using the following method (Isaac , Emmanuel , & Richard , 2020)

$$V_w = q_w t + \sum_{i=1}^{n} V_i$$

Where: -

V_w = Total amount of water utilized to wash vehicle(L)

q_w = Volumetric flow rate of HTP Sprayer pump (L/s)

t = Time required to wash vehicle using HTP Sprayer pump

v_i = Volume of water in graduated bucket at the i^{th} time of use (L)

n = number of buckets used for entire car wash

The total volume of water utilized to wash each category of vehicle is computed separately

2.6. Estimation of wastewater flow from each vehicle washing centers is computed using the following formula (Isaac, Emmanuel, & Richard, 2020)

The volume of waste water flow is result of water utilized to wash,evaporation loss and carryout. Thus, return flow values are evaluated as per the following equation.

$$q_{ds} = R \times W_d \sum_{i=1}^{n} P_i \times V_i$$

Where,

qd = Daily volumetric flow rate of wastewater of Vehicle wash centers (L/day)

R= Estimated return flow of the vehicle wash centers (0.8 paved surface)

i = Category of vehicles.

Wd = Mean number of vehicles washed per day

pi = Proportion of vehicles in the ith category

vi = Volume of water used to wash the vehicle in the ith category (L)

N= Number of vehicles washed in ith category per day

3.Result and Discussion

3.1. Vehicle washing characteristics and pattern at vehicle washing centers:

Vehicle washing centers in Shrigonda town are mainly located along the importantat roads. Almost all the vehicle wash centers depends on groundwater (Bore well) due to free available groundwater. None of the vehicle wash centers use the Municipality supplied water. Almost all vehicle wash centers (100%) N=13 use hand-held spray guns, and none have a wastewater recycling mechanism. Overall, 764 in the dry season and 982 in the wet season vehicle are washed at thirteen vehicle wash centers during the day. Out of these in the dry season, 46.98% were motorbikes, 36.78% were cars,11.12% were LTVs, and 5.10% were HTVs.Whereas in the wet season, 42.87% were motorbikes,40.93% were cars,11.40% were LTVs, and 4.78% were HTVs. The motorbike is the highest category of vehicle washed at all thirteen centers.

3.2 Water quantity used for a different vehicle

In the dry and wet seasons, 764 and 982 vehicles were monitored in the thirteen centres to find water use per vehicle. The water volume utilized to wash per vehicle during the dry and wet seasons is shown in Figure:2 and 3.

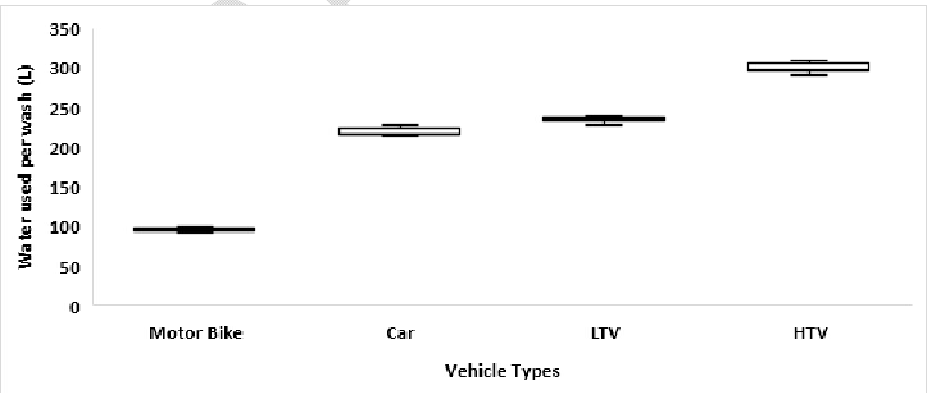

Figure 2. Amount of water used to wash vehicles in the dry season

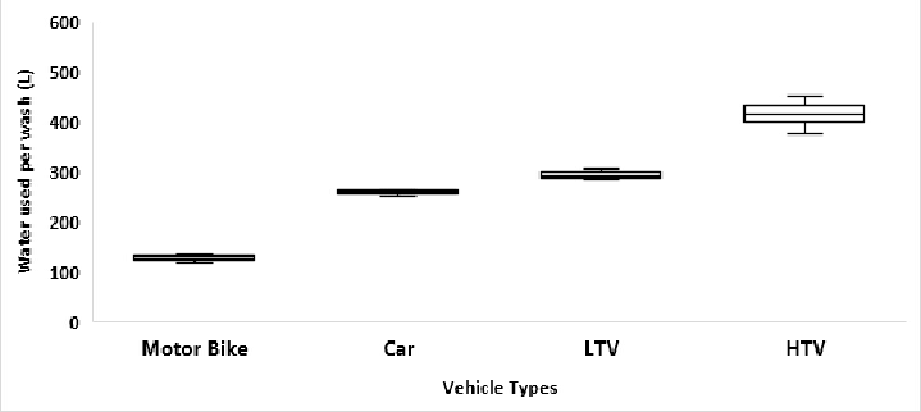

Figure 3. Amout of water used to wash vehicles in the wet season

The average amount of water used to wash per vehicle is differing between 95.83L -300.79L in the dry season and 128.28L -415.40L in the wet season. More oversized vehicles need more water, and smaller vehicles need less water to wash the vehicle.

Seasonal variations in mean water volume used for washing different vehicles

Table 1: Season-wise water volume used for washing different vehicles

Washing Centers	Dry Season			Wet Season			P-value	P-value
	No. of Vehicles	Mean water volume (L)	SD	No. of Vehicles	Mean water volume (L)	SD		
1	79	242.61	81.12	106	271.02	109.88	0.033876647	<0.05
2	53	215.03	87.46	71	275.96	115.08	0.006185219	<0.05
3	66	212.13	84.58	82	279.60	119.29	0.021188406	<0.05
4	71	213.50	87.91	81	281.75	122.69	0.02411822	<0.05
5	55	212.11	88.58	74	278.95	134.53	0.02059185	<0.05
6	51	212.78	85.16	77	275.48	116.04	0.009795341	<0.05
7	33	213.71	89.22	31	278.85	131.68	0.013369114	<0.05
8	89	211.64	87.10	108	269.81	115.48	0.012804889	<0.05
9	55	212.05	85.36	81	263.54	102.14	0.003856433	<0.05
10	56	210.78	83.93	68	276.57	130.29	0.022379547	<0.05
11	44	215.59	84.85	61	274.57	122.08	0.027411469	<0.05
12	62	213.74	86.25	73	259.94	106.56	0.034875404	<0.05
13	48	211.36	83.18	69	270.21	109.90	0.012224445	<0.05

(Source: Computed by researcher)

Based on the one-way ANOVA test mean water volume used to wash during the dry and wet seasons is statistically important (p=<0.05). There is a higher water volume required to wash vehicles during the wet season (281.75-259.94) and slight variation among the thirteen washing centers (table 1). It is mainly because of unpaved/earthen roads. A large amount of mud is stuck to the vehicle and needs a relatively higher amount of water to remove it. Whereas during the dry season, comparatively need less water (242.61 L-210.78 L) to wash vehicles because dry roads just accumulate dust on vehicles. There is also center-wise variation in the average volume of water used to wash the vehicle and it ~~is~~ depends on person who is washing the vehicle.

3.3 Daily vehicle washes and water used for washing vehicle

Heavy vehicles need more water, but very few are washed daily over the washing centers (N=13). The correlation between the number of vehicles washed daily and the water used for washing vehicles at different washing centers (Figures 4 and 5) has a negative correlation. It means that vehicle washing centers wash more vehicles daily, which need less amount of water and vice versa.

Table 2: Correlation of water volume utilized to wash vehicles in the Dry season

Types of Vehicles	Mean no. of Vehicles	Water/Liter/Vehicle
Motor Bike	28	95.83
Car	22	219.62
Light Transport vehicle (Pickup, Tata Chhota Hatti)	7	235.64
Heavy Transport Vehicle (Trucks)	3	300.79

(Source: Computed by researcher)

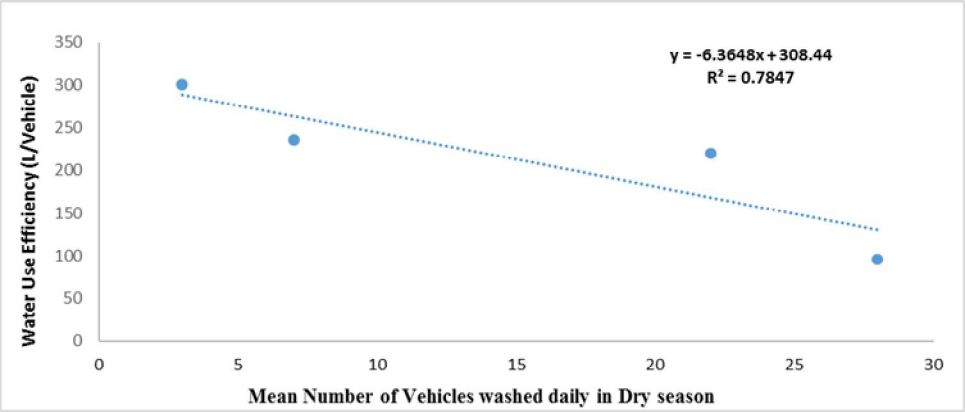

Figure 4: Correlation of water quantities used to wash vehicles in the Dry season

Table 3: Correlation of volume of water used to wash vehicles in the Wet season

Types of Vehicles	Mean no. of Vehicles	Water/Liter/Vehicle
Motor Bike	33	128.28
Car	31	258.79
Light Transport vehicle (Pickup, Tata Chhota Hatti)	9	290.89
Heavy Transport Vehicle (Trucks)	**4**	**415.40**

(Source: Computed by researcher)

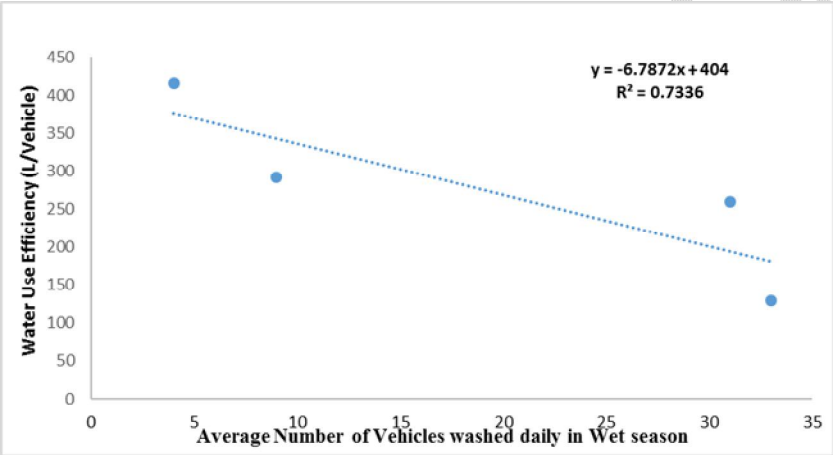

Figure 5: Correlation of water volume used to wash vehicles in the Wet season

4.Conclusion:

This investigation found that vehicle washing centers in Shrigonda town use semi-manual washing methods. All washing centers (N=13) are extracting groundwater for washing. During the dry season daily , 58.61 and the wet season, 75.53, the average number of vehicles washed all over the washing centers use~~ing~~ the mean of 95 Liters to 300.79L water in the dry season and 128.28 Liters to 415.40 Liters of water in the wet season. All (N=13) centers generate 102301L of waste water daily in dry season and 168114 Liters in the wet season. All centers use a handheld spray gun and a plastic bucket to wash vehicles. Washing centers wash~~esh~~ more vehicles which need less amount of water, and vice versa. Overall, 270415 L/day of wastewater was generated by the vehicle washing centers in Shrigonda town. As per the Bureau of Indian Standards minimum of 70 to 100/ lphd water is adequate for domestic use of urban communities with a complete flushing system (BIS, 1993,2002). As per these values, wastewater generated is equivalent to the water need of 1352 people daily.

The present study recommends to the Municipality authority that existing and new vehicle wash centers be authorized by verifying all environmental impact assessment norms viz site suitability, source of water, amount of daily wastewater generated, recycling mechanism etc. The tax should be imposed for groundwater extraction based on the volume of water extracted. Financial inducement such as concessions in tax should be given for the washing centers that adopts water-saving technology and installs rooftop rainwater harvesting at home or commercial rooftops in compensation for the volume of wastewater generated. More studies are required to assess the physico-chemical properties of sewage and its environmental impact. The owner of the washing center should apply cost benifit analysis for detremining the charges of each vehicle washing.

6.References

1. Aboulhassan, M. A., Souabi, S., Yaacoubi, A., & M., B. (2006). Removal of surfactant from industrial wastewaters by coagulation flocculation process. International Journal of Environment Science and Technology, 3(4), 327-332.
2. BIS. (1993,2002). Code of Basic Requirment for Water Supply,Darainage and Sanitation. New Delhi: Burea of Indian Standerd.
3. Ghaly, A., Mahmoud, N. S., Ibrahim, M., Mostafa, E. A., Abdelrahman, E. N., Emam, R. H., . . . Hatem, M. (2021). Water Use, Wastewater Characteristics, Best Management Practices and Reclaimed Water Criteria in the Carwash Industry: A Review. International Journal of Bioprocess &, 7(1), 240-261.
4. IMD. (n.d.). Indian Meteorological Department.
5. Isaac , M., Emmanuel , A. D., & Richard , B. (2020). Clean vehicles, polluted waters: empirical estimates of water consumption and pollution loads of the carwash industry. Heliyon, 6(5), 1-9. doi:https://doi.org/10.1016/j.heliyon.2020.e03952
6. K. Boussu, C. Kindts, C. Vandecasteele, & B. Van der Bruggen. (2007). Applicability of nanofiltration in the carwash industry. Separation and Purification Technology, 54, 139-146.
7. Mujumdar, M. M., Rajagolkar, S. P., & Jadhav, P. (2020, June 2). Treatment of Vehicle Washing Waste Water for Maximum Reuse of Treated Water and Reduce Fresh Water Consumption. International Journal of Recent Research Aspects, 7(2), 1-5.
8. News18. (2012). Retrieved from https://www.news18.com/news/india/pune-ban-on-misuse-of-water-at-car-washing-centres-489820.html
9. PCP. (1974,1988). THE WATER (PREVENTION AND CONTROL OF POLLUTION) ,ACT 1974. Retrieved from https://www.indiacode.nic.in/bitstream/123456789/15429/1/the_water_%28prevention_and_control_of_pollution%29_act%2C_1974.pdf
10. SMC. (2017). Shrigonda Municipality .
11. Times of India. (2017). Retrieved from https://timesofindia.indiatimes.com/city/nagpur/mpcb-issues-notice-to-car-service-centre/articleshow/57610607.cms