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By Elanda Fikri

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Study of Liquid Waste Quality and Potential Pollution Load of Motor Vehicle Wash Business in Bekasi City (Indonesia)

Elanda Fikri[1*], Arifah Nur Shabrina Putri[2]

[1]Department of Environmental Health, Bandung Health Polytechnic, Cimahi Utara, 40514, Doctorate Program of Environmental Studies, Diponegoro University, Semarang, Indonesia, 50241, *Corresponding author e-mail:elandafikri@yahoo.com

[2] Department of Environmental Health, Bandung Health Polytechnic, Cimahi Utara, 40514

Abstract

The increasing number of motor vehicles in Bekasi city each year has led to the development of motor vehicle wash business that can cause water pollution due to the resulting liquid waste. The use of various chemicals in these activities is one factor that affects the quality of liquid waste. This study aims to identify the quality of liquid waste from motor vehicles wash in Bekasi city. The sample in this study was liquid waste from semi-automatic motor vehicles wash business in North Bekasi region. The result of the research conducted in 3 locations was that the three locations had not yet carried out the processing of liquid waste produced before being discharged into the environment. The results of test parameter presented in location 1, location 2, and location 3, respectively, were pH around 6.0, 5.0, and 4.8. TSS was 279.7 mg / l, 259.4 mg / l, 333.6 mg / l, COD was 657.1 mg / l, 182.1, 460.0 mg / l, oil and fat were 79.1 mg / l, 46.2 mg / l, 86.7 mg / l, phenol was 2.7 mg / l, 1.5 mg / l, 3.2 mg / l, and the highest potential pollution load was in COD parameter and TSS. Therefore, it is recommended that a motor vehicle wash business begins to pay attention to the impact of liquid waste by processing it before being discharged into the environment and Bekasi City government should begin to control water pollution, especially in those businesses.

Keywords : quality of liquid waste, pollution load, motor vehicle wash business

INTRODUCTION

Water pollution is the entry or inclusion of organisms, substances, energy, and / or other components into the water, therefore the water quality drops to a certain level which causes the water to no longer function in accordance with its designation (Ministry of Environment Regulation Number 1 of 2010 concerning Management of Water Pollution Control). Pollution can occur due to various factors, one of which comes from human activities, namely business activities. This has an impact on the number of businesses that are currently developing, one of which is the washing of motor vehicles.

Now there are many vehicle wash business in various regions in Indonesia, supported by the reason that the use of these business is considered more practical. However, vehicle wash business can worsen environmental quality and can also disrupt public health. This is due to the characteristics of vehicle wash waste containing pollutants such as BOD, COD, TSS, detergent (surfactant), oil, and fat. Washing vehicle

waste water that does not go through processing first but is directly thrown into the body of water can pollute the river water.

Especially pollution due to the presence of high oil and fat in the body of water will cause a decrease in the quality of water body, this is caused by the nature of oil that is difficult to decompose so that it can cause a decrease in the self-purification of the water body (Herganintya, et al., 2014, El-Gawad, 2014). The decline in the ability of self-purification is characterized by low oxygen content in the water (Dissolved Oxygen) which can interfere with the biota life in the river and can also cause pollution to the surface water and soil and can also be media where the proliferation of pathogenic microorganisms and vector carrying disease. In addition, the composition of oil and fat also contains many harmful ingredients (such as phenols and polyaromatic hydrocarbons) that are carcinogenic to humans (Lau W, et al, 2013; Kwach, et al, 2009 in Ibrahim and Hashim, 2018).

Vehicle wash businesses in Indonesia still do not process their laundry waste before being discharged into water body. Based on research conducted by Herganintya, et al. (2014), oil and fat content in car wash liquid waste was 36 mg / L, and COD 700 mg / L, Setiawan and Situmorang (2017) research in Karawang Regency ranged from 86 - 159 mg / L and COD 87.54 mg / L, and Pranoto (2017) research in Yogyakarta showed the value of oil and fat was 51 mg / L and COD was 425 mg / L, and Evy et al. (2013) research in Malang showed the value of oil and fat was 29.33 mg / L, COD was 549 mg / L, and TSS 272 mg / L which had exceeded the liquid waste quality standard set in Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standard which refers to the Waste Water Quality Standards of Businesses and / or Activities that do not have a Defined Waste Water Quality Standard.

The problem regarding river pollution especially in Bekasi City has become a crucial problem. Rivers in Bekasi are now highly polluted, which is characterized by being covered with white foam, pungent odor, and also blackened dirt, therefore the source of pollutants in Bekasi is assumed to be domestic waste (60%) and industrial waste (40%) (Putri, 2018).

Bekasi city is one part of megapolitan area, namely Mega City Jabodetabek, which is the second largest urban area in Asia after Tokyo Metropolitan City which is 0.35% of the total area in Indonesia and inhabited by 11.3% of Indonesia's population (Pravitasari et al., 2015). Data from Central Statistics Agency in 2018 showed that the population growth rate was 1.47% with population density reaching 13,318 people / km^2 and it had been projected that Bekasi city would experience a population explosion up to 3.6 million by the year 2022. The rapid population growth in Bekasi City will result in changes in patterns and lifestyles, as well as increasingly high standard of living with increasing demand for goods and services. The need for motor vehicle wash business is no exception.

Based on Central Statistics Agency (2016) data, the number of private two and four-wheeled vehicles in Bekasi City reached 1,572,922 vehicles, with 1,259,146 units of motorcycles and 313,776 units of cars. Therefore, the vehicle wash business in Bekasi city can potentially pollute the environment.

This study aims to identify the existing condition of liquid waste treatment and the quality of liquid waste in terms of parameters pH, COD, TSS, oil, fat, and phenol, also potential pollution load from COD, TSS, oil, fat, and phenol parameters of wash business in Bekasi city.

MATERIALS AND METHODS

The type of research used was descriptive. The research was carried out in 3 vehicle wash business locations in North Bekasi Subdistrict in May 2019. The population was divided into two types, which were the population of locations, namely all motorbike wash locations in Bekasi City, and environmental population, namely all liquid waste of motor vehicle wash business in Bekasi city.

The location sample in this study was a semi-automatic type vehicle wash business. The sampling technique used was purposive sampling. Environmental samples in this study was liquid waste from semi-automatic motor vehicle wash activities with a total sample of 3 liters from each location. The sampling method used was composite sampling based on the solid time of wash business.

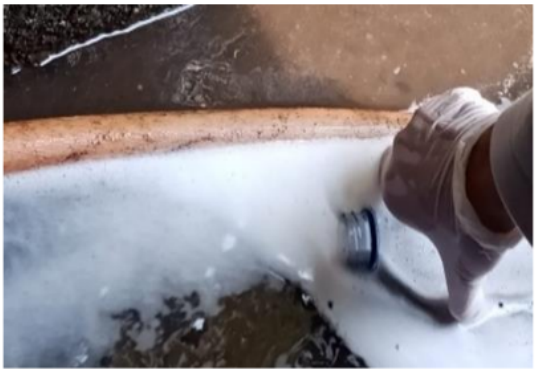

Fig. 1. Sampling of waste water to prevent aeration

Fig. 2. treatment of samples (stored in cool boxes with ice packs)

Data was processed using a computer, and was analyzed with information obtained from observations and related theories and also analyzed by comparing the quality standard of Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards that refers to Waste Water Quality Standards Businesses and / or activities that do not yet have a defined liquid waste quality standard.

RESULTS AND DISCUSSION

Existing Condition for Liquid Waste Management of Motor Vehicle Wash

Existing condition in 3 business locations for washing motor vehicles is that the liquid waste produced is not processed first but directly discharged into rivers and sewers around the wash business and to make the liquid waste produced from the three locations visually seen that it is colored, smelling, foaming, there are films or layers of oil and fat that can potentially pollute river water and groundwater indirectly.

Based on these conditions, liquid waste treatment activities need to be carried out. Waste water treatment activities aim to eliminate pollutant parameters that exist in liquid waste to the extent permitted to be discharged into water body in accordance with permitted standard requirements. Seen from the sequence, liquid waste treatment processes can be divided into primary processing (primary treatment), secondary processing (secondary treatment), and tertiary processing or further processing. (Said, 2017).

Fig.3 Washing process using high pressure

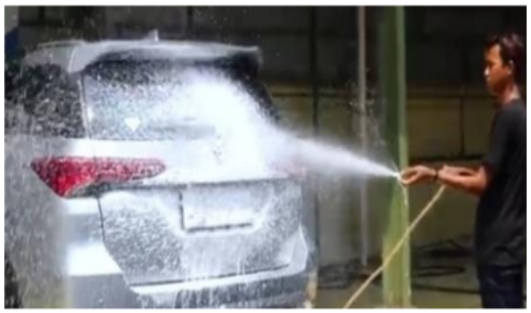

Fig.4 The process of giving detergents

Quality of Motor Vehicle Wash Liquid Waste

1. pH Level

Table 1. pH Level of Motor Vehicle Liquid Waste

Location	pH Level	Raw Quality	Note	Analysis Method
Location 1	6.0	6 – 9	Qualified	
Location 2	5.0	6 – 9	Unqualified	SNI 6989.73:2009
Location 3	4.8	6 – 9	Unqualified	

Based on Table 1, it can be seen that the pH level in liquid waste of motor vehicles wash business in location 1 is 6.0, location 2 is 5.0, and location 3 is 4.8 or it can be seen that liquid waste in the three business locations for washing motor vehicles has a pH level of the acid category. When compared with

the Republic of Indonesia Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards where the value of the standard pH level is 6 - 9, it can be said that location 1 has fulfilled the requirements and for locations 2 and 3 do not meet the requirements.

This can be ascertained because of the use of shampoo, soap, or detergent in the washing process where builders increase the efficiency of surfactants by creating appropriate acidity conditions so that the washing process can take place properly by dispersing and suspending impurities (Minaqua, 2016). The impact of abnormal pH level will change the pH of the water which will further disrupt the life of microorganisms in the water (Nadhiroh, 2014).

2. Debit

Table 2 Debit Data of Liquid Waste from Motor Vehicles Wash Business in Bekasi City in 2019

Location	Debit (m^3/second)
Location 1	28,5 x 10^{-6}
Location 2	28,0 x 10^{-6}
Location 3	27,6 x 10^{-6}

Based on Table 2, it can be seen that the highest liquid waste discharge produced by the motor vehicle wash business is at location 1 which is 28.5 ml / sec and the lowest liquid waste discharge that is produced is at location 3.

3. Total Suspended Solid (TSS)

Table 4.3 TSS Content Data of Liquid Waste from Motor Vehicles Wash Business in Bekasi City in 2019

Location	TSS (mg/L)	Raw Quality (mg/L)	Note	Analysis Method
Location 1	279,7	200	Unqualified	APHA Section 2540 D 23rd Ed 2017
Location 2	359,4	200	Unqualified	
Location 3	333,6	200	Unqualified	

Based on Table 3, it can be seen that the highest TSS value contained in liquid waste from motor vehicle wash business is at location 2, which is 359.4 mg / l. When compared with waste water quality standards according to RI Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards which is 200 mg / L, it can be concluded that the TSS content in liquid waste in the motor vehicles wash business has exceeded or can be said to be ineligible.

TSS content in the three locations can be affected because the impurities contained in the vehicle are carried along during washing.

Based on Phungula (2016), there were several pollutants attached to motor vehicles which were classified into 3 types, the first one was traffic pollutants including dust, heavy metal particles, oil and fat, brake pads, the second one was environmental factors including dirt due to the road condition used by vehicles, the third one was vehicle wash chemicals such as detergent and vehicle shampoo.

It is also supported by a high-pressure washing equipment that is able to completely clean the surface of the vehicle. In addition, the use of shampoo, soap, or detergent in washing also affects the presence of TSS content. This is also in line with the research conducted by Hashim and Ibrahim (2018) in Malaysia, where the motor vehicles wash business using high pressure washing equipment produced liquid waste with a TSS content of 392 mg / l.

The impact of TSS content could affect the condition of waters because high concentration could interfere with life in the water which blocked sunlight which helped plants to carry out photosynthesis (Ningrum, 2019)

4. Chemical Oxygen Demand (COD)

Table 4 COD Content Data of Liquid Waste from Motor Vehicles Wash Business in Bekasi City in 2019

Location	COD (mg/L)	Raw Quality (mg/L)	Note	Analysis Method
Location 1	657,1	100	Unqualified	
Location 2	182,1	100	Unqualified	SNI 6989.73-2009
Location 3	460,0	100	Unqualified	

Based on Table 4 above, it can be seen that the highest COD content in liquid waste from motor vehicles wash business is at location 1 which is equal to 657.1 mg / l. When compared with the value of waste water quality standards according to RI Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards for COD parameters of 100 mg / L, the third liquid waste of the vehicle wash business has exceeded the standards set or can be said to be ineligible.

COD content is influenced by chemicals found in shampoo, soap, or detergent used in the washing process. Ingredients contained in shampoo, soap, or detergent in all three wash businesses of detergent motor vehicles with an active ingredient, namely anionic surfactant.

In general, detergent is composed of three components, namely surfactant (as a base material) of 20-30%, builders (phosphate compounds) of 70-80%, and additives (bleach and fragrance) which are relatively small, namely 2-8%. Phosphate content or Sodium Tripolyphosphate (STTP) in shampoo, soap, or detergent can stimulate the growth of water weeds. An increase in water weeds will cause an increase in

phosphate decomposition, and an inhibition of the exchange of oxygen in water so that dissolved oxygen level in water is low (Kirk and Othmer, 1982 in Yuliani, et al 2015).

The difference in COD content in liquid waste produced by the three motor vehicles wash business activities is likely to occur due to the amount of shampoo, soap, or detergent used differently such as the dosage of use.

The impact of COD content when directly discharged into a body of water will reduce dissolved oxygen in water, can threaten the extinction of organisms in the water, and can also lead to the emergence of anaerobic conditions namely the emergence of foul odors and aesthetic problems (Ningrum, 2018). In addition, according to Wibowo (2013), water quality also affects health, given the nature of water which is easily contaminated by various microorganisms and is very easy to dissolve various materials. The condition of the water nature causes water to easily function as a medium for channeling or spreading disease.

5. Oil and Fat

Table 5 Oil and Fat Content Data of Liquid Waste from Motor Vehicles Wash Business in Bekasi City in 2019

Location	Oil and Fat (mg/L)	Raw Quality (mg/L)	Note	Analysis Method
Location 1	79,1	10	Unqualified	APHA Section 5520 oil & fat F 23rd Ed 2017
Location 2	46,2	10	Unqualified	
Location 3	86,7	10	Unqualified	

Based on Table 5 above, it can be seen that the highest oil and fat content in the motor vehicles wash business at location 3 is 86.7 mg / l. When compared with the quality standard according to RI Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards for oil and fat parameters, which is 10 mg / L, the oil and fat content in liquid waste from motor vehicles wash business has exceeded the standard set, namely 5 mg / l or can be said to be ineligible.

The presence of oil and fat content in liquid waste resulted from the use of detergent or soap in washing motor vehicles can clean the presence of oil and fat. According to Khanmohammadi et al. (2007) in Puspitasari, et al. (2013), the active ingredients of shampoo, soap, or detergent were surfactants which could increase the water wetting so that fatty impurities could be moistened and lifted.

Washing activities on vehicle engines where the possibility of carrying oil attached to the equipment when being cleaned or gasoline is leaked. This is in line with the research conducted by Pranoto

in 2017 where the engine cleaning activities on vehicles caused the presence of oil and grease in liquid waste from motor vehicle wash.

6. Phenol

Table 6 Phenol Content Data of Liquid Waste from Motor Vehicle Wash Business in Bekasi City in 2019

Location	Phenol (mg/L)	Raw Quality (mg/L)	Note	Analysis Method
Location 1	2,7	0,5	Unqualified	IKM/7.2.90/MB (Spectrophotometry)
Location 2	1,5	0,5	Unqualified	
Location 3	1,2	0,5	Unqualified	

Based on Table 6, it can be seen that the highest phenol content is in liquid waste. The third location of vehicle wash business is 3.2 mg / l. If compared with related regulations, namely with Republic of Indonesia Ministry of Environment Regulation Number 5 of 2014 concerning Waste Water Quality Standards for the phenol parameter, which is 0.5 mg / L, it can be seen that the phenol content of the three motor vehicle wash businesses has exceeded the existing quality standard or is ineligible.

The presence of phenol content in liquid waste from motor vehicle wash business is influenced by oil and fat content. According to Kwach et al. (2009), the content of oil and fat is complex and can also contain many hazardous substances (such as phenols and polyaromatic hydrocarbons). It can be said that the presence of phenol content is related to the presence of oil and fat and it can be seen also that location 3 is the location where the liquid waste contains the highest phenol which is 3.2 mg / l. Location 3 is also the location with the highest oil and fat content among other locations.

The impact of phenol content on water body will cause unpleasant taste and smell, and at certain concentration values can cause death in aquatic organisms because phenol is classified as dangerous, corrosive, and toxic. (Ariyani, 2011). In addition, the effect of phenol on humans can cause irritation to the eyes, nose, and throat. Phenol is toxic to the respiratory system and can cause damage to the nervous system tissue if it is consumed or continuously inhaled (Faisal and Saksono, 2013)

Potential Pollution Load

Based on the Regulation of Ministry of Environment Number 1 of 2010 concerning Management of Water Pollution Control, it is stated that the water pollution load is the amount of a pollutant contained in waste water.

The waste water is discharged directly into Bekasi river and for locations 2 and 3 indirectly also flowed into Bekasi river, therefore it can potentially reduce the River Pollution Load Capacity of Bekasi

City which will reduce water quality which causes the function of ecosystem to be disturbed and does not function according to its designation. Pollution of rivers also has the potential to pollute ground water. Groundwater can be either deep well water or shallow well water (Ningrum, 2018).

Table 7 Potential Pollution Load of Liquid Waste from Motor Vehicle Wash Business at Location 1, Location 2, and Location 3

Parameter	Potential Pollution Load (kg/day)		
	Location 1	Location 2	Location 3
TSS	$6{,}8 \times 10^{-1}$	$8{,}7 \times 10^{-1}$	$7{,}9 \times 10^{-1}$
COD	1,6	$4{,}4 \times 10^{-1}$	1,09
Oil and Fat	9×10^{-1}	$1{,}1 \times 10^{-1}$	2×10^{-1}
Phenol	6×10^{-4}	3×10^{-4}	6×10^{-4}

Based on Table 7, it can be seen the highest potential pollution load in liquid waste is at the first location of the vehicle wash business, which is chemical oxygen demand (COD) parameter, which is 1.6 kg / day. At location 2 the highest potential pollution load in liquid waste is total suspended solid (TSS) parameter, which is 8.7 x 10-1 kg / day. And at location 3 the highest potential pollution load in liquid waste from motor vehicle wash business is Chemical Oxygen Demand (COD) parameter which is equal to 1.09 kg / day.

CONCLUSION

1. The existing condition of liquid waste treatment of motor vehicle wash business in 3 locations as the research sites found that the three locations did not process the liquid waste before being disposed of into the environment or 100% did not carry out liquid waste treatment.
2. The highest potential liquid waste pollution load for motor vehicle wash business per parameter at location 1 was Chemical Oxygen Demand (COD) parameter of 6.8 x 10-1 kg / day, in location 2 was Total Suspended Solids (TSS) parameter, namely at 8.7 x 10-1 kg / day, and at location 3 was Chemical Oxygend Demand (COD) parameter which was equal to 1.09 kg / day.

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Conflict of interest

The Authors do not declare conflict of interest

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