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Exhaust Gas Emission from Automotive Workshop Facilities of Vocational School in Yogyakarta

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Exhaust Gas Emission from Automotive Workshop Facilities of Vocational School in Yogyakarta

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Abstract. Management of learning facilities and infrastructure is not only a learning arrangement, and physical facilities, but prepares classroom conditions and school environment in order to create comfort and an effective learning atmosphere. Therefore, schools and classes need to be managed properly, and create a supportive learning climate. One of the problems in the management of practical facilities is exhaust gas emission produce from practice facilities. The purpose of this study is to identify the load of emissions produced by vocational school practice facilities.

The approach of this research is quantitative research, with descriptive methods, and research techniques using surveys. The research population is a practice facility in the Automotive Engineering Workshop in 9 (nine) Vocational Schools in Yogyakarta.

The results showed that the exhaust gast emission potential from the Automotive Engineering Program in the city of Yogyakarta, based on data collected through surveys, can be calculated estimated fuel consumption per year and the amount of emissions from several emission factors according to applicable standards. Amount of emission: NOx 0.08134 (Ton / year), SOx 0.00077 (Ton / year), NMVOC 0.06539 (Ton / year), PM10 0.00349 (Ton / year), CO 2.73184 (Ton / year), and CO2 48.32946 (Ton / year) Although the source of exhaust emissions from the workshop practice facilities of the Automotive Engineering Expertise in the city of Yogyakarta has a small emission value when in a single situation / condition, it can provide significant potential when accumulating or area, causing a negative impact on the health of both students and teachers that is around it.

1. Introduction

Schools as ongoing learning and teaching activities, both basic, junior and high, have the potential to contribute to emissions from the activities in them. These emissions are estimated to originate from the use of laboratory equipment, motorized vehicle parking, use of generator sets, and the use of cooking facilities in the canteen in the school concerned. The activity of motorized vehicle parking and cooking activities in school canteens has the potential to contribute to emissions. The greater the capacity of student accommodation, especially in secondary schools, the greater the potential for the contribution of emissions. Meanwhile, activities in the laboratory on the Automotive Engineering Program that operate the engine by burning fuel certainly have the potential for the amount of emissions produced. Therefore, in this study, the identification and calculation of the potential of air pollution is needed because of the operational facilities. The number of schools within the administrative area of Yogyakarta City is currently 105 schools, consisting of 10 kindergartens, 171 elementary schools, 66 junior high schools and 52 high schools, and 33 vocational secondary schools.

Some pollutants from motor vehicle exhaust are CO, HC, NO_2, SO_2, Pb and dust particulates. This CO and HC gas has a relatively large percentage concentration in any exhaust emissions of motor vehicles, especially those with gasoline. One of the air pollutant gases from the combustion of fuels in motorized vehicles is CO_2 as one of the greenhouse gases (GHGs) that plays a role in increasing the rate of global warming so that it has an impact on global climate change.

Sources of air pollution can be classified as fixed sources ("stationary sources" /"fixed sources") and non-fixed sources ("motor [mobile] vehicles"); while air pollutants are distinguished in gas pollutants and particle pollutants. Knowledge of sources of air pollution and pollution materials is the basis of the implementation of air management as a fundamental activity in order to provide legal solutions to air pollution events.

In some literature it can be found that pollutants that have an impact on air pollution can be divided into several categories based on their physical properties, namely in the form of particles namely dust, aerosols, heavy metals etc. Gas in the form of CO, NOx, H_2S, SOx, HC and Energy in the form of temperature and noise. While based on the process, it can be divided into primers, namely pollutants which are directly emitted from the source, secondary, namely pollutants formed due to reactions in the air between various elements, so that other impacts arise such as acid rain from HNO_3, and H_2SO_4.

Whereas based on emission patterns can be divided into point sources such as factory chimneys, volcanic eruptions. The line source is a road that is passed by motorized vehicles and area sources such as forest fires. Determining the causes of sources of air pollution in an area becomes very difficult and complex because of the large source and area and the influence of weather in the region.

Health risks caused by air pollution in cities in general have attracted much public attention in recent decades. In many large cities, motor vehicle exhaust gases cause discomfort to people who are on the roadside and cause air pollution problems as well. Some results of epidemiological studies can be concluded that there is a close relationship between the level of urban air pollution with the incidence (prevalence) of respiratory diseases.

2. ResearchMethod

This research was conducted with a quantitative research approach with survey research to identify the conditions of practice equipment and calculate the potential for air pollution caused by the operation of the equipment. This research was conducted in 9 Vocational School in the City of Yogyakarta. The time of the study was carried out from March 2017 to November 2017. The data in this study are quantitative data on potential pollution which are calculated based on the size of the emission factor. The research population is all the equipment and practical facilities available at the Vocational Workshop, in the City of Yogyakarta. The method of data collection is done by observation. The instruments used in this study are:observationsheet.

3. Result and Discussion

Based on data obtained from the Education and Culture Office of the City of Yogyakarta there are 33 Vocational Schools, 9 of which are Vocational Schools which hold the Automotive Engineering Program. To ascertain the location of these schools, a primary survey has been carried out to obtain validity of the data and simultaneously ensure the existence of the school location in its geographical coordinates for the purpose of plotting locations on the map. Plotting maps of locations from the survey results are shown in the following figure.

Based on data collected through the survey, it can be calculated the estimated fuel consumption used per year and the amount of emissions from several emission factors according to the applicable standards, including: NOx, SOx, NMVOC, PM_{10}, CO, and CO_2. For NOx, SOx, NMVOC, PM10, CO emission factors refers to EMEP / EEA Corinair Small Combustion, while CO_2 still uses emission factor provided by the IPCC Guidelines (see Table 1).

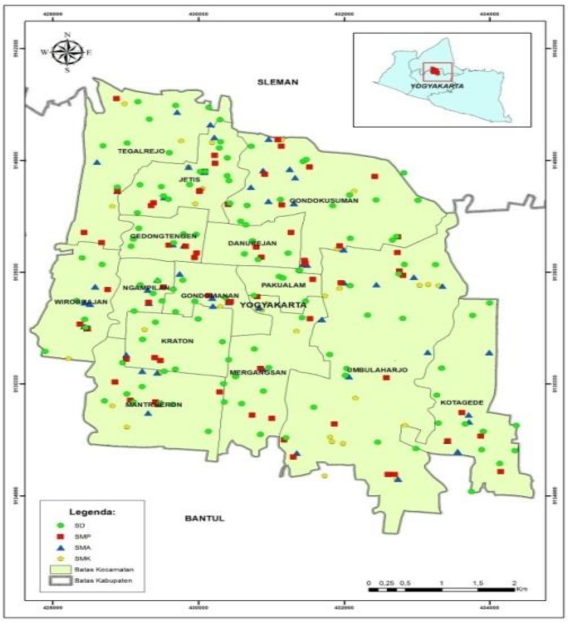

Figure 1. Map of school location distribution in Yogyakarta City
Source: Results of field survey (processed), 2017

Table 1. Emission factors for the school category

Tool type	**Fuel Type**	Emission factors **(g/GJ)**					
		NO_x*	**SO_x***	**NMVOC***	**PM_{10}***	**CO***	**CO_2** (g/TJ)**
Genset	Dieseil Fuel	513	47	25	20	66	74100
Genset	Gasoline	513	47	25	20	66	69300
Stove/oven	LPG	60	0,3	2	2,2	30	63100
Fireplace/Grill	Charcoal	50	11	600	760	4000	112000
Stove/Fireplace	Kerosene	513	47	25	20	66	71500
Ethylene las	Ethylene	135	0,5	89	2	56	63100
Lawn Mowers	Gasoline	2765	0,0358	242197	3762	620793	3197
Stand Engine/Car Trainer	Gasoline	7117	0,0358	17602	157	770368	69300
Stand Engine	Dieseil Fuel	32792	0,214	3385	2086	10722	74100

*) Avaliable on*EEA EMEP Inventory Guidebook 2013*
**) Available*IPCC Guidelines For National Greenhouse Inventory 2006*

Based on the results of the primary survey, an overview of the ownership of teaching learning facilities/ equipment has the potential to produce emissions and other equipment in the school (see Table 1). The list of schools contained in Table 2 is the location of the schools surveyed to obtain information on estimated fuel consumption used to support teaching and learning activities and other supporting activities in the school concerned.

Table 2. Number of students, type of equipment and estimation of fuel consumption in schools in the city of Yogyakarta

No	School Name	Number of Student	Equipment	Fuel Type	Fuel Consumption /year	Unit
1.	SMK Perindustrian	242	Stand Engine	Bensin	100	Liter
			Genset	Solar	50	Liter
2.	SMK MarsudiLuhur1	50	Kompor Gas	LPG	40	Kg
3.	SMK Pancasila Sakti Yogyakart	27	Genset	Solar	2,5	Liter
			Kompor Gas	LPG	160	Kg
4.	SMK BOPKRI 4	16	MesinKerangka Mobil	Bensin	600	Liter
5.	SMK N 3 Yogyakarta	1837	Kompor Gas	LPG	900	Kg
			Stand Engine	Bensin	200	Liter
			Stand Engine	Solar	100	Liter
			Car Trainer	Bensin	30	Liter
			Las Asitelin	Gas Etilen	0	Liter
6.	SMK N 2 Yogyakarta	2170	Genset	Solar	100	Liter
			Kompor Gas	LPG	240	Kg
			Kompressor	Bensin	1300	Liter
			Stand Engine	Bensin	2080	Liter
			Stand Engine	Solar	520	Liter
			Car Trainer	Bensin	80	Liter
			Mobil Praktik	Bensin	520	Liter
			Diesel	Solar	80	Liter
			Las Asitelin	Gas Etilen	200	Liter
7.	SMK PIRI 1	690	Genset	Bensin	10	Liter
			Kompor Gas	LPG	150	Kg
			Stand Engine	Solar	30	Liter
			Stand Engine	Bensin	600	Liter
			Kompresor	Bensin	2,5	Liter
			Las Asitelin	Gas Etilen	100	Liter
8.	SMK Muhammadiyah 3 Yogyakarta	1426	Genset	Bensin	50	Liter
			Kompor Gas	LPG	48	Kg
9.	SMK TamansiswaJetis	561	Genset	Solar	50	Liter
			Las Asitelin	Etilen	50	Liter
			Kompor Gas	LPG	120	Kg
			Stand Engine	Bensin	15	Liter
			Kompresor	Bensin	15	Liter

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From the school data in Yogyakarta City that have been collected, then the potential emission can be calculated according to the type of emission parameters, as shown in the following table 3.

Table 3. Annual emissions estimates generated from school activities in the city of Yogyakarta

No	School name	Emission (Ton/tahun)					
		NO_x	SO_x	NMVOC	PM_{10}	CO	CO_2
1.	SMK Perindustrian	0.00150	0.00009	0.00130	0.00005	0.05490	0.38462
2.	SMK MarsudiLuhur 2	0.00011	0.00000	0.00000	0.00000	0.00006	0.11787
3.	SMK Pancasila Sakti Yogyakarta	0.00050	0.00001	0.00002	0.00002	0.00023	0.47865
4.	SMK BOPKRI 2	0.02693	0.00014	0.00121	0.00138	0.01552	28.34701
5.	SMK N 3 Yogyakarta	0.00641	0.00001	0.00324	0.00029	0.12813	3.49370
6.	SMK N 2 Yogyakarta	0.03857	0.00033	0.05147	0.00151	2.18541	12.31642
7.	SMK PIRI 1	0.00447	0.00002	0.00765	0.00014	0.33051	2.00597
8.	SMK Muhammadiyah 3 Yogyakarta	0.00103	0.00008	0.00005	0.00004	0.00018	0.26206
9.	SMK TamansiswaJetis	0.00148	0.00009	0.00044	0.00005	0.01673	0.56955
Total Emission Assumptions of Surveyed Vocational High Schools		0.18258	0.00223	0.14068	0.00772	5.80261	109.63134
Average Emission of Vocational High Schools Surveyed		0.018258	0.000223	0.014068	0.000772	0.580261	10.963134

According to the emission calculation results above, it can be seen that the biggest emissions generated from teaching and learning activities and other supporting activities found in schools are CO_2 emissions. The level of vocational school is 109.63 tons/year. Furthermore, carbon monoxide (CO) emissions of 5.8 tons/year, NOx emissions of 0.18 tons/year and NMVOC emissions (HC) of 0.14 tons / year, while for SOx emissions of 0.00223 tons/year and PM_{10} of 0.0077 tons/year. The amount of emissions generated from learning activities and others at the vocational school provides opportunities for health problems for teachers, students and for employees and the surrounding community due to exposure to these emissions to health.

Environmental problems that pose a threat to residents in urban areas today are air pollution. One of the most dominant sources of air pollution in urban areas is emissions of motorized vehicles that are difficult to control. Likewise with the source of emissions contained in the school area as a place of learning. Identification of the potential for air pollution from practical learning facilities represents the magnitude of the level of danger caused by learning facilities both for students, teachers and technicians and all school residents. The pollutant levels identified indicate the potential for interference with the quality of the local environment (health problems) and globally (increasing GHG emissions).

The potential for the amount of dust (PM_{10}) from the results of learning activities in the Automotive Engineering Program is 0.0077 tons/year, although the size of particulates is still far below the quality standards set in accordance with ambient air quality standards in Republic of Indonesia Regulation Number 41 of 1999 concerning Air Pollution Control, the magnitude of these pollutants had a significant impact on health, particularly the potential direct impact on the deterioration of the quality of the local environment in the form of health problems for residents in the vicinity.

The potential levels of CO gas parameters at the vocational schools in the City of Yogyakarta show that the level of CO gas emissions has not exceeded the specified quality standard. While the NOx potential based on calculations, when compared to the quality standard of 92.5 mg/Nm^3, is generally still far below the quality standards set by the government in accordance with Republic of Indonesia Government Regulation Number 41 of 1999 concerning Air Pollution Control. The potential for SO2 gas emissions contained in ambient air around the Vocational School in the city of Yogyakarta shows that SO_2 gas emissions levels are far below the quality standard (262 μg/Nm^3) with an average of 13.43 μg/Nm^3. These conditions indicate that SO_2 gas levels released by practical facilities, especially vehicles and props, have not significantly affected health.

Based on the presentation of data which has been described as the result of the calculation of potential pollution, it shows that overall all pollutant parameters of air are carbon monoxide (CO), nitrogen oxide (NOx), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), hydrocarbons (HC) around the vocational school in the city of Yogyakarta are still below the specified quality standards,

4. Conclusion

Based on the results of the research identification of sources of air pollution originating from the vocational practice facilities of the Automotive Engineering Program in the city of Yogyakarta, based on data collected through surveylusion can be calculated the estimated fuel consumption used per year and the amount of emissions from several emission factors according to applicable standards. Amount of emission: NOx 0.18258 (Ton/year), SOx 0.00223 (Ton/year), NMVOC 0.14068 (Ton/year), PM_{10} 0.00772 (Ton/year), CO 5.80261 (Ton/year), CO_2 109.63134 (Ton/year). Although the source of exhaust emissions from the workshop practice facilities of the Automotive Engineering program in the city of Yogyakarta has a small emission value when in a single situation / condition, it can provide significant potential when accumulating or area, causing a negative impact on the health of both students and teachers that is around it.

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