



## Journal of Global Environmental Dynamics (JGED)

Contents list available at JGED website: <https://jurnal.uns.ac.id/jged/index>  
ISSN: 2774-7727

# Estimation of Emissions Generated by Merchants at CFD on Slamet Riyadi, Surakarta City

Bella Kurniawati<sup>a\*</sup>, Diva Maulida N<sup>a</sup>, Murni Nurwulandari<sup>a</sup>, Nisa Indah W<sup>a</sup>, and Revido Aji J<sup>a</sup>

<sup>a</sup>*Environmental Science, Faculty of Mathematics and Natural Science, Sebelas Maret University, Indonesia*

**ABSTRACT.** Air pollution is starting to become a serious problem in various countries in the world including Indonesia, due to the presence of emission gases in the air such as carbon monoxide (CO), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particles. One of the efforts made by the government to reduce air pollution is by promoting the Car Free Day (CFD) program. However, there are still many food vendors along the CFD road that use charcoal, gasoline, and LPG gas which allows emissions. This research aims to compare the amount of emissions generated by the activities of food traders on Car Free Day on Slamet Riyadi Road, Surakarta City. The research method used is quantitative analysis method using a descriptive approach where the data is obtained from direct retrieval with structured observation and interviews. Processing data using the formula  $E = AD \times ef$  to determine the level of CO, PM 2.5 and VOC (Volatile Organic Compounds) generated from each emission factor. The results of the research on LPG fuel contributed to CO emissions of 337105.44 tons, and PMB emissions of 2.5 amounted to 6.41 tons, and VOC (emissions Volatile Organic Compounds) of 10.15 tons. Further fuel or types gasoline accounted for CO emissions of 116813.18 tons, emissions of PM2.5 33.71 tons, and VOC (Volatile Organic Compounds) emissions of 42.14 tons. As for charcoal, it contributed CO emissions of 220228.8 tons of emissions and PM emissions of 2.5 1743.67 tons, and VOC (Volatile Organic Compounds) emissions of 1396.8 tons. Charcoal fuel contributes to the highest value of PM emissions of 2.5 and VOC, namely 1743.67 tons and 1396.8 tons compared to LPG and gasoline. With the large number of emissions produced during the CFD activity, this contradicts the original goal of the CFD (Car Free Day) activity, namely to restore air quality and maintain the physical health of the people who exercise in the area.

**Keywords:** Fuel, Car Free Day, Emissions, Global Warming, Air Pollution.

**Article History:** Received: 15 October 2020; Revised: 1 November 2020; Accepted: 11 February 2021; Available online: 15 April 2021

**How to Cite This Article:** Kurniawati, B., Maulida, N. D., Nurwulandari, M, Indah, W. N, and Aji, J. R.. (2021) Estimation of Emissions Generated by Merchants at CFD on Slamet Riyadi, Surakarta City. Journal of Global Environmental Dynamics, 2(1), 4-7.

## 1. Introduction

Air pollution is starting to become a serious problem in various countries in the world, including Indonesia. The impact of air pollution can cause the depletion of the ozone layer, cause acid rain, damage crops, and can accelerate the rusting process four times faster on objects made of iron. Pane et al (2016). This air pollution can also cause further environmental damage, namely causing a greenhouse effect which will increase the temperature of the earth's surface, known as global warming. This will cause the sea level to rise because the ice on the cap will melt. Global warming also has an impact on climate change on earth which will cause drought and floods around the world so that it will have a negative impact on world food supplies. Global warming today is an issue that should be a concern for the world community to be more concerned with its environment. Many of the triggers of global warming are contributed by the presence of gas emissions in the air which results in a greenhouse effect so that the temperature on earth increases every year. The gases that have the most influence in air pollution are carbon monoxide (CO), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulates produced by motor vehicles.

Air pollution due to pollutant gases whose levels exceed the quality standard, can come from daily human activities. Wiratama (2015) states that all human activities every day have contributed to the increase in greenhouse gas emissions in the atmosphere. Currently, human activities tend to come

from fossil fuels such as oil, natural gas and coal. The lifestyle of urban communities that interacts directly with the environment has a higher level of complexity when compared to rural communities. Not a few contributions from greenhouse gases come from the combustion of motor vehicle fuels. The large number of people in Indonesia who daily use motorized vehicles has certainly contributed to this situation.

Therefore, the efforts of the government to reduce air pollution from motor vehicle fumes, one of which is by promoting the Car Free Day (CFD) program. The legal basis for implementing CFD is in the Minister of Home Affairs Decree Number 426/296/SJ of 2015 concerning the implementation of Car Free Day and the provision of open space. The CFD activities carried out in all cities in Indonesia, including the city of Surakarta, are expected to reduce emissions from polluting gases, especially motor vehicles. Based on the research that has been done, it can be seen from the CFD program held at Slamet Riyadi Road, Surakarta, which is used by the community to carry out activities such as sports, education, playing and even performing cultural arts.

Many food vendors are found along the road where CFD is held, which is very unfortunate because the results of combustion starting from LPG gas, charcoal and gasoline used by these traders allow emissions in the air. Based on this background, this research was conducted to determine the level of emission resulting from CFD activities on Slamet Riyadi Road, Surakarta City.

\*Corresponding author: [bellakurnia10@gmail.com](mailto:bellakurnia10@gmail.com)

Based on Wahyudi's (2017) research, charcoal derived from firewood is a type of fuel that is categorized as high in emissions. Physically, burning wood produces smoke and soot which is far more than burning LPG and biogas. The wood burning activity for boiling soybeans, which in the tofu making process carried out in his research is the main contributor to GHG emissions with a contribution of 98%. Then in Albana and Saragih's research (2016), it is stated that one of the factors that produce exhaust gas emission from gasoline or gasoline is the combustion process of an imperfect mixture of fuel and air. Carbon monoxide (CO), hydrocarbons (HC) and carbon dioxide (CO<sub>2</sub>) are some of the exhaust emissions produced and are very dangerous to humans and cause global warming, so these exhaust emissions must be minimized. The carbon footprint from the use of LPG fuel also contributes to emissions in the air during CFD activities. Indrawati et al. (2015) states that CO emissions are 2 generated from the use of vehicle fuel, namely gasoline, cooking activities using LPG gas and the use of household electrical appliances that come from electrical energy. Therefore, the CFD activity on Slamet Riyadi Road, Surakarta, which aims to reduce emissions is deemed ineffective because there are still fuel combustion activities used by traders that allow emissions to arise.

Carbon dioxide is a type of chemical compound consisting of two oxygen atoms that are covalently bonded to a carbon atom (Seprihadinansyah et al, 2018). Carbon dioxide is a gas at standard temperature and pressure. Carbon dioxide (CO<sub>2</sub>) is the main problem source for the global warming phenomenon, which is now the biggest challenge faced by the whole world community (Sylvia et al, 2018). PM<sub>2.5</sub> itself is the mass concentration of PM for particles passing through the inlet or selective filter pipe which has an efficiency of 50% at an aerodynamic diameter of 2.5 μm (Virgianto and Dzikrullah, 2019). PM<sub>2.5</sub> itself is one of the air quality parameters whose threshold is regulated by a Government Regulation. Due to its size, which is 2.5 micrometers or even smaller, PM<sub>2.5</sub> will directly enter the alveolus and will pollute the lungs and cause respiratory problems. VOC (Volatile Organic Compound) is a compound that contains carbon that is volatile at certain pressures and temperatures that can pollute the air (Nursamsu et al, 2017). VOCs can be emitted as gases from solids or liquids that contain VOCs. The concentration of VOC emitted indoors is much higher when compared to outdoors due to the accumulation of VOCs in the room. The health effects of VOCs include irritation of the eyes, nose and throat, headaches or dizziness, loss of coordination, nausea, liver and kidney damage, and damage to the central nervous system.

According to Saputra (2012) the concept of Car Free Day was originally aimed at reducing the use of motorized vehicles and reducing air pollution. In its development, this activity has been able to bring positive impacts, including roads that are more quiet and comfortable because there are no traffic jams and the happiest achievement is that the air quality is gradually improving. Another positive impact that comes from the application of CFD is the increased public interest in exercising. The sections of roads designated as CFD areas are almost always filled with sports people. Aryo (2015). Starting from just walking, cycling and even often playing football or badminton. This condition has a direct impact on improving the quality of public health and helping the local economy because they can sell on Car Free Day. But Car Free Day can have a negative impact on tourists who come to Car Free Day places using motorized vehicles and food vendors selling using LPG gas and household appliances that use electricity still cause emissions. With this article, it aims to compare the

amount of emissions produced by the activities of food traders on Car Free Day on Slamet Riyadi Road, Surakarta City.

## 2. Materials and Methods

The research method used by the researcher is a quantitative analysis method with a descriptive approach. Researchers use quantitative methods because in research it involves calculating data that can be processed into numbers. Where data obtained from direct retrieval with structured observation and interviews.

### 2.1 Description of the Research Location

The research location can be seen in Figure.1 of the city of Surakarta, where Car Free Day was held. Along Slamet Riyadi Road which is one of the collector streets of Surakarta. The research was conducted on the Sunday when Car Free Day took place. The research location takes the end and end of the Slamet Riyadi Road which is 5.5km away.

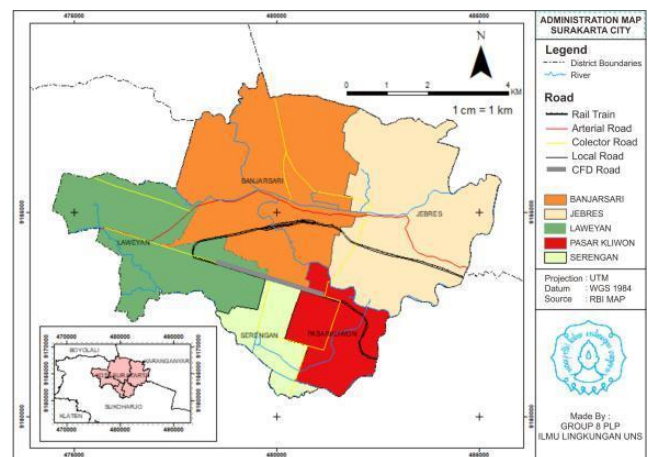


Fig.1 Administration Map of Surakarta City

### 2.2 Collecting Data Method

Data in this study using direct questions or interviews with traders along the road area Car Free Day. The road area is Car Free Day very long and the duration of the study is only limited by the opening and closing of Car Free Day for 3 hours, requiring researchers to divide observations by making 10 segments along the road area Car Free Day shown in Figure 2.

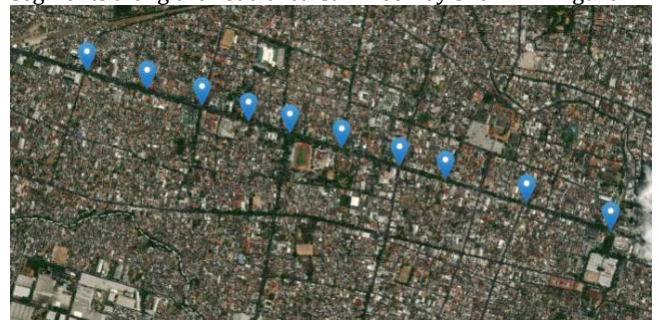


Fig.2 Car Free Day Segments

Source: earthexplorer.usgs.gov (2020)

From the division of 10 segments, researchers will also be divided to research in that segment. Researchers will ask questions that have been made together including: 1. Types of food made; 2. The type of fuel used; 3. Average usage of this fuel during CFD.

### 2.3 Data Processing Method

After all data from each segment are collected into one. Next will do data processing. The processing in this study uses an emission inventory formula (Himawan and Cynthia, 2018):

$$E = AD \times ef$$

with,

E : is an estimate of the burden of emission (tons / year)  
AD : is the activity data (according to the type of activity data, in units of heat of an emission factor (from EEA corinair and IPCC.

The processing of emission calculations also include table Net Calorific Value (NCV) and Activity Emission Factor that has been determined to measure carbon dioxide, PM2.5, and the VOC shown in Table 1.

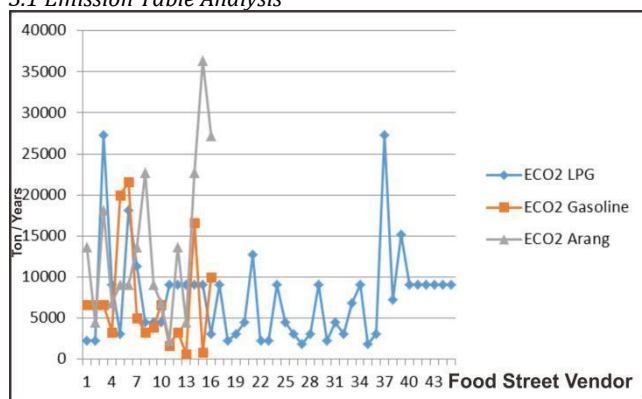
**Table 1.** Type of fuel

Type of Fuel	Net Calorific Value(NCV) and Activity Emission Factor		
	NCV	CO <sub>2</sub> PM <sub>2,5</sub>	VOC
LPG	46,7	63100 1,2	1,9
Gasoline	0,0348	69300 20	25
Charcoal	29,307	94600 749	600

Researchers convert all fuel usage data into tones. Furthermore, data processing will produce a number that can be converted into curves, making it easier to read.

## 3. Result and Discussion

### 3.1 Emission Table Analysis



**Fig.3** Trader Data Graph

From Fig. 3 it is explained that the number of traders involved was 78 traders. Information was obtained that the type of fuel used as a source of emissions in the CFD route in Surakarta City consists of 46 traders using LPG fuel, 16 traders using gasoline or gasoline, and 16 traders using charcoal fuel. Judging from the amount of fuel used by CFD traders in Surakarta City in 1 (one) year reached 9.096816 tons, namely LPG type of fuel contributed 5.0832 tons, gasoline or gasoline contributed 1.685616 tons, while the type of fuel charcoal accounts for 2,328 tonnes. It can be seen that

LPG is the dominant type of trade. According to the results of the interview, the majority of LPG fuel users think that the use of LPG is more practical because it is easy to use. Moreover, the majority of traders use LPG cylinders that are 3 kg in size so they are said to be easy to carry.

### 3.2 Analysis of Highest Results Emission

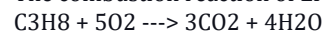
**Table 2.** Totally of Emission in Car Free Day

Type of Fuel	Totally of Emission Types in Ton / Year		
	ECO <sub>2</sub>	EPM <sub>2,5</sub>	EVO <sub>C</sub>
LPG	337105,44	6,41	10,15
Gasoline	116813,18	33,71	42,14
Charcoal	220228,8	1743,67	1396,8

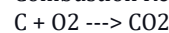
At the time of CFD, based on the calculation results obtained the total annual air assumption data generated from emission sources ranging from LPG type fuel which contributed to CO<sub>2</sub> of 337105.44 tons, PM<sub>2.5</sub> emissions amounted to 6.41 tons, and VOC (Volatile Organic Compounds) of 10.15 tons. Further fuel or types gasoline accounted of CO<sub>2</sub> amounting to 116813.18 tons, emissions of PM<sub>2.5</sub> 33.71 tons, and VOC (Volatile Organic Compounds) emissions of 42.14 tons. Meanwhile, charcoal fuel contributed CO<sub>2</sub> 220228.8 tons of emissions, PM<sub>2.5</sub> 1743.67 tons, and VOC (Volatile Organic Compounds) 1396.8 tons.

From this data, it can be seen that the average trader uses 5.3424 tons of LPG, 1.6585 gasoline, and 2,328 tons of charcoal annually. After calculating the estimated air emissions, LPG produced the most CO<sub>2</sub>, which was 337105.44 followed by Charcoal as much as 220228.8 and Gasoline as much as 116813.18. One of the reasons for this is because more traders use LPG because it is considered more effective and efficient in terms of its use. The main component of LPG is a mixture of propane (C<sub>3</sub>H<sub>8</sub>) and butane (C<sub>2</sub>H<sub>6</sub>), and contains small amounts of other light hydrocarbons such as ethane (C<sub>2</sub>H<sub>6</sub>) and pentane (C<sub>5</sub>H<sub>12</sub>) (Asnawi and Adi, 2017). The combustion reaction is the reaction of substances with oxygen gas (O<sub>2</sub>). For hydrocarbon combustion, complete combustion of substances produces carbon dioxide gas (CO<sub>2</sub>) and water vapor (H<sub>2</sub>O) (Aditama and Sri, 2014).

The combustion reaction of LPG:



Combustion Reaction of Charcoal:



The CO<sub>2</sub> parameter dominates the assumption of air emission resulting from trading activities. This indicates the dominance of combustion activity, because CO<sub>2</sub> is the main product of the combustion process of hydrocarbons, especially in fossil fuels.

On the other hand, the results of the calculation of emission estimates for PM<sub>2.5</sub> and VOC with the highest value was Charcoal followed by gasoline and finally LPG gas. The highest value of PM<sub>2.5</sub> is Charcoal, which is 1743.67, then Gasoline is 33.71 and finally LPG Gas is 6.41. For the highest VOC value is Charcoal, which is 1396.8, then gasoline is 38.54 and the last is LPG Gas 10.15. Contrary to the calculation result, Charcoal produces more PM<sub>2.5</sub> and VOCs instead of Gasoline and LPG Gas. Due to the burning of charcoal which produces gas and air particles it does not look like PM<sub>2.5</sub> and VOC, therefore both values are higher. Charcoal burning is incomplete combustion so that it only produces CO<sub>2</sub> which

is poisonous and very dangerous to human health. PM<sub>2.5</sub> which is produced by charcoal is very small, which is about 2.5 micrometers or even smaller.

### 3.3 Impact of Emissions on the Environment and Health

The combustion process will contribute to emissions that can affect the environment and health. As with LPG, according to Moriganti et al. (2013) stated that LPG combustion results in low emission and greenhouse effect (J. Morganti et al., 2013). LPG produced from the conversion of kerosene will result in a reduction in exhaust gas emissions, either in the form of pollutants that cause air pollution or in the form of greenhouse gases that cause global warming. The reduction in pollutant and greenhouse gas emissions is not only caused by LPG from pollutants (pollutants), as well as CO<sub>2</sub>, but is also supported by the higher efficiency of the LPG stove (Suarna, 2010).

Furthermore, the exhaust emission type fuel or gasoline causes dirty environment and contribute to global warming, acid rain, and damaging public health (Albana and Septi, 2016). In addition, the impact that will be generated if environmental pollution has exceeded the threshold, it will be a serious threat to plants, animals and human health, such as causing asthma and cancer (Astra, 2010).

Whereas in the exhaust gas emissions of charcoal types, CO gas that comes from burning charcoal has toxic properties and certainly causes air pollution (Setyawan and Ulfa, 2019). In addition, the impact of cooking using firewood / charcoal will have an impact on the global environment and the health of people who cook, because when cooking they are inhaling smoke directly, which will cause respiratory disease (Pell et al., 2017).

## 4. Conclusion

From the research that has been done, it can be concluded that the fuel that contributes to the CO<sub>2</sub> emissions most is LPG, assuming 337105.44 tons / year. Furthermore, PM<sub>2.5</sub> emission contributors most of which is charcoal with the assumption of 1743.67 tons / year. While the largest contributor to VOC emissions is gasoline or gasoline with the assumption of 1396.8 tons / year. The majority of CFD (traders in Car Free Day Slamet Riyadi's) use LPG fuel. Apart from being easy to carry, LPG is also more practical and easier to use by traders. With the large number of emissions produced during the CFD activity, this contradicts the original purpose of the CFD (Car Free Day) activity, namely to restore air quality and maintain the physical health of the people who exercise in the area.

## References

Albana, M. H. dan S. C Saragih. 2016. Penggunaan Tembaga (Cu) sebagai Katalis pada Saluran Gas Buang Gasoline Engine dan

- Pengaruhnya terhadap Emisi Gas Buang yang Dihasilkan. *Jurnal Integrasi*. 8(1) : 34-36.
- Asnawi dan Ali S., 2017. Pengaruh Penggunaan Elpiji Sebagai Bahan Bakar Terhadap Unjuk Kerja Motor Bakar Bensin. *Jurnal Teknologi Kimia Unimal*. 6(2): 43-51.
- Astra, I. M. 2010. Energi dan dampaknya terhadap lingkungan. *Jurnal Meteorologi dan Geofisika*. 11(2). 131-139.
- Himawan, W. dan Cynthia P. S. 2018. Aspek Hukum dan Lingkungan Program Inventarisasi Emisi dalam Penyusunan Air Quality Management Kota Surakarta. *EKOSAINS*. 10(3): 15-21.
- Indrawati, E. D., Hermawan dan H. S. Huboyo. 2015. Analisis Emisi CO<sub>2</sub> Antropogenik Rumah Tangga di Kelurahan Patukangan, Pekauman dan Balok, Kabupaten Kendal. *Indonesian Journal of Conservation*. 4(1) : 1-7.
- Morganti, K. J., Foong, T. M., Brear, M. J., da Silva, G., Yang, Y., & Dryer, F. L. 2013. The research and motor octane numbers of liquefied petroleum gas (LPG). *Fuel*. 108. 797-811.
- Nursamsu, Tari M, Dara S., dan Ida W. 2017. Penerapan Dalam Pemanfaatan Arang Jerami Yang Ramah Lingkungan di Kampung Paya Bujok Bramo. *Jurnal Jeumpa*. 4(1): 52-57.
- Pane, M. A. A., & Putra, D. S. 2016. Pengaruh Tegangan Pompa Bahan Bakar Terhadap Kandungan Emisi Gas Buang. *Jurnal Ilmiah Poli Rekayasa*. 12(1). 53-62.
- Pell, Y. M., Tarigan, B. V., & Jhon, J. 2017. Analisis Karakteristik Briket dan Pembakaran Briket Arang Campuran Tempurung Kemiri dan Tongkol Jagung. *LONTAR Jurnal Teknik Mesin Undana (LJTMU)*. 4(2) 30-35.
- Sasmita, A. 2015. Pengaruh kegiatan car free day (CFD) di Kota Pekanbaru untuk pengurangan emisi karbon dari kegiatan transportasi. *Jurnal Purifikasi*. 15(2). 75-79.
- Saputra, Isro dan Ridwan Sutriadi. 2012. Analisis Car-Free Days Berdasarkan Persepsi Pengunjung Dalam Konteks Perubahan Perilaku Penggunaan Kendaraan Pribadi. Studi Kasus: Car Free-Days Jalan Ir. H.Juanda. *Jurnal Perencanaan Wilayah dan Kota B SAPPK V3N2*.
- Seprihadaniyansyah, G. M., Anton K., dan Marlia A. 2018. Menggunakan Katalitik Konverter dan Arang Akasia Guna Mengurangi Emisi Gas Buang Kendaraan. *Jurnal Elemen*. 5(1): 11-19.
- Setyawan, B., & Ulfa, R. 2019. Pengaruh Komposisi Bahan Baku dan Perekat Terhadap Emisi Gas Briket Arang Kulit Kopi Dan Tempurung Kelapa. *Prosiding: Konferensi Nasional Matematika dan IPA Universitas PGRI Banyuwangi*. 1(1). 267-276.
- Suarna, E. 2010. Program Konversi Minyak Tanah Ke LPG Sebagai Suatu Tehnik Pengurangan Emis. *Jurnal Rekayasa Lingkungan*. 6(2). 1-7.
- Sylvia, N., Rahmad Z., Annisa G., dan Lukman H. 2018. Tinjauan Proses Penyerapan Gas Karbon Dioksida (CO<sub>2</sub>) Menggunakan Absorben Air (H<sub>2</sub>O) pada Kolom Absorpsi Jenis Packing. *Prosiding Seminar Nasional Teknik Kimia (SNTK)*. 7-14.
- Virgianto, R. H. dan Dzirkullah A. 2019. Analisis Konsentrasi PM<sub>2,5</sub> Selama Penyelenggaraan ASIAN GAMES KE-18 DI Jakarta. *Jurnal Statistik dan Matematika*. 1(1): 44-62.
- Wahyudi, J. 2017. Penerapan Life Cycle Assessment untuk Menakar Emisi Gas Rumah Kaca yang Dihasilkan dari Aktivitas Produksi Tahu. *URECOL*. 6(1) : 475-480.
- Wiratama, I.G. 2015. Jejak Karbon Konsumsi LPG dan Listrik pada Rumah Tangga di Kota Denpasar, Bali. Tesis. Program Studi Ilmu Lingkungan Universitas Udayana.