Assessment of the air quality monitoring system in Sleman district by vehicle emission measurement

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Abstract. Solving environmental problems is usually not directly linked with economic benefits. Everybody knows, for example, that a polluting factory’s chimney is harmful to the people. However, it is difficult to estimate the exact financial benefits of the installation of a new smoke filter. The results show the activities of the quality of air pollutants from mobile sources in the implementation of the emissions test in 2019 obtained an increase both in terms of water quality or quantity of the test vehicle. In terms of quality, the use of more modern technologies on the vehicle prove to contribute to the reduction of emissions from mobile sources. Increased the number of test vehicles and followed by a number of people who consciously want to do emissions testing. This condition reflects the improvement in public awareness of water quality, particularly with respect to pollution contributed by the vehicle. Besides, the benefits gained by the vehicle user directly is certainly the reduction in fuel consumption due to an awareness of its maintenance. This can be indicated through exposure removes emissions to be lower or meets the quality standard of emission.

1. Introduction
In the recent month of major structural changes in Indonesia, it was not quite the issue of air quality that hit the headlines most. Nevertheless, to develop appropriate environmental policies for the country with the 4th largest population on earth, it is crucial to understand the condition of the ambient air. Be that in cities near the devastating forest fires, where in 1999 the Indonesian standard for small-sized particulate was exceeded by factor 10, or in a metropolis like Jakarta, where millions of motorized vehicles daily pollute the urban air.

Indonesia and other cities have experienced an eventful last decade. Economic boom, the financial crisis that hit the country and its neighbours and an eventual new beginning with the first democratically elected government has determined the atmosphere in Indonesia. Naturally, the changes and transformations in the structures of the country have also impacted its environmental policies, which include air quality monitoring as well. Competencies and responsibilities have frequently been redistributed between different agencies and between national and provincial authorities.

The National Environmental Impact Management Agency holds the main responsibility for developing air-related strategies. The agency is currently establishing an air quality-monitoring network in Indonesia. On the other hand, Local Environmental Impact Management Agencies on provincial level and district are in charge of operating the monitoring equipment.

It is important to have an energy policy which not only make sure the energy security but also manages the environmental sustainability and capability in providing non-reducing future utility. The consumption of energy is essential in bring out the human well-being but on the other hand it increases
the energy level consumption which leads to the problems of new socio-economy. There is a research done that investigate about economic growth and development with low-carbon energy [1]. They found that energy field accounted for about 66% of all greenhouse gas emissions (GHG) worldwide. This has caused environmental problems including global warming threat leads to significant impact on countries performance [2]. Work in reducing carbon dioxide (CO2) emission from the consumption of energy could be obtained by urging energy efficiency and household conservation that dominates the total energy consumption worldwide [3]. Moreover, energy efficiency and household conservation are characterized by specific CO2 emission that are not influenced by other countries [4].

1.1 Combustion Process
If the combustion in a vehicle’s engine is not optimal, several toxic gases are emitted. In a gasoline car, the air – fuel ratio is indicated by the coefficient lambda ($\lambda$). With a surplus of air, the combustion temperature rises, and the emission of Nitrogen Oxide (NO) is likely to be high. With a surplus of gasoline, the combustion tends to be incomplete, and Carbon Monoxide (CO) as well as Hydrocarbons (HxCy or HC) are emitted.

![Figure 1: Emissions of an Otto Engine in dependence on air – fuel ratio [5]](image1)

Other important factors, which influence the emission quality of gasoline cars: a) Ignition timing b) Ignition intensity; c) Engine wear; d) Fuel quality; e) Load e) etc. A diesel engine needs an air surplus to reach an optimal combustion. Is the air – fuel ratio too low, the engine emits soot (small particulate), which can be measured as the percentage of opacity.

![Figure 2. Emissions of a diesel engine in dependence on air – fuel ratio](image2)

1.2 Health Effects of the Emitted Pollutants
When Carbon Monoxide (CO) is inhaled it can enter the blood stream and disrupt the supply of oxygen to the body’s tissues. The consequent reduced oxygen availability can give rise to a wide range
of health effects. Emitted Nitrogen Oxides (NOx) rapidly reacts to NO2 in the air. Adverse effects of NO2 include: altered lung function, respiratory illnesses, lung tissue damage, and eye irritations [6]. For Hydrocarbons (HC), there is no generalization can be made, as health effects are compound-specific. Some HC are of significant toxicity, and a number are proven or suspected carcinogens. Effects of small-sized particulate in the air include increased mortality, morbidity and deficits in lung function. The soot from diesel engines is potentially carcinogenic [6].

2. Methods

The activity of controlling air pollution from mobile sources through emission testing and inspection and maintenance of motor vehicles for drivers, employees and owners of official vehicles in the Sleman Regency Government is planned to be attended by 42 offices with 125 participants consisting of drivers, owners and policy makers at the service in the Sleman Local Environmental Impact Management Agencies. The implementation of training activities can be grouped into two types of activities, namely motor vehicle emission testing activities to determine emission quality and explanation activities and vehicle maintenance activities.

In cooperation with the Local City Environmental Impact Management Agency and the City Police (Polres), and Local Transport Agency conducted emission tests on roads and at parking lots. The tests were conducted in, 9 – 10 April 2019. For this study, the test results are used. Valid data from the Road Emission Tests 403 unit vehicle.

3. Results & Discussion

Several sources are responsible for the particulate in the air. A certain amount of particulate origins from natural sources, such as oceans and volcanoes. Especially in cities, the major part of the particulate pollution however is artificial. Along roads, the share of vehicle emission is generally lower than in other areas. This fact indicates that a comparably big part of traffic’s particulate emission has a diameter larger than 10 μm. Nevertheless, the percentage of ambient resulting from traffic calculated in the WHO report is similar to the percentage of TSP calculated by Urbair.

During vehicle emission measurement, maintenance for official vehicle were asked to record all activities conducted to achieve the emission reduction. The measurement form, which the technician had to fill in, consists of vehicle data, emission data and a list of possible maintenance (such as cleaning the air filter and fuel filter, changing the air filter and fuel filter, setting the valve and sparkplugs). If a replacement of component is needed, the service is certainly more expensive.

Small maintenance (tune-up) has apparently been the main work done in the workshops to achieve emission reduction. For most of the cars, the maintenance included the cleaning and adjusting of parts of the engine. The air filter for example was cleaned in 78% of gasoline car services and in 65% of diesel car services respectively.

It has taken a long time to find an appropriate approach for this study. Benefits of Emission Maintenance are the resulting savings of gasoline, a better performance of the engine and a higher reliability of the car.

While the latter two are highly complicated to put in monetary terms, it possibilities to estimate the fuel saving in connection with the performed maintenance. While the maintenance is done and emissions measured, would be a handy opportunity. Therefore created a new form to be distributed at the workshops. The mechanics were supposed to fill in emissions before and after the service, work performed and the costs.

Based on the results of exhaust emission tests that have been carried out in Sleman, the results show that in emission measurement result shows that the emissions exposure of vehicles operating in several types and years of manufacture are still at a "reasonable" limit. Positive factors that support emissions exposure originating from motorized vehicles include improvements both in the quality of fuel and the application of high technology in vehicles. The application of advanced technology also has an impact on increasing efficiency in fuel consumption.

However, air quality monitoring needs to be a concern and a priority in the tasks of the relevant institutions. Through monitoring and spot checking, it can increase public attention and awareness of the importance of vehicle inspection and maintenance.
Of the 403 vehicle units, the vehicles tested to be quoted can be classified as follows:

- Number of vehicles meets emission limit: 335 or reaches 83%.
- Type of Gasoline Vehicle: 329 units or 82%.
- Types of Petrol Vehicles do not meet emission limit: 45 or 14%.
- Number of Diesel Vehicles: 74 units (18%).
- Diesel Vehicle types do not meet emission limit: 14 or 19%.

Based on the test results, exposure to emissions of non-official vehicles (private and public) that crossed the road in Sleman, obtained the results in table 1.

**Table 1. Emissions of non-official vehicles (private and public) that crossed the road in Sleman**

| Description                     | Amount | Unit |
|---------------------------------|--------|------|
| Minimum Opacity value           | 3.50   | %    |
| Maximum CO Value                | 10.50  | %    |
| Minimum CO for carburetor       | 0.03   | %    |
| Maximum CO for carburetor       | 10.497 | %    |
| Minimum CO for injection        | 0      | %    |
| Maximum CO for injection        | 9.229  | %    |
| Minimum HC Value                | 0      | ppm  |
| Maximum HC Value                | 2880   | ppm  |
| Minimum HC for carburetor       | 4.3    | ppm  |
| Maximum HC for carburetor       | 2880   | ppm  |
| Minimum HC for injection        | 0      | ppm  |
| Maximum HC for injection        | 1000   | ppm  |

Exposure to opacity of non-official vehicles is in the range of 3.5 to 89%. Emission quality improvement appears where the fulfillment of EQS for non-official vehicles with diesel fuel reaches 81%. Gasoline vehicles also found zero percent HC exposure with 61 or 14% units. Vehicle emission measurement of motor vehicles in the Sleman was successfully carried out within two days with a total of 528 unit test units consisting of 125 official vehicles and 403 public or non-official vehicles.

The percentage of vehicles that do not meet the Emission Quality Standard (EQS) for official vehicles is 20% and for non-official vehicles is 15%. Therefore, the total number of test vehicles that do not meet EQS is 84 units or 16% of the total test vehicles. The amount of vehicle processing that does not meet EQS can be classified as reasonable. Increased fulfillment of EQS actually occurred in diesel-fueled vehicles were of the 11 units of test vehicles for service, there were 5 that did not meet EQS. Of the total Diesel vehicles, EQS fulfillment is 79%. This figure shows a 3% increase compared to 2018 test results. For gasoline-powered vehicles, there is no significant change.

Judging from the age of the vehicle, the majority of test vehicles are production between 2011 and 2015. The age of a young vehicle does contribute to reducing the burden of emissions released into the air, including in connection with the fulfillment of EQS. However, this is not a dominant factor, but an element of regular Care and Examination will make a direct contribution. This is proven that not all new vehicles will meet EQS, and vice versa.

**4. Conclusion**

The quality of air pollutants from mobile sources in the implementation of emissions testing has improved both in terms of air quality and the quantity of test vehicles. In terms of quality, the use of more modern technology in vehicles has proven to contribute to the reduction of emissions from mobile sources. Another thing that cannot be ignored is the contribution of the vehicle owner who carries out routine maintenance for his vehicle. The number of diesel vehicles that meet Emission quality standards also increased high. This is also influenced by the two factors that have been stated above.
In terms of quantity, the number of test vehicles is increasing and is followed by the large number of people who consciously want to conduct emissions testing. This condition illustrates that there is an increase in public awareness of air quality, specifically related to the pollution contributed by their vehicles. Besides that the benefits obtained by vehicle users directly are of course in reducing the consumption of vehicle fuel due to awareness of care. This can be indicated by exposing emission emissions that are lower or meeting emission quality standards.

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