ANALYSIS OF SOET EMISSIONS USING DIESEL - METHANOL (CH3OH) MIXTURE ON L-300 VEHICLES

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ABSTRACT
In this research, it is intended to identify the concentration of soot in the exhaust emissions of the L-300 diesel engine by adding an additional substance in the form of methanol CH3OH. The research method in this study used an experimental method with the help of a smoke tester used to test the soot concentration in exhaust emissions of diesel motorized vehicles. The experiment was carried out at night using different mixtures and where each mixture will be carried out 8 times to collect data. Experiments used a smoke tester to test soot emissions on: fuel not mixed with methanol additive (M0D100), 5% methanol mixture (M5D95), 10% methanol (M10D90), 15% methanol mixture (M15D85). After carrying out the research and data processing, it was obtained that the M0D100 mixture had a soot emission concentration of 36.52%. The M5D95 mixture decreased the concentration of exhaust emissions to 31.05%. Then in the M10D90 mixture, the soot emission concentration decreased to 27.17%. whereas in the M15D85 mixture the soot concentration increased to 33.76%.

Keywords: diesel; emissions; mehtanol; soot

INTRODUCTION
Air pollution is associated with exhaust emissions resulting from an imbalance in emissions that have a negative impact on society. Approximately 60 percent of air pollutants are caused by motorized vehicle engines. (RR Ukirsari Manggalani, 2022). Exhaust gas emissions from diesel engines generally have the same content as gasoline engine exhaust emissions, but diesel emissions have lower emission levels (Sulistyo et al., 2023). Diesel engine exhaust emissions are HC, CO and NOX (Kamajaya, 2016)(Septiyanto et al., 2017). According to verury (Verury Verona Handayani, 2020) Air pollution from burning fossil fuels is the main cause of air pollution. The effects of air pollution include stroke, lung cancer and even heart disease (Cakrawati Sudjoko, 2021). To reduce these problems, additional materials or ingredients are needed that can reduce exhaust emissions, including the addition of methanol (Marbun, 2020). The purpose of this study is to determine whether methanol has an effect on reducing exhaust emissions and to determine the opacity of each mixture.

Vehicle exhaust emissions are residual substances that pollute the air which appear due to vehicle exhaust (Faris, 2022). Exhaust gas emissions on vehicles, namely exhaust air from the remaining combustion process of the vehicle engine which is channeled out into the free air through the exhaust or vehicle exhaust (Muhammad Umar Wakhid, 2018). The types of exhaust emission particles produced by diesel engines are HC, CO and NOX. Explanation of compounds according to (Sugiarti, 2015), Carbon monoxide is the result of incomplete combustion of automotive fuel. Hydrocarbon (HC) emissions come from a variety of sources. Nitrogen oxides (NOx) are formed when vehicle fuels from fossils such as coal and petroleum are burned, and are formed when nitrogen in the open air is oxidized to NO (nitro oxide) and then oxidized back to NO2. Nitrogen oxide in the air we inhale can cause lung disease (Khasanah et al., 2018). Can react with the atmosphere, this substance produces very fine nitrate compounds, which then penetrate to the deepest part of the lungs (Hendrialdi et al., 2020)

Additive additives are additives that can also be added to motor vehicle fuel and whose purpose is to increase or reduce motor vehicle exhaust emissions (Syarifudin & Syaiful, 2019). Assessments carried out on diesel engines showed that the effect of using fuel additives as a combination of oxidized fuels (ethanol, dimethyl carbonate and dimethoxymethane) increased the cetane number and reduced the amount of smoke. g (Rahmadian & Permatasari, 2017).

METHOD

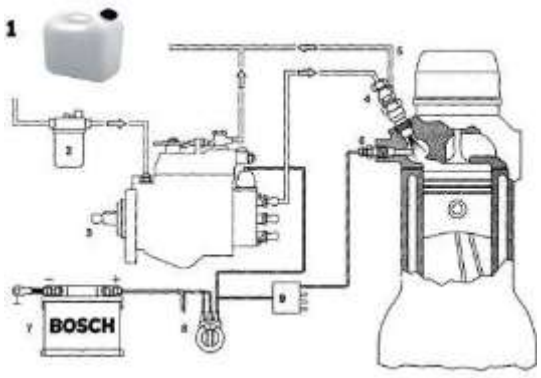
The experimental method was used in this study. Experimental research is a form of research that can be used to find out what these variables are and how the relationships between these variables are formed. In the classic sense, an experiment is a study that determines the effect of the treatment variable (independent variable) on the impact variable (the dependent variable). In this study, an experiment was conducted to determine whether methanol can reduce exhaust emissions in diesel engine vehicles and to determine the ratio of a mixture of diesel fuel and methanol to exhaust emission tests. The research design to determine the concentration level of soot emissions is as follows:

Preparation of tools and materials

Table 1.
Tools and materials

'Tools and materials"	Usability in research	Results
biodiesel	As a vehicle fuel that will be tested	Vehicles can live
Methanol Additive	As material in research	Reducing exhaust emissions
L300 Diesel car	As an object in research	Research can be carried out
Smoke tester	To find out the test results of the study	Can know the test results
jerrycan	As a substitute for the material tank	The test results will be
Measuring cup	burn	more accurate

Procedure for measuring the soot emission concentration of diesel engines
In this study the fuel tanks were replaced with jerry cans in order to get more accurate results. The hose connected to the fuel tank is replaced with a jerry can filled with biodiesel fuel and additives. As shown in Figure 1Gambar 1. Skema Sistem Pengujian



J
erigen
F
uel filter
D
rive shaft
N

The data collection procedure is as follows:

1. Prepare a test vehicle, use a jerry can to replace the fuel tank so that the results are more accurate because there is no residual fuel mixed in the jerry can, then connect the hose leading to the tank to the jerrycan
2. Prepare the test equipment, make sure whether the tool is in a calibrated condition

3. Set up (accelerate) the RPM so that it reaches 2,900 rpm to 3,100 rpm and then hold for approximately 60 seconds and return to idle again;
4. Insert the smoke tester probe into the inlet exhaust gas pipe as much as 30 cm, if it is less than 30 cm, you need to install an additional pipe;
5. Press the gas pedal to the maximum (full throttle) quickly and reach maximum engine speed, and hold for 1 to 4 seconds. Release the gas then wait for the engine to idle again, record the soot concentration value;
6. Repeat data collection eight times;
7. The data will be in the form of a percentage of the average soot concentration value displayed in the form of a percentage (%) recorded on the test ki

RESULT AND DISCUSSIONS

This research was carried out at the periodic testing of motorized vehicles at UPT PKB Motor Vehicle Testing Bandung Regency with the test vehicle being the L-300 type car. The following are the experimental results of exhaust emission tests for diesel-fueled L-300 vehicles before and after adding additives with several variations of the mixture.

Table 2.
"Exhaust Gas Emission Test Results"

mixture	data" to-								Average
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	
M0D100	38.4	36.4%	37.4	37.3	34.5	38.4	33.4	36.3	36.52 %
M5D95	29.4	32.2	28.2	29	34.1	33.1	29.2	33.2	31.05 %
M10D90	26	24.5	28.4	26.6	29.4	26.3	28.3	27.9	27.17 %
M15D85	30.2	32.2	35.6	35.6	34.7	32.6	33.3	36.2	33.76 %

Information:
1. M0D100 1 liter biodiesel fuel that does not use methanol additives
2. M5D95 1 liter biodiesel fuel added 5% methanol additive (50ml)
3. M10D90 1 liter biodiesel fuel added additive methanol 10% (100ml)
4. M15D85 1 liter biodiesel fuel added additive methanol 15% (150ml)

In the table, exhaust emissions from diesel engine vehicles are shown in the form of smoke density or opacity. The results of emission tests for biodiesel-fueled vehicles using an exhaust emission tester (smoke tester) before and after the addition of methanol additives at different variations can produce smoke density

Completely Randomized Design

The completely randomized design is the simplest of the standard experimental designs. Completely randomized design (CRD) is usually used for laboratory experiments. this method is called a Fully Randomized Design because randomization of the treatments is carried out on all experimental variables (Ade Slinton Sitepu, 2022). The basis for decision making in a completely randomized design test is carried out as follows:

Hypothesis:
$H0$: treatment has no effect on soot concentration results
$H1$: treatment effect on soot concentration results

Decision making: Based on probability
if probability > 0.05 then $H0$ is accepted
if probability ≤ 0.05 then $H1$ is rejected

Table 3
Description of "Anova"

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
M0D100	8	36.513	1.7860	.6314	35.019	38.006	33.4	38.4
M5D95	8	31.050	2.3275	.8229	29.104	32.996	28.2	34.1
M10D90	8	27.175	1.5980	.5650	25.839	28.511	24.5	29.4
M15D85	8	33.800	2.0791	.7351	32.062	35.538	30.2	36.2

Table 3 shows that the test results using no additives have an average test result of 36.51%, a minimum value of 33.4% and a maximum value of 38.4%. Using the additive methanol 50ml has an average value of 31.05%, has a minimum value of 28.2% and a maximum value of 34.1%. Using 100ml methanol additive has an average yield of 27.17%, has a minimum value of 24.5% and a maximum value of 29.4% Using 150ml methanol additive has an average yield of 33.80%, has a minimum value of 30.2 and a maximum value of 36.2%. all done in 8 trials. Next to see the test in the Anova table.

Table 4.
ANOVA One Way

Emisi

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	381.708	3	127.236	32.870	.000
Within Groups	108.384	28	3.871		
Total	490.092	31			

Table 4 shows that the Sig/Significance column yields a result of 0.00. Because the value is smaller than the value α = 5% (0.05), then $H0$ is rejected, which means that the treatment has a significant effect on salinity.

A. Regression Analysis
Regression analysis is a technique or method of analyzing research hypotheses to test whether or not there is an influence between one variable and another, which is stated in the form of a mathematical equation of the regression line (Tanoto, 2021).

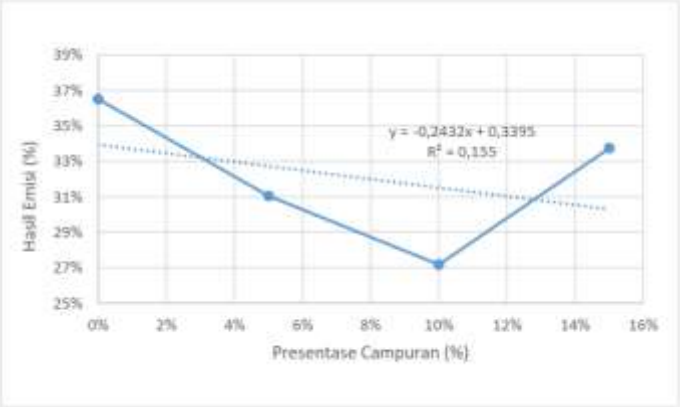


Figure 2. Graph of Regression Results

The results obtained in the ANOVA table show that in the Significance/P valve column, a result of 0.00 is obtained. Because the value is smaller than the value α = 5% (0.05), then *H*0 is rejected, which means that the treatment has a significant effect on salinity. Figure IV.5 contains a regression graph that uses a simple regression equation, namely that between the dependent/dependent variable is the result of exhaust emissions and the independent/free variable is methanol and biodiesel fuel additives which have a causal relationship, the equation is obtained: y = -0.2432x+0.3395 R2=0.155

Information is obtained that, if there is no mixture of additives or the value x = 0 then the emission value is 36.52%. If the mixture is added by x=0.05%, the emission will decrease by 31.05%. If the mixture is added by x=0.1%, the emission will decrease by 27.17%. Then the last mixture was added by x = 0.15%, the emission increased from the previous one to 33.76%. On the coefficient of determination (R2) a test is carried out to determine and/or predict the level of contribution of the influence given by the independent variables which together with the dependent variable. Based on Figure IV.5 the coefficient of determination on the variable (R2) on the variable dose of the additive mixture is 0.155, this shows that all independent/free variables have an influence of 15.5% on the results of the exhaust emission test (dependent variable). While other factors, namely 84.5%, are influenced by other variables not tested in the study.

CONCLUSIONS

The addition of methanol additives in the ratio of each mixture produces different results. If no methanol is used, the average soot concentration is 36.52%. In the second test, the addition of 50 ml of methanol reduced exhaust emissions by 31.05%. In the 3rd test, there was an addition of 100 ml of methanol, the exhaust emissions were reduced by 27.17%. At the addition of 150 ml, exhaust emissions increased to 33.76 percent of exhaust emissions. The coefficient of determination for the additional mixed variable, namely the dose variable R2, is 0.155, which means that all independent variables have an effect, namely 15.5%.

REFERENCE

Ade Slinton Sitepu. (2022). Rancangan Acak Lengkap dengan spss.

Cakrawati Sudjoko. (2021). Strategi Pemanfaatan Kendaraan Listrik Berkelanjutan Sebagai Solusi Untuk Mengurangi Emisi Karbon. Jurnal Paradigma: Jurnal Multidisipliner Mahasiswa Pascasarjana Indonesia, 2(2), 54–68.

Faris, N. A. (2022). Analisis Pengaruh Pdrb Sektor Pertanian, Industri, Dan Transportasi Terhadap Emisi Karbondioksida Di Provinsi Jawa Timur. Jurnal Ilmiah Mahasiswa FEB. https://jimfeb.ub.ac.id/index.php/jimfeb/article/view/8176

Hendrialdi, Nugroho, B. K., & Sulistyo, A. B. (2020). Strategi Pengendalian Emisi Gas Buang Kendaraan Bermotor Berdasarkan Model Regresi di Kota Denpasar. Jurnal Teknologi Transportasi Dan Logistik, 1(2), 109–116.

Khasanah, U., Huboyo, H. S., & Andarani, P. (2018). Inventarisasi Emisi Gas Rumah Kaca (CO2) dan Polutan Udara (NOx, SOx, HC, CO dan PM10) Beserta Dipersinya Menggunakan Software Aermod pada Sektor Transportasi No Road di Kota Semarang. Jurnal Teknik Lingkungan, x, 1–9.

Kamajaya, M. F. (2016). Perbedaan Konsumsi Bahan Bakar Dan Kepekatan Gas Buang Mesin Diesel Menggunakan Bahan Bakar Solar Dan Campuran Solar Dengan Minyak Cengkeh. Universitas Negri Semarang, 1–35.

Marbun, J. (2020). Analisis Sistem Injeksi Air/Metanol Dan Air/Etanol Terhadap Konsumsi Bahan Bakar dan Emisi Gas buang. Jurnal Teknik Mesin ITI, 4(3), 109. https://doi.org/10.31543/jtm.v4i3.518

Muhammad Umar Wakhid. (2018). Analisis Dampak Emisi Gas Buang Kendaraan Bermotor Co Di Uin Raden Intan Lampung. Unversitas Islam Negeri Raden Intan, lampung.

Rahmadian, G. Y., & Permatasari, R. (2017). Pengaruh Penambahan Zat Aditif Octane Booster X Terhadap Kinerja Dan Emisi Gas Buang Kendaraan Sepeda Motor Tipe All New Cbr150r. Sinergi, 21(3), 179. https://doi.org/10.22441/sinergi.2017.3.004

RR Ukirsari Manggalani. (2022). MPR: Kendaraan Bermotor Jadi Penyumbang Terbesar Polusi Udara di Indonesia. Suara.Com.

Septiyanto, A., Maulana, S., Nugroho, A., Septiyanto, A., Maulana, S., & Nugroho, A. (2017). Pengaruh exhaust gas recirculation (EGR) terhadap performa dan mmisi jelaga mesin diesel direct injection. Sainteknol : Jurnal Sains Dan Teknologi, 15(2), 129–136.

Sulistyo, A. B., Ariani, N. W. W. A., & Kusuma, I. G. B. W. (2023). Design of exhaust gas emission tester. AIP Conference Proceedings, 020012. https://doi.org/10.1063/5.0138702

Syarifudin, S., & Syaiful, S. (2019). Pengaruh Penggunaan Energi Terbarukan Butanol Terhadap Penurunan Emisi Jelaga Mesin Diesel Injeksi Langsung Berbahan Bakar Biodiesel Campuran Solar Dan Jatropa. Infotekmesin, 10(1), 18–22. https://doi.org/10.35970/infotekmesin.v10i1.20

Tanoto, U. (2021). Analisis Regresi; Pengertian, Manfaat, Jenis dan Contoh Penerapannya.

Verury Verona Handayani. (2020). 4 Pengaruh Polusi Udara Pada Kesehatan.