# Utilization of Sansevieria As a CO and HC Exhaust Gas Filter in Motorized Vehicles in Preventive Climate Change Efforts

**Tri Sunan Agung, Belinda Safa Salsabila Zuhri, Dedy Suprayogi**
*Sunan Ampel State Islamic University Surabaya, Indonesia*
trisunanagung@gmail.com

**Keywords :** CO, Filter, HC, Motor Vehicles, Sansevieria

**Abstract :** Motor vehicle emissions cause air pollution, such as: CO and HC gases. These two gases cause climate change and pose threats to human health, such as poisoning, and cancer. Sansevieria sp. is a plant that can absorb 107 pollutants in the air such as carbon monoxide, formaldehyde, and trichlorethylene. Based on this potential, researchers innovate to make filters based on sansevieria. This study examines the effectiveness of filtering CO and HC gases after installing filters in motorized vehicles. This research method uses a quantitative descriptive with an experimental approach. The independent variable is the composition of the number of filters and gels, while the dependent variable is the effectiveness of reducing HC and CO levels. Filter testing using a gas analyzer with a motorcycle engine speed from 1500 RPM to 9000 RPM. The results of this study showed that CO and HC emissions after being treated in sample A from 1500 RPM to 9000 RPM showed a reduction of 67% CO and 25% HC. Meanwhile, in sample B, the decrease in CO was 80% and HC was 51%. The ability of the sansevieria filter to reduce CO and HC gas emissions can be a climate change prevention effort, because it can reduce the potential for GHG due to motorized vehicles.

## INTRODUCTION

Transportation is a means that connects human-human interactions as well as a means of moving goods to various places (Fatimah, 2019). This makes transportation a vital element for the country's development due to its role as a provider of community needs in various activities such as economics, education, tourism, and others (Fahrezi, et al, 2022). With increasing economic growth and routine community activities, the demand for transportation has increased.

Today more and more people prefer to use private vehicles. As stated in research by Fontry (2017) regarding a survey of the choice of private vehicles compared to public transportation. In this study it was stated that there were several factors in the selection including the type of work and type of trip. Types of work private workers, civil servants, and students are the top three in choosing private vehicles. In addition, the type of trip that takes place multiple times in one time period or multi-trip is also a deterrent to public transportation.

The preferred use of private vehicles is in line with research by Fahrezi, et al (2022) which states that in the city of Surabaya, with a population that is predominantly workers and students, the number of private vehicles reaches 73.41% and the number of public transportation is 26.58%. With an increase in the number of each of 8.3% and 0.9% per year. An increase in the number of these vehicles can bring problems to the environment as a result of the emissions produced in proportion to the increase in these vehicles (Kusumawardani & Navastara, 2017). Research shows that the transportation sector contributes up to 60 percent of pollution to the air (Sundari, 2019).

The transportation sector contributes to pollutants including Hydrocarbons (HC) and

Carbon monoxide (CO). Incomplete combustion of gasoline in motorized vehicles releases CO into the air, while fuels made from hydrocarbons can result in the release of hydrocarbon gases into the air when unburned gasoline comes out with the exhaust gases. In conclusion, these gases is the main result of incomplete combustion (Gunawan, et al. , 2020; Maharani & Kholis, 2020).

CO and HC gases can cause serious problems for human health, CO gas can cause poisoning in humans due to its stronger bond with hemoglobin than O2. So that the blood's ability to deliver O2 is reduced and causes a lack of O2 intake throughout the body (Gunawan, et al, 2020). Meanwhile, excessive HC gas will cause damage to the respiratory system and will continuously cause cancer, where it was stated in a study by Aristawati, et al (2021) that the HC level that humans can inhale is only 200 ppm. Meanwhile, research by Nurullita and Mifbakhuddin (2021) states that the CO level that can be emitted by motorized vehicles is 25 ppm to maintain the level of pollution in the air.

When CO and HC gases accumulate, they will have an impact on increasing the greenhouse effect. This phenomenon will lead to global warming where the earth's surface temperature is increasing. Global temperature changes will result in extreme global climate change (Pratama and Parenduri, 2019). Climate change will affect health, food security, weather, availability of clean water, and the sustainability of vital ecosystems for human life (Roberto, 2020). In essence, this accumulated pollution becoming a ticking time bomb that will destroy the balance of the ecosystem and threaten human life (Ariantono, 2020; Mojibayo and Samson, 2020). Preventive efforts with natural products need to be carried out to overcome the impact of climate change due to CO and HC pollution from motor vehicles.

Sansevieria is a plant that is common in Asia and Africa. This plant belongs to the Aparagaceae family with around 100 species spread across Indonesia (Ganing, 2021). This plant's ability to live in an atmosphere that is not too humid and has minimal lighting makes it very easy to find in tropical countries like Indonesia (Sari, 2022). Sansevieria or mother-in-law's tongue contains pregnane glycosides which function to convert pollutant substances into organic acids, sugars and amino acids which do not pose a danger to humans. This conversion process is carried out through metabolic breakdown (Tahir, 2008 in Ganing, 2021).

Metabolic breakdown in this plant takes place with the absorption of pollutants by the stomata which are then broken down into ions. These ions will then be processed by pregnane glycoside and released through the roots in the form of organic acids (Poedijadi A, 2006 in Riksanto, 2021).

The effectiveness of Sansevieria in filtering pollutants has been proven by various previous studies, including research by the United States Space Agency (NASA) in 1999 which showed that Lidah Mertua leaves are able to absorb 107 types of harmful elements. Another study by Adita and Naniek (2013) also proved the Mother-in-Law's Tongue Plant can absorb up to 84% CO (Yute, 2021). Meanwhile, according to Arie & Purwanto (2006) in their book also conveys about research conducted by the Wolverton Environmental Service that a single Sansevieria leaf is able to absorb as much as 0.938 μg of formaldehyde per hour (Ganing, 2021).

Based on the explanation above, the researchers aim to use sansevieria as a filter that can reduce the amount of CO and HC released by motorized vehicles. This can potentially reduce air pollution due to motorized vehicles and become a climate change prevention effort.

## METHOD

This study has a useful research flowchart for detailing the stages of the research, as follows:

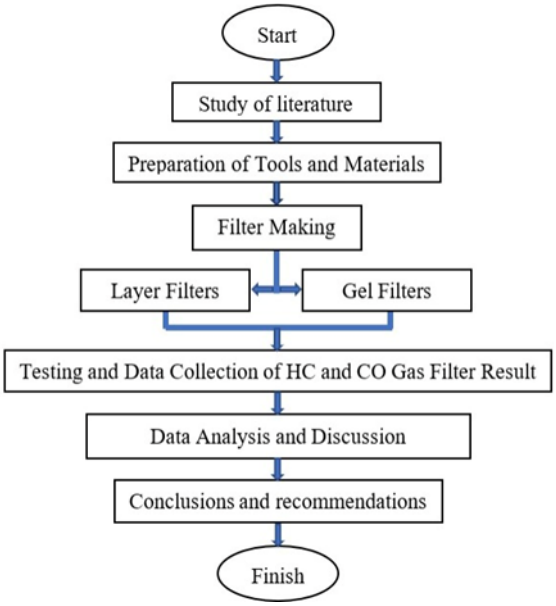


Figure 1: Research flowchart

**Types of research**

The method used is a type of quantitative descriptive research with an experimental approach. This is a simple experiment with the result being a number that clearly defines the research objective. In this study the researchers wanted to know and measure the use of filters made from Sansevieria in reducing CO and HC exhaust emissions from motorized vehicles. So, in the end the plan can be an alternative solution to prevent climate change.

**Research variable**

The variables used in this study are:

a. Independent variable

Comparison of the number of layers of filters and gel filters, namely:

Table 1: Details of independent variables

| No. | Treatment | Information |
|---|---|---|
| 1. | Without Layer Filter + Gel Filter | control |
| 2. | 3 Layer Filters + Gel Filters | Sample A |
| 3. | 5 Layer Filters + Gel Filters | Sample B |

b. Dependent variable

Effectiveness of reducing CO and HC levels in motorized vehicles.

**Time and place**

The research was carried out at the Laboratory of the Faculty of Science and Technology, Campus 2 of UIN Sunan Ampel Surabaya and the UNESA Machine Performance Testing Laboratory. With research time from February to July 2023.

**Tools and materials**

Tools used, such as: Smoother/Blender (1 unit), Analytical Balance (1 unit), 500 ml Beaker (1 piece), Sieve (1 piece), and Spatula (1 piece). While the materials needed are Sansevieria (200 grams), Adhesive (100 ml), and Glycerol (40 ml).

**Manufacturing procedure**

The making of Sansevieria filters is divided into 2 procedures, namely: layer filter and gel filter. The details are as follows:

a. Filter layer making

1) Cleaning sansevieria plants with running water;
2) Weigh 100 grams of sansevieria on an analytical balance;
3) Cut the sansevieria plants into small pieces and grind using a blender with the addition of 400 ml of water;
4) Filter the crude extract of the sansevieria plant and get about 200 ml;
5) Mixing the crude extract with 100 ml of adhesive glue, so that the filter ratio that occurs is 2:1;
6) Print the filter dough using a spatula and place it on mica plastic;
7) Drying the filter mixture for about 1 day under direct sunlight.

b. Gel filter making

1) Cleaning sansevieria plants with running water;
2) Weigh 100 grams of sansevieria on an analytical balance;
3) Cut the sansevieria plant into small pieces and grind using a blender with 200 ml of water added;
4) Filter the results of the condensed extract of the sansevieria plant and get about 120 ml;

5) Mixing the thick extract with 40 ml of glycerol, so that the gel ratio that occurs is 3:1 to form sanseveria gel.

**Data analysis technique**

This study uses an emission analysis test which is carried out by measuring motor vehicle exhaust gas. This is to detect CO and HC content in exhaust gas before and after being given treatment. The purpose of this data analysis is to describe the data that has been obtained from emission testing. Data analysis was obtained from test results at the UNESA Machine Performance Testing Laboratory using a brain bee analyser tool. The speed used ranges from 1500 RPM – 9000 RPM.

## RESULTS

The results of the study obtained the following results of the design of the sansevieria filter prototype:

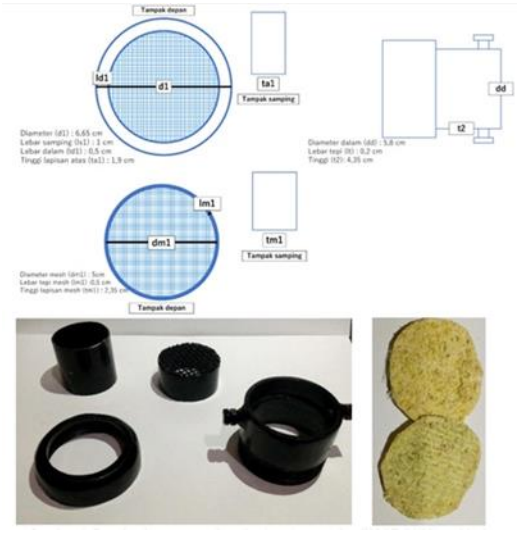

Figure 2: Sansevieria filter prototype design

After testing, exhaust emission data on motorbikes were obtained before treatment as shown in the following table.

Table 2: Control sample test results

| Control (Without Layer Filter + Gel Filter) | | |
|---|---|---|
| RPMs | CO | HC |
| 1500 | 0.67 | 399 |
| 2000 | 2.25 | 235 |
| 3000 | 3.00 | 222 |
| 4000 | 3.37 | 227 |
| 5000 | 4.13 | 296 |
| 6000 | 3.43 | 276 |
| 7000 | 2.62 | 234 |
| 8000 | 2.18 | 202 |
| 9000 | 1.81 | 163 |
| Total | 23.46 | 2254 |
| Average | | |

In the control sample, it is known that the average CO emission is 2.607% vol or 3.04% gr and HC is 250.4 ppm vol or equivalent to 0.952 gram.

Table 3: Sample test results A

| Sample A (3 Layer Filters + Gel Filters) | | |
|---|---|---|
| RPMs | CO | HC |
| 1500 | 0.95 | 210 |
| 2000 | 0.32 | 177 |
| 3000 | 0.41 | 172 |
| 4000 | 0.44 | 157 |
| 5000 | 0.70 | 232 |
| 6000 | 0.95 | 230 |
| 7000 | 1.06 | 169 |
| 8000 | 1.01 | 143 |
| 9000 | 1.04 | 156 |
| Total | 6.88 | 1646 |
| Average | | |

Sample A (3 Layer Filters + Gel Filters) found that the average CO emission before treatment was 2.607% vol and HC was 250.4 ppm vol. After being treated with three three-layer A samples, the average CO emission decreased to 0.76% vol and HC decreased by 182 ppm vol.

Table 4: Sample B test results

| Sample B (5 Layer Filters + Gel Filters) | | |
|---|---|---|
| RPMs | CO | HC |
| 1500 | 0.20 | 179 |
| 2000 | 0.23 | 173 |

| Sample B (5 Layer Filters + Gel Filters) | | |
|---|---|---|
| 3000 | 0.29 | 170 |
| 4000 | 0.53 | 179 |
| 5000 | 0.55 | 91 |
| 6000 | 0.60 | 87 |
| 7000 | 0.66 | 86 |
| 8000 | 0.64 | 71 |
| 9000 | 0.49 | 55 |
| Total | 4.19 | 1091 |
| Average | | |

Sample B (3 Layer Filters + Gel Filters) found that the average level of CO decreased by 80% to 0.46% vol, while the average level of HC decreased by 51% to 121 ppm vol. So if the graph is formed as follows:

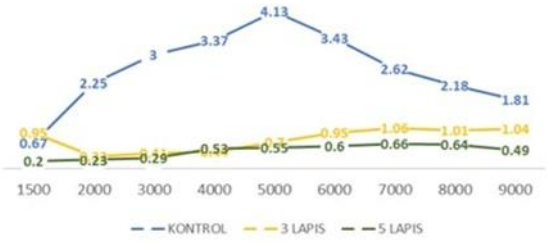


Figure 3: Graph of CO reduction

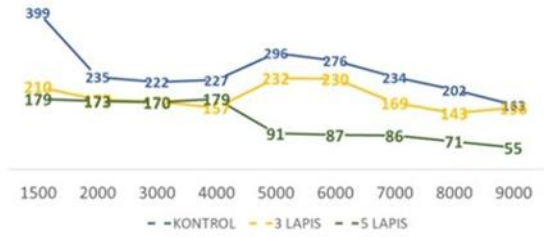


Figure 4: Graph of decreasing HC levels

## DISCUSSION

Sansevieria is a plant that belongs to the Aparagaceae family with about 100 species spread across Indonesia. With the ability to grow in an atmosphere that is not too humid and has minimal lighting, this plant is commonly found in tropical areas such as Asia and Africa (Ganing, 2021; Sari, 2022). Sansevieria or mother-in-law's tongue contains pregnane glycoside which functions to convert pollutants into organic acids, sugars and amino acids which do not pose a danger to humans (Tahir, 2008 in Ganing, 2021).

Sansevieria leaves have the ability to filter pollutant substances through metabolic breakdown processes (Tahir, 2008 in Ganing, 2021). This process is carried out by the pregnane glicosyde compound which processes pollutant ions into organic acids (Poedijadi A, 2006 in Riksanto, 2021). In addition, CO can also be adsorbed on surfaces with low porosity such as filters. Research by Pakaya, 2022 regarding the use of filters made from plant fibers showed significant filtering results for heavy metals and oil. The metabolic breakdown and adsorption process is then applied to the sansevieria filter by processing it into a gel and a plate that is attached to the exhaust of the motorbike.

The filter is made by collecting and cleaning fresh Sansevieria leaves to remove dirt and dust particles. Then the leaves are cut into small pieces of approximately 0.5 cm and pulverized using a blender together with water. The ratio used between the leaves and water is 1: 2. Then the fine Sansevieria leaf mixture is filtered to reduce the water content.

Sansevieria plates are made using PVAc (polyvinyl acetate) adhesive. The addition of glue will glue the sansevieria fibers so that they can filter CO and HC exhaust gases in motorized vehicles. The ratio used between the leaves and glue is 2: 1. The leaves and glue are stirred until well mixed and printed on mica. Filter printing is done with a thickness of approximately 0.3 cm to create a layer that is strong and not easily torn. Then the mold is dried in the sun for 1-2 days. The dry filter is removed from the mica. Sansevieria gel was made by mixing refined sanseviera and 85% glycerol in a ratio of 3: 1. Sansevieria and glycerol were then stirred until homogeneous. The gel is placed between the sansevieria filter plates and placed on the motorcycle exhaust for exhaust gas testing.

Around 107 types of hazardous elements can be filtered out by Sansevieria based on research compiled by the United States Space Agency (NASA) in 1999. Where other research

by Adita and Naniek (2013) in Yute (2021) also states that the highest absorption of CO gas by Sansevieria can be reached 84%. And based on research by Wolverton Environmental Service that a single Sansevieria leaf is able to absorb as much as 0.938µg of formaldehyde per hour (Ganing, 2021). This is the basis for researchers to develop Sansevieria as a filter for exhaust gases in motorized vehicles, especially CO and HC.

Based on the CO and HC gas filtration tests, the difference in the level of effectiveness between samples A and B was determined based on the number of filter layers used. This is because the fewer layers used, the faster the filter will be damaged due to the high air pressure released by the vehicle engine. The use of 3 filter layers is standard use where high air pressure can be retained by layer 1 and filtering can take place from layer 1 to layer 3. This is different from the 5-layer filter which is more efficient and able to filter 80% of the harmful exhaust emissions emitted by motorized vehicles.

Meanwhile, the duration of use of the filter is determined based on the color change in the filter. If the filter is still light brown then the filter can still be used. However, if the filter used is dark brown then the filter cannot be used. This is because the pregnane glycoside compound has reacted with CO and HC so that the compound is saturated and cannot be used again.

The Sansevieria filter has been proven to be able to reduce CO and HC levels in motor vehicle exhaust emissions. CO and HC gases are included in the type of greenhouse gases (GHG). Greenhouse gases (GHG) are able to absorb solar radiation, namely long wave radiation. The long waves of solar radiation that enter the atmosphere should be able to be released back into space. however, these waves are retained by GHG and reflected back to the earth's surface. This incident causes the temperature on the earth's surface to increase (Sumampouw, 2019).

Increasing the temperature of the earth's surface that occurs continuously in a large area will cause global warming. Global warming will affect changes in rainfall patterns and intensity. This will have implications for changes in water reserves, extreme weather events, and global climate change (Haryanto & Prahara, 2019).

Based on this explanation, the abundant amount of GHG in the atmosphere contributes to climate change. Thus, the most effective approach to slowing global warming is to reduce GHG production. The source of GHG production is dominated by motor vehicle emissions. Motor vehicle emissions contribute 60% of total air pollution and produce 89% of carbon emissions (Kaleka et al., 2023).

The problem of carbon emissions has become a big concern at this time. This attention is shown by national and global concern by various parties, one of which is the government. One of the government's efforts is the Gold Indonesia target of 2045 and a low carbon development program that focuses on reducing GHG production.

## CONCLUSION AND SUGGESTIONS

The effectiveness of the filter as a means of filtering CO and HC exhaust emissions is considered very good based on the test results that have been analyzed. The use of 3 layers of filters can reduce CO levels by 67% and HC by 25%. Whereas with 5 layers of filter, it reduces CO levels by 80% and HC by 51%. Filter effectiveness is obtained based on the number of layers and gel used. The ability of the sansevieria filter to reduce CO and HC gas emissions can reduce the potential for GHG due to motorized vehicles. It can be concluded that the use of sansevieria filters can be an alternative for climate change prevention efforts in terms of GHG reduction. In addition, it is suggested that it is necessary to carry out further tests related to the efficiency of materials and tools so that they can be applied to every type of motorized vehicle.

## REFERENCES

Ariantono, B. 2020. Dampak penyinaran UV A terhadap isolat bakteri Tempat Pembuangan Akhir (TPA) Jatibarang Semarang dalam

penguraian Ppastik Low Density Polyethylene (LDPE). Skripsi, Unika Soegijapranata Semarang.

Aristawati, I. V., Nurbaiti, U., & Fianti, F. 2021. Uji kadar CO, CO2 dan HC pada pembakaran rokok konvensional tanpa pengaruh udara luar dengan Outomotive Emission Analyzer. Jurnal Penelitian Sains, 23(2), 91-95.

Fahrezi, T. Z. A., Hariyani, S., & Waloejo, B. S. 2022. Pemilihan moda antara kendaraan pribadi terhadap Suroboyo Bus koridor Utara-Selatan pada rute Purabaya-Rajawali. Planning for Urban Region and Environment Journal (PURE), 11(3), 47-58.

Fatimah, S. 2019. Pengantar transportasi. Myria publisher.

Fontry V. P. 2017. Analisis pemilihan moda perjalanan antara kendaraan pribadi dan angkutan umum (studi kasus: rute perjalanan Palangka Raya–Banjarmasin).

Ganing, W. 2021. Kualitas tanaman lidah mertua (Sansevieria sp.) sebagai fitoremediasi untuk mereduksi pencemaran karbon monoksida (CO). Doctoral dissertation, Universitas Hasanuddin.

Gunawan, S., Hasan, H., & Lubis, R. D. W. 2020. Pemanfaatan adsorben dari tongkol jagung sebagai karbon aktif untuk mengurangi emisi gas buang kendaraan bermotor. Jurnal Rekayasa Material, Manufaktur dan Energi, 3(1), 38-47.

Haryanto, H. C., & Prahara, S. A. 2019. Perubahan iklim, siapa yang bertanggung jawab?. Insight: Jurnal Ilmiah Psikologi, 21(2). https://doi.org/10.26486/psikologi.v21i2.811

Kaleka, Y. U., Anggraeni, D. M., Garung, E. R., & Deke, O. 2023. Emisi Gas Rumah Kaca (GRK) on road dengan tier-2 di Sumba Barat Daya. Borneo Journal of Science and Mathematics Education, 3(1).

Kusumawardani, D., & Navastara, A. M. 2018. Analisis besaran emisi gas CO2 kendaraan bermotor pada Kawasan Industri SIER Surabaya. Jurnal Teknik ITS, 6(2), 399-402.

Maharani, S. H. & Kholis, N. 2020. Studi literatur: Pengaruh penggunaan sensor gas terhadap persentase nilai error karbonmonoksida.

Mojibayo, Samson, 2020. A preliminary investigation of cassava starch potentials as natural polymer in bioplastic production. The American Journal of Interdisciplinary Innovations and Research. https://inlibrary.uz/index.php/tajiir/article/view/11601.

Nurullita, U. & Mifbakhuddin, M. 2021. Efektifitas tanaman hias, jamur, dan carbon aktif dalam menurunkan konsentrasi carbon monoksida di udara. Jurnal Kesehatan Lingkungan Indonesia, 20(1), 15-20.

Pakaya, F. 2022. Analisis kapasitas adsorpsi komposit serat kapuk terhadap logam berat Pb2+, Cu2+, dan Ni+. Seminar Nasional KP, 109–117.

Pratama, R. & Parinduri, L., 2019. Penaggulangan pemanasan global.

Riksanto, R., El Furqan, D. F., Amalia, C., Syamsir, N., & Padmawijaya, G. 2021. Pengaruh ekstrak lidah mertua (Sansevieria trifasciata) dalam menurunkan kadar karbon monoksida akibat asap sidestream rokok filter. Al-Iqra Medical Journal: Jurnal Berkala Ilmiah Kedokteran, 4(2), 71-83.

Roberto, J. W. 2020. Desain teknis kapal hybrid listrik bersumber energi angin dan gas pada rute Jakarta-Surabaya dan Surabaya-Makassar. Skripsi, Universitas Darma Persada.

Sari, A. W. 2022. Inovasi pengemasan tumbuhan lidah mertua menjadi solusi penghilang bau tak sedap pada kulkas dan ruangan (Viefresh As). Doctoral dissertation, UIN Fatmawati Sukarno Bengkulu.

Sumampouw, O. J. 2019. Perubahan iklim dan kesehatan masyarakat. Deepublish.

Sundari, S. N. 2019. Polusi udara kendaraan bermotor tidak berpengaruh terhadap penyakit ispa. Jurnal Kesehatan Lingkungan: Jurnal dan Aplikasi Teknik Kesehatan Lingkungan, 16(1), 697-706.

Yute, W. 2021. Analisis kemampuan penyisihan polutan karbon monoksida dan karbon dioksida oleh tanaman hias. Doctoral dissertation, Universitas Andalas.