

HS202 - REPORT

VEHICLE EMISSION CAPTURE TO CONTROL AIR POLLUTION



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Declaration

We hereby declare that the report entitled “Buy and Sell used Products” was submitted by us, for the partial fulfilment of the course on Human Geography and Societal Needs (HS202) in the second year of the B. Tech Programme in IIT Ropar. We further declare that this written submission represents our ideas and others’ ideas or words have been included. We also have adequately cited and referenced the original sources in the case of others’ ideas or words. We have not misrepresented any idea/data/fact/source to the best of our knowledge. Therefore, we affirm that our group has adhered to all principles of academic honesty and integrity.

Date: 25-04-2022.

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Certificate

This is to certify that the B.Tech. the project titled “VEHICLE EMISSION CAPTURE” prepared by Ayush Singh, Dileep Kumar Kanwat, Rahul Goyal – is approved for submission for the course HS202: Human Geography and Societal Needs in the Department of Humanities and Social Sciences, Indian Institute of Technology, Ropar.

Signature of Examiner/Guider:

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ABSTRACT OF THE REPORT:

As we all know that air pollution is a major problem for India. In the world ranking of top 50 cities having the worst air pollution, 35 cities are from India only. Thus, our country's air is highly polluted. In this report, we try to manage the vehicle emissions which are a major cause of contribution to the poor air quality of India. We try to understand the problem, why is it important to even talk about this, and our effort and ideas on trying to solve the problem of vehicle emissions which cause a huge impact on India, and thus, the whole world.

Nowadays, when purchasing power is rising exponentially, and people are able to afford more and more things in our country, we see an increasing rise in Vehicle demand. With this increasing demand, comes the problem of High Energy Consumption, Fossil Fuel Depletion, and Air Pollution. The basic idea of this report will be to identify Air Pollution from Vehicle Emissions as a major threat to the Environment and provide a commercially viable and economically feasible method to solve this problem.

We try to compress and liquefy the exhaust gases which will then be called "exhaust liquid". After that, we can store the exhaust liquid inside a storage tank in the vehicle and later extract it. Thus, no emissions will be made to the environment.

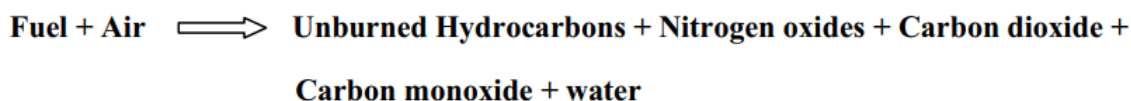
DEFINITION OF THE PROBLEM

A) PROBLEM STATEMENT:

We can say that India is the worst country in the world when it comes to Air Quality Standards. India has the highest number of air-polluted cities in the world. One of the major contributors of Air pollution in India is the vehicular emissions due to fossil fuel combustion. We tend to solve this problem of Air pollution due to vehicular emissions. But one may ask, what even is Air Pollution?

Air pollution is defined as the emission of harmful gases like CO₂, CO, HC, SO₂, and NO_x from industrial chimneys, automobiles, and aircraft. Worldwide air pollution is caused due to the emission of hydrocarbons, nitrogen oxides, carbon monoxide, and carbon dioxide. Emission of these gases takes place mainly due to the incomplete combustion of fuel and air mixture.

AIR POLLUTION EXPLAINED CHEMICALLY



All the major gases on the right-hand side of the chemical equation are responsible for air pollution except, of course, Water (H₂O).

B) IDENTIFICATION OF THE PROBLEM:

Here is a reported list of the world's top 20 most polluted cities:

S.No.	CITY NAME	COUNTRY
1.	BHIWADI	INDIA
2.	GHAZIABAD	INDIA
3.	HOTAN	CHINA
4.	DELHI	INDIA
5.	JAUNPUR	INDIA
6.	FAISALABAD	PAKISTAN
7.	NOIDA	INDIA
8.	BAHAWALPUR	PAKISTAN
9.	PESHAWAR	PAKISTAN
10.	BAGPAT	INDIA
11.	HISAR	INDIA
12.	FARIDABAD	INDIA

13.	GREATER NOIDA	INDIA
14.	ROHTAK	INDIA
15.	LAHORE	PAKISTAN
16.	LUCKNOW	INDIA
17.	JIND	INDIA
18.	GURUGRAM	INDIA
19.	KASHGAR	CHINA
20.	KANPUR	INDIA

Source and Reference: <https://www.igair.com/in-en/world-most-polluted-cities>

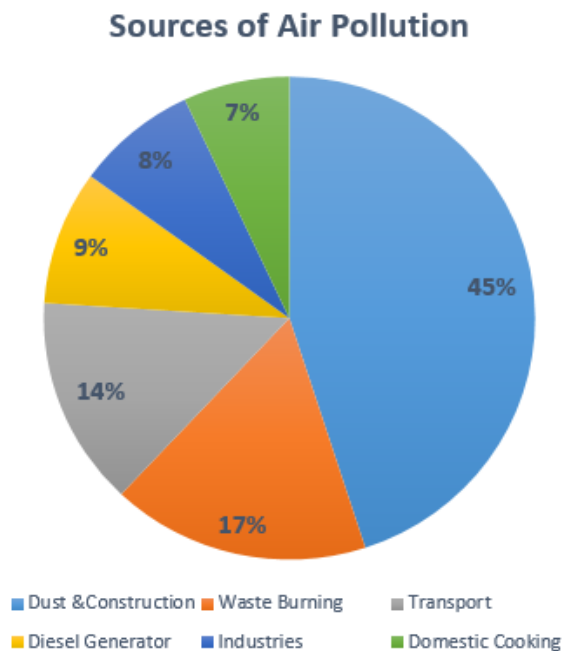
Source reliability: While many other air quality reports and applications use satellite data to calculate air quality, this report relies only on PM2.5 readings from ground-level monitoring stations. Data on air quality was compiled from government-run regulatory monitoring stations as well as privately owned, non-regulatory monitoring stations run by individuals, educational institutions, and non-profit organisations. The majority of the data included in the study was gathered in real time. Supplementary year-end historical data sets were incorporated when they were available to give the most up-to-date and complete global data analysis feasible.

From the table attached above and from the statistics provided, we can say that India has to recognize Air-Pollution as a major problem in the country as it has the highest number of air-polluted cities in the world.

The methodology adopted to find out this huge concerning problem of India was- We looked at online surveys, data, reports, statistics and charts which explain the place of India in the world in terms of air pollution. We also studied and researched several scholarly articles about this topic to understand the importance of taking up air pollution as a major problem of our modern society.

C) DETAILED DESCRIPTION:

Till now, we can understand that Air-Pollution is definitely a high-priority problem for India. Now, where does this pollution come from? How does the Air in our environment get contaminated? To answer these questions, we're going to take a look at the major sources or contributors of Air-Pollution which affect Air-Quality the most and are responsible for the worst quality Air which India has in today's time.



Pie chart data:

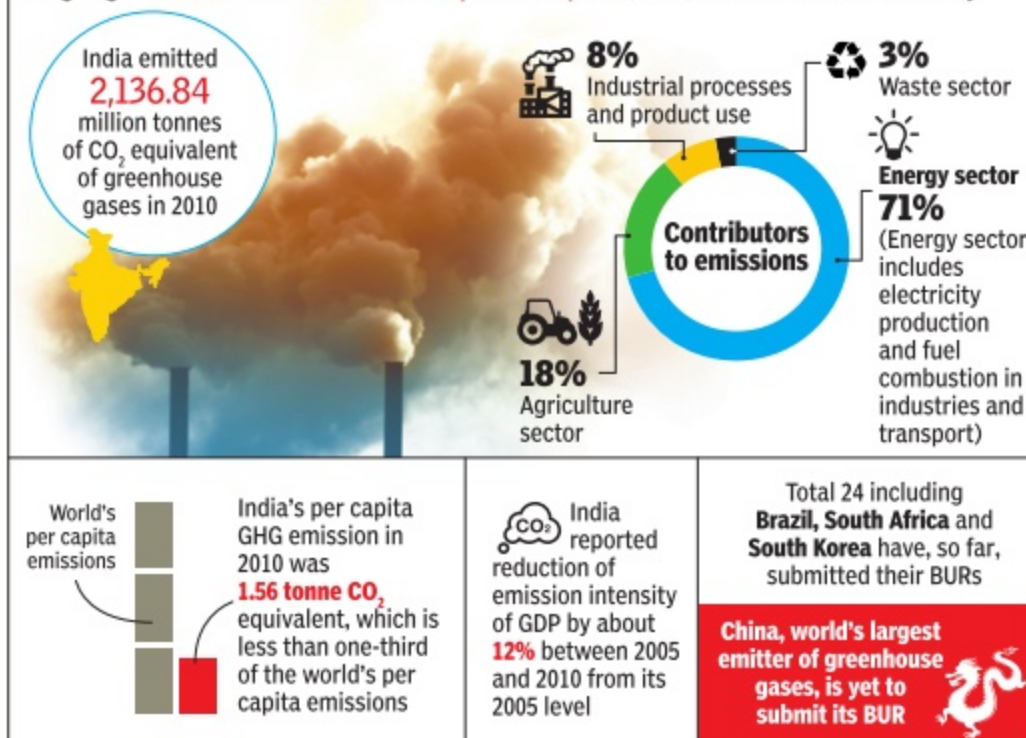
- Dust & Construction - 45%
- Waste Burning - 17%
- **Transportation - 14%**
- **Diesel Generator - 9%**
- Industries - 8%
- Domestic Cooking - 7%

Source and Reference:

- https://en.wikipedia.org/wiki/Air_pollution_in_India
- http://indpaedia.com/ind/index.php/Air_pollution: India

STATUS REPORT

Highlights of India's first **Biennial Update Report (BUR)** to the UN climate body



Source and Reference:

- <http://epaperbeta.timesofindia.com/Article.aspx?eid=31808&articlexml=India-cut-carbon-emission-intensity-by-12-in-23012016013007>

As we can see from the above statistics, Vehicular emissions are quite a major factor for the problem of Air-Pollution in India. **Pollution emissions from automobiles are normally minimal, but as the number of vehicles on the road grows, so does pollution. The transportation sector is responsible for around 35% of CO, 30% of HC, and 25% of NOx emissions into the environment. The environment and human health are both harmed by these contaminants. The**

air-fuel ratio has a significant impact on vehicle emissions.

Source and Reference:

- Google Scholar Article -

<https://www.sciencedirect.com/science/article/abs/pii/S0048969710000513>

D) CURRENT DEVELOPMENT IN DOMAIN:

The control techniques for exhaust gas emissions currently available are:

- ◆ Engine modifications,
- ◆ Fuel pretreatment,
- ◆ Fuel additives,
- ◆ Exhaust gas recirculation (EGR),
- ◆ Positive crankcase ventilation (PCV)
- ◆ Application of catalytic converters

The current development in these sectors are as follows:

➤ **Engine modifications:**

The PM reduction was accomplished by improvements designed to ensure a more complete burn of fuel within the engine. The primary enhancements include improved fuel delivery systems, improved configuration of combustion chambers, and turbocharging. The HC, CO, SOX, NO and other substances

emitted by diesel engines can also be reduced through the following engine modifications processes:

➔ Variable Compression Ratio (VCR)

➔ Modification of Combustion Chamber Configuration

➔ Fuel Injection System Modification

- High-Pressure Fuel Injection
- Engine Derating
- Variable Injection Timing
- Electronic Fuel Injection
- Water Injection
- Exhaust Gas Recirculation (EGR)
- Changing the Engine Circle

Source and Reference:

- https://www.researchgate.net/publication/300452481_Diesel_Engine_Modification_Techniques_to_Minimize_its_Exhaust_Emission_Theoretical_Survey

➤ Catalysis:

A catalytic converter is a device that reduces emissions in automobiles. It transforms the more hazardous chemicals released by automobile exhaust into less dangerous pollutants. Vehicles have a catalytic converter installed in the internal combustion engine. Internal combustion engines fueled by gasoline or diesel, including lean-burn engines, as well as kerosene heaters and stoves, use catalytic converters. A catalytic converter is a simple device that reduces pollutants generated by vehicles by using fundamental redox reactions. It transforms the toxic emissions produced by automobile engines into less damaging gases. It's made up of a metal shell with a ceramic honeycomb-like interior and insulating layers. The tiny wall channels in this honeycomb interior are covered with an aluminium oxide wash finish. This porous covering increases surface area, allowing for more reactions and contains valuable metals like platinum, rhodium, and palladium. To transform the undesired pollutants, the converter employs simple oxidation and reduction processes. The oxidation process involves the loss of electrons, whereas the reduction process involves the gain of electrons. The fuel injection system is controlled by the catalytic converter. An oxygen sensor checks the amount of oxygen in the exhaust stream, and the engine adjusts the air-to-fuel ratio to keep the catalytic converter

working at the stoichiometric point and near 100 percent efficiency.

Source and Reference:

- Google Scholar Article -
<https://www.sciencedirect.com/science/article/pii/S2666916120300062>

➤ **Engine Gas Recirculation (EGR):**

In internal combustion engines, exhaust gas recirculation is a nitrogen oxide emissions reduction technique used in petrol/gasoline, diesel engines and some hydrogen engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders.

E) **NEED AND SIGNIFICANCE OF RESOLVING THE PROBLEM:**

Why even bother about Air-pollution? What's the big deal? Well, if we throw some light on the harmful effects and consequences of air pollution on the ecosystem and the environment, we will be able to understand why Air-Pollution is so dangerous and why solving this problem of vehicular emissions which contribute to air pollution a lot is the need of the hour. Let's take a look at the harmful and toxic effects air pollution can create:

- Humans and animals live due to the inhalation and exhalation process of air which is done continuously by the lungs. We can never stop breathing for more than one or two minutes because it is a vital continuous process of the body. Now, when we inhale polluted air, which contains toxic gases and harmful substances, it can lead to severe respiratory and health problems. Some of them are:
 - Aggravated cardiovascular and respiratory illness
 - Added stress to the heart and lungs, which must work harder to supply the body with oxygen
 - Damage to the respiratory system and cells present inside it

- Accelerated ageing of the lungs.
- Loss of lung capacity and decreased lung-function
- Development of diseases such as asthma, bronchitis, emphysema, and possibly cancer resulting in a shorter lifespan.
- Smog can irritate the eyes and throat, as well as harm the lungs, particularly in children, the elderly, and those who work or exercise outside. It's even worse for persons with asthma or allergies because the additional pollutants can aggravate their symptoms and precipitate asthma attacks. The tiniest airborne particles of soot, whether gaseous or solid, can infiltrate the lungs and bloodstream, worsening bronchitis, causing heart attacks, and even hastening death.

➤ Warmer temperatures result from greenhouse gases trapping the earth's heat in the atmosphere, which leads to the hallmarks of climate change: rising sea levels, more intense weather, heat-related fatalities, and increased transmission of infectious illnesses. Carbon dioxide accounted for 81 per cent of total greenhouse gas emissions in 2018, while methane contributed 10%.

Source and Reference:

- <https://www.sparetheair.com/health.cfm>
- <https://www.nrdc.org/stories/air-pollution-everything-you-need-know>

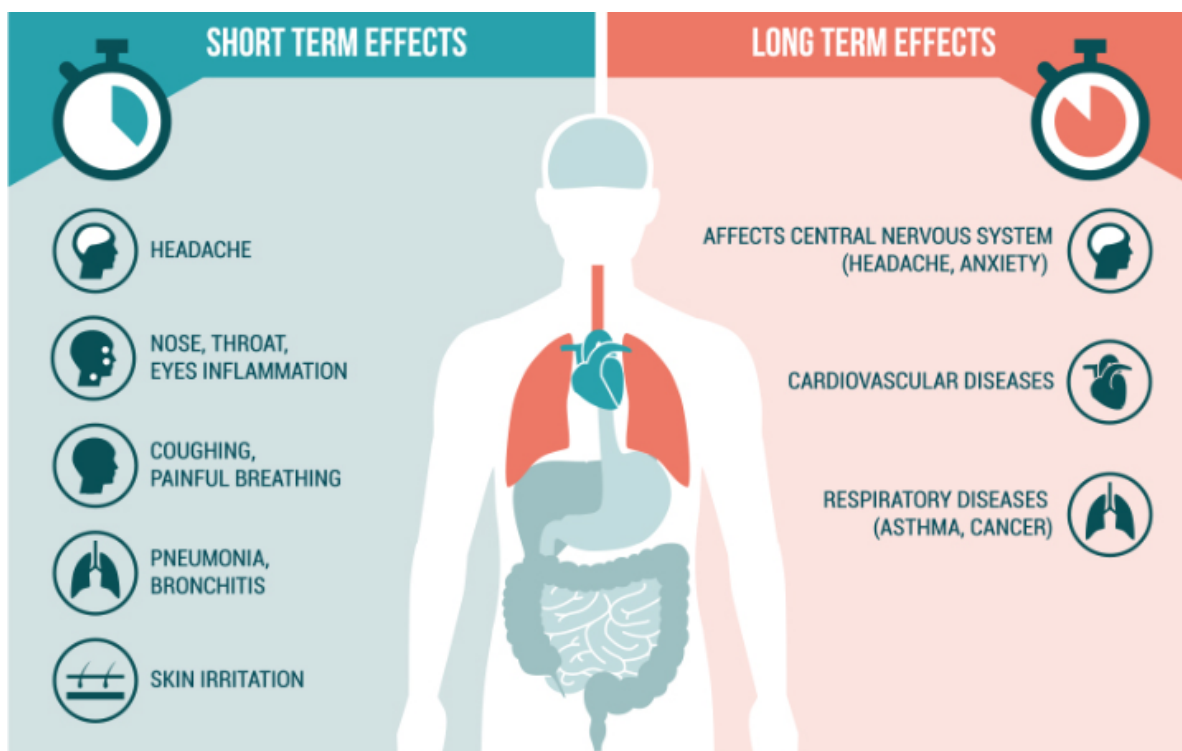


Figure - Harmful Effects of Air-Pollution

Source and Reference:

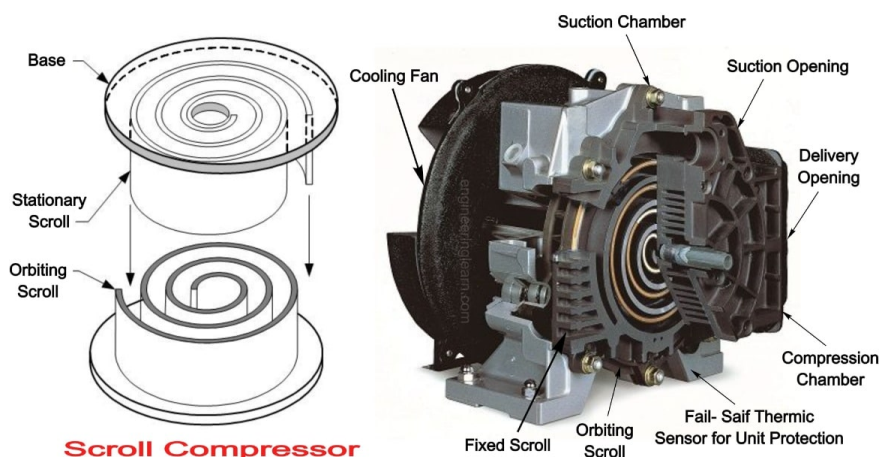
- <https://www.lalpathlabs.com/blog/health-effects-of-air-pollutionc>

OBJECTIVES TO MINIMISE GAP

1. Minimize/Eradicate the exhaust gasses coming out of the vehicles such as CO₂, CO, and Nitrogen Oxides
2. Make the solution easily accessible to the general public.
3. The solution should be economically viable. If it's too expensive for people, it'll be ignored by the majority of the population and only a handful of rich people would be able to afford it. Thus, the solution should also contain economic methods that will help it to be commercially viable, and economically feasible.
4. Make use of the by-products also, of the process so that the costs can be reduced and a no-wastage policy could be followed.

TOOLS AND TECHNIQUES

1. Exhaust Gas-compression technique
2. Scroll-type Compressor to compress & liquefy gasses



3. Pipes for connection
4. Vacuum seals to prevent leakages
5. Storage tanks to store the liquid mixture of exhaust gasses
6. The liquid extraction process to extract the exhaust liquid
7. AI/ML software to monitor emissions
8. Vehicles/Automobile modifications to adjust the fuel tank and exhaust liquid tank
9. Modified and advanced Fuel stations are able to store the exhaust gasses compressed and stored in the liquid form.
10. Chemical & Physical Separation process is required to separate the different component gasses in the exhaust liquid and make use of them.

DETAILED WORK PLAN

Now since we know that the Indian subcontinent has pollution as one of the major issues, and the most affected country with this problem is India. As discussed above, out of the top 50 most polluted cities in the world 35 are from India.

Source and Reference: <https://www.iqair.com/in-en/world-most-polluted-cities>

We cannot deny this fact since we see in our surroundings how people are suffering,

especially senior citizens. They suffer from various respiratory-related diseases and in severe cases, some of the patients are diagnosed with Lung Cancer. Which eventually kills the patient.

So a well-organized work plan is needed for this issue. And by the means of this report, we are aimed to suggest some solutions to this problem.

There are some techniques and plans which can improve the air quality and reduce pollution. We are suggesting such solutions to solve the discussed issues.

A. USING AI AND ML TO MONITOR AND ANALYZE THE VEHICLE EMISSIONS:

The Exhaust gases released after burning the fuel cause air pollution and decrease the air quality index(AQI). So if we track these gases, find out which pollutants need to be resolved, and get the report of engine functioning, we can find which gases need to be controlled in that particular vehicle and if the condition is out of control we can take that vehicle down from the road.

The RTO (regional transport office) should track the data of all the vehicles in the locality and, based on the route these vehicles travel, a parameter should be fixed that vehicles above this range will be banned from further use.

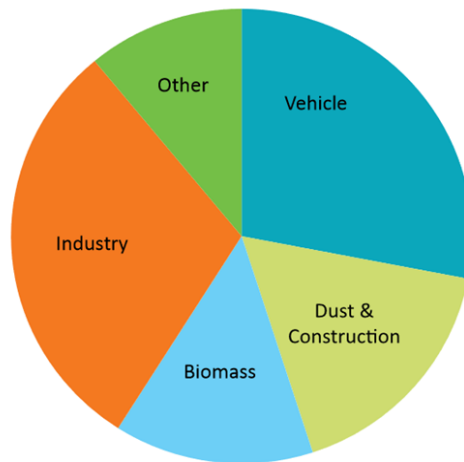
Nowadays since AI and ML technologies are on the boom and we see that almost everything is assisted by them. So using Artificial intelligence to control air pollution will be a great improvement in the available present air pollution control techniques.

Now if artificial intelligence and machine learning are used these tools can analyse the exhaust contents and find out the condition of the vehicle engine. Then from the data, we can also conclude whether the vehicle sustains the environmental goals set up by the government. Based on the data collected from the exhaust of a vehicle, AI can predict the malfunctioning in the engine system of the vehicle and based on the regular exhaust analysis, it may also tell how much it can work and when the engine needs to be replaced. Now, apart from the engine the suspension of a vehicle also plays an important role in fuel consumption and if a vehicle consumes more fuel then it would certainly produce more polluting gases. So we can also capture the suspension data and analyse it with the suspension of a new vehicle and conclude on the bases of all these readings when a vehicle is no longer sustainable for the environment. A vehicle in this condition is producing the highest risk to people and causes air pollution by giving poison to

its user as well as to society.

B. USING A SCROLL TYPE COMPRESSOR TO COMPRESS THE EXHAUST GASSES:

If we look at the division of this Air pollution, we see that a major 27% share goes to vehicle emissions. If somehow, we could control this, it'll be a great boon for our country.



Source: NCAP report

Source and Reference:

NCAP REPORT

Now, to capture vehicle emissions, we must first understand what their constituents are. The major components of the Exhaust gas are Nitrogen, Carbon Dioxide, and Water Vapour. Nitrogen and water vapour are not very harmful to the environment, the major concern is CO₂. However, excess Nitrogen and its oxides present in the air are also not very good.

To capture this exhaust gas, we use something called a scroll-type compressor. A scroll compressor is a specially designed compressor that works in a circular motion, as opposed to up-and-down piston action. Scroll compressors are becoming more popular, as they are more reliable and efficient than reciprocating types. Right now, they are the latest tech for compressing gases in an AC.

We connect the compressor to the exhaust pipe of the vehicle and then to a storage tank fitted inside the vehicle, just like the fuel tank. Even better, we can just split the fuel tank in half to store fuel and Emissions. Now the compressor works very

efficiently and compresses nearly all of the exhaust gases. Upon exerting high pressure, the gases turn to liquid form. Thus, now, we should have a liquid mixture of nitrogen, CO₂, and water without anything leaking into the open air. In this way, instead of just letting the vehicle emissions go into the open air, we have successfully captured them and saved the environment from the harmful gases which may have otherwise leaked into the atmosphere.

C. CAPTURING THE EXHAUST GASSES AND CONVERTING THEM TO USEFUL ELEMENTS:

Major contents of vehicle exhaust are carbon dioxide, carbon monoxide, sulphur oxides, nitrogen oxides, Hydrocarbons, Ozone, Aldehydes, traces of lead, arsenic, and other heavy metals, water vapour and particulate matter and soot. Out of these, carbon monoxide, sulphur dioxide, and nitrogen oxides cause major air pollution. These components cause numerous health-related issues and constitute a major part of air pollution.

No	Name	Ecologically harmful consequences	Technical solutions
1	Carbon oxide	Toxic effect on humans and animals	Optimization of the combustion process of fuels. Application of additives
2	Sulphur oxides	Irritation of respiratory system; acid rain formation; destruction of catalytic converters	Development of fuels with reduced sulphur content
3	Nitrogen oxide	Irritation of respiratory system; the formation of acid rains and smog; participation in the destruction of the ozone screen	Catalytic reduction of nitrogen oxides in combustion products
4	Hydrocarbons	Carcinogenic action; participation in the creation of the greenhouse effect, the formation of ozone and smog	Reduction of saturated vapour pressure of fuels; optimization of the combustion process, the use of additives
5	Ozone	Toxic effect on flora and fauna; participation in smog formation	Reducing the emission of ozone-forming substances: hydrocarbons and nitrogen oxides
6	Aldehydes	Irritant effect on organisms; participate in the formation of smog	Improving the combustion process
7	Compounds of lead and other metals	Toxic effect on flora and fauna; violation of the balance of microelements in water and soil; poisoning of afterburning catalysts	Development of fuels that do not contain metal compounds
8	Particulate matter and soot	Carcinogenic action, participation in the formation of smog and acid rain	Decrease in ash content of fuels, reduction of sulphur and aromatic hydrocarbons content

Source and Reference:

- **ORIENTAL JOURNAL OF CHEMISTRY:- The Main Components of Vehicle Exhaust Gases and Their ...<http://www.orientjchem.org> , vol35no1 , the-main-co...**

So these compounds need to be captured and abstained from releasing into the environment. So what we can do to capture these gases is to first, use an advanced catalytic converter to convert almost all the monoxide gases into less harmful gases so that they can be further treated accordingly. Second,_ adjust an inbuilt chemical reaction chamber that can convert these oxides into a harmless elemental state. Then these elemental state components produced from waste exhaust gases can be used for other industrial purposes. Carbon made from carbon dioxide may be used to make ink, graphite, artificial diamond, and other useful industrial and domestic articles. Now how this can be accomplished but it is tedious and needs to be worked upon. There are some chemical reactions that can make it happen.

INNOVATION OF THE PROPOSED INTERVENTION

The ideas we are presenting are unique in the industry. There has been some work but it's not as per the required need of the society. What we are suggesting is a feasible technique and is likely to happen in the near future. Vehicle carbon emission control is today's need and our project ideas may aid in it and make some fortunate changes to the present condition.

The innovative ideas presented in each of the work plans are mentioned below and discussed:-

- ❖ **USING AI AND ML TO MONITOR AND ANALYSE THE VEHICLE EMISSIONS.**

- The amalgamation of carbon emission control and artificial intelligence has already taken place and people are working on it but what new thing we are suggesting is to provide a double-check for the data. The user of the vehicle, as well as the dedicated authorities, both of them get to track the vehicle's condition. If a vehicle user doesn't want to change and his vehicle is causing excessive carbon emission and air pollution then he/she will be identified by the concerned authorities (like RTO, vehicle or transport department, etc).
- The real-time tracking option is what we need so that we don't have to rely upon old data. It would provide greater reliability over the system instead of the track, store, analyze system. We can get the instantaneous data of the vehicle which we are caring for, and then we don't have to wait until the data is evaluated and analysed. In the case where we wait for the data to be analysed, it used to take time, and until that the vehicle moved freely causing hazardous impacts on the environment.

❖ USING A SCROLL TYPE COMPRESSOR TO COMPRESS THE EXHAUST GASSES:

- The use of a scroll-type compressor will help a lot. This technology is used in AC and refrigerators. But we are planning to join it with the vehicle carbon emission control system. It will certainly decrease the carbon footprint. Here we are compressing the exhaust and then storing it to prevent the gases from escaping into the open atmosphere hence preventing pollution and carbon emission.

❖ CAPTURING THE EXHAUST GASSES AND CONVERTING THEM TO USEFUL ELEMENTS:

- The technique of capturing the exhaust gasses and converting them into

useful elements is not new. It is used in various types of industries. These industries produce numerous types of harmful gasses so to meet the industry's environmental protocol, sometimes they filter those gasses. But it has never been used in vehicles. We are going to use it in automobiles, it will be a revolutionary idea that can make an astounding change in the current scenario.

- Making and extracting useful elements from the exhaust will be a great step toward sustainable development. We are utilising the resources properly by reusing the byproduct of waste made during the burning of fuel.

APPROACH TO IMPLEMENT PROPOSED INTERVENTION

Whenever a work plan is made, a well-planned approach is needed to implement the idea. Certainly Here is the same case we are trying to have a well-structured approach to implement our work plan and ideas.

❖ USING AI AND ML TO MONITOR AND ANALYSE THE VEHICLE EMISSIONS.

Our main motive here is to track down the vehicles by analysing their exhaust data and data related to the suspension condition. This data can also be analysed by human beings and till now it has been done by humans only in some cases, machines assisted but there are always chances of error and also one more thing. It becomes very difficult to analyse the data and predict whether the targeted vehicle is suitable for further use.

Here comes the boom of computer science, Artificial intelligence, and machine learning. They are very helpful in such conditions where we have to analyse a lot of things.

Based on the recent studies we saw that artificial intelligence integrated with vehicles, used to monitor their exhaust gasses, their engine functioning, and their suspension can help to make the vehicle more fuel-efficient. And if the vehicle is fuel-efficient it will produce less exhaust and hence carbon emission will be reduced.

Source and Reference:

- GOOGLE SCHOLAR:- An IoT based system for magnify air pollution monitoring and prognosis using hybrid artificial intelligence technique

Now our plan is to install sensors, exhaust analysing devices, and other tracking equipment. These devices will track down the exhaust gases and analyse the contents. They will further transmit this information to the artificial intelligence software. Here AI will analyse this data on the basis of past vehicle reports and standard reports. It will also take engine and suspension under consideration.

Based on this analysis the final report will be created and this report will be sent to the user and the relevant authorities. They then direct the appropriate orders regarding that vehicle and in this way this system works.

❖ USING A SCROLL TYPE COMPRESSOR TO COMPRESS THE EXHAUST GASSES:

This method is a state of engineering technology and sets an example in the engineering world. Here we are using a Scroll Type Compressor to compress the exhaust gases released by the engine when it burns the fuel. It will completely stop the release of harmful gases and carbon emissions into the environment.

What we are planning to do here is use a scroll-type compressor just like the one used in Air Conditioning(AC) but more powerful since it needs to work a lot more than an AC compressor. And use it to compress the exhaust gases released. It is a bit hard to adjust along with the system of automobiles, but we can manage that by using half of the fuel tank to store the compressed exhaust gases. We can split the fuel tank into two parts and use half of it.

Now to successfully complete this process, certain modifications need to be made to the vehicles. Some major modifications which will be very necessary to complete this compression and storage process are as follows:

- ❖ Modification of the automobile Engine so that it emits only pure gaseous emissions without any minute solid particles upon combustion of fuel. This is necessary for the compressor as our compressor needs only gaseous state to work upon.
- ❖ Modification of fuel tank to store fuel as well as exhaust emissions in liquid state after it has been compressed by the gas compressor after exerting high pressure. To store the “exhaust liquid” which will contain the mixture

of different emission gases in liquid form, we need another kind of storage tank inside the vehicle. We can also split the fuel tank to store the “emission liquid”.

- ❖ Vacuum connections need to be made from the exhaust outlet to the compressor and then to the storage tank, to ensure zero leakage of gases into the atmosphere.

In this way, this idea can be implemented and can be used to decrease carbon emissions and air pollution in the atmosphere.

❖ CAPTURING THE EXHAUST GASSES AND CONVERTING THEM TO USEFUL ELEMENTS:

This idea is very feasible and somewhere easy to implement and may be implemented in near future. Capturing of exhaust gasses is already done in industries where they release a lot of polluting gasses into the atmosphere. So to match the industry’s environmental protocol they filter the exhausts. Here we are implementing the same idea in vehicles.

Our vehicles already have a catalytic converter installed in them, which converts toxic and hazardous gasses into less toxic ones, like carbon dioxide, water vapour, etc. but these are still harmful to our environment. Carbon dioxide and water vapour are the gasses that are responsible for the highest global warming. So these gasses can not be allowed to be emitted into the atmosphere. So we need to consider them too and do something to get rid of them. Some chemical reactions like decarbonization and sulphur dioxide conversion into sulphur may help to achieve this goal.

So what we do is make the exhaust gases pass through this exhaust treatment and filtration compartment that will be connected right next to the catalytic converter. Then there will be different adsorption steps involved to adsorb different gases like carbon dioxide, nitrogen, sulphur dioxide, etc.

According to a study activated carbon Filtrasorb 400C (Reference 4469) (F400) supplied by Chemviron Carbon shows a very distinctive property of adsorbing carbon dioxide, water vapour, nitrogen, sulphur dioxide, etc.

Source and Reference:

- <https://pubs.acs.org/doi/10.1021/acs.energyfuels.1c00339>

Now after these gases are adsorbed we can separate them and use them for further treatment.

Carbon dioxide separated from the emission is treated with decarbonization. And after the process, this carbon dioxide is converted into solid carbon which can be stored and further used for some carbon-oriented purposes. Now, this storing of solid carbon diminishes the possibility of carbon emission to almost zero since now carbon is in solid form and stored. That's why the carbon capture and storage (CCS) technique is very successful in decreasing carbon emissions.

But how does it work, actually thermal chemistry methods widely used in industries are used here. A liquid metal column is used and carbon dioxide is injected into it. When CO₂ enters the column bubbles are formed just like when we shake coke, bubbles are formed. When these bubbles move up through the column, flakes of solid carbon are formed out of carbon dioxide. And this whole process is completed instantly.

Source and Reference:

- **ScienceDaily :-**

<https://www.sciencedaily.com/releases/2022/01/220119121411.htm>

Now a similar type of reaction can be performed with sulphur dioxide. Flue gas desulphurization technologies are the most widely used techniques in the industries but they are slow and produce a large amount of solid waste in the form of metal sulphides which need to be disposed of. That's why this method is not feasible for vehicles. Alternatively, catalysis reactions can be used but they require high temperatures and that is why this method is also not appropriate for our application.

So a new technique has been invented. According to the researchers, a single-step plasma-assisted catalytic reaction can be used. It rejects the need for high temperatures and does not produce any waste materials.

Source and Reference:

- **ScienceDaily :-**

<https://www.sciencedaily.com/releases/2020/10/201028171423.htm>

By using these techniques the harmful gasses can be separated out and converted into elemental products which can be used for appropriate industrial and domestic uses.

CONSTRAINTS TO IMPLEMENTATION, DESIGN ISSUES:

- ❖ **USING AI AND ML TO MONITOR AND ANALYSE THE VEHICLE EMISSIONS.**

In the implementation of this idea, we will have some constraints that we would need to resolve in order to make our idea happen so here what design issues we may face are as follows:-

- ★ In starting the computer program dedicated to the working of artificial intelligence will need an extensive amount of programming. Various types of parameters will need to be taken into consideration. It might be tedious and complex in starting to figure out the exact set of instructions that will decide the overall vehicle carbon emission index that further decides what should be done on which vehicle.
- ★ The changes, in the beginning, maybe economically heavy since various types of sensors and devices will be mounted over the vehicle which will certainly add up to an amount that would seem to be difficult to afford by middle and lower-middle-class car users.
- ★ The relevant authorities will have to hire personnel who have expertise in artificial intelligence and machine learning. They might have to change all of their systems to make these kinds of changes. Since it will change their working manner.

- ❖ **USING A SCROLL TYPE COMPRESSOR TO COMPRESS THE EXHAUST GASES:**

We have our plan, ready to be executed. But we certainly have many issues that need to be addressed. Some of the major problems, constraints and design issues are as follows:

- ★ Compressing the exhaust gases completely to liquid form requires quite a lot of power and energy. The compressor needs to be very powerful in order to be able to liquefy all the exhaust gases. Supplying such power to the vehicle would be quite a challenging task as we may have to install more and larger batteries in the vehicle.
- ★ The scroll-type compressor which we are looking forward to has some disadvantages too. Being fully hermetic, perhaps the biggest disadvantage of scroll compressors is that they are generally not easily repairable. They cannot be disassembled for maintenance.

Source and Reference:

- <https://www.enggcyclopedia.com/2012/03/scroll-compressors/#:~:text=Disadvantages,on%20rotating%20in%20both%20directions.>

- ★ The surface of moving parts is mostly in a curved shape, and the machining and inspection of these curved surfaces are more complex. Manufacturing requires high-precision machining equipment and precise centring assembly technology, so the manufacturing cost is higher.
- ★ Between moving parts or between moving parts and fixed parts, a certain movement gap is often maintained to achieve sealing. Gas leakage is bound to occur through the gap, which limits the rotary compressor to achieve a larger compression ratio. Therefore, most rotary compressors are used under the air conditioning.
- ★ We suggest that modifications should be made to the vehicles in order to be able to accommodate the system due to which there will be no emissions in the environment, but making such modifications is not at all easy.

- ★ To accommodate such a setup, we'll have to restructure the vehicles. We have to add quite a few new components inside the automobiles which are otherwise not present in them. Adding such components will not be very difficult in four-wheel-drive vehicles because they have a lot of space in them, but in two-wheel drive, there is considerably less space to add anything else. Thus, it is a major design challenge, especially for two-wheelers.
- ★ Adding new components makes the vehicle much heavier than before. Thus, the aerodynamic property of the vehicles will be reduced if we implement our idea. Moreover, vehicles may start to consume more fuel if they have to bear more weight. Hence, this is a major drawback that we have to solve in the future.
- ★ Modifications to the existing fuel pumps need to be made in order to extract the emission liquid which will be stored in the vehicle. Due to this, Vehicle's fuel storage capacity will be reduced. Also, as the fuel stations are already established and are constructed expensively, it's a major issue to modify currently established and running fuel stations for the extraction & transportation process or making new fuel stations will be very costly.
- ★ Successfully extracting and separating all the emission gases from the exhaust liquid and trying to include them as raw materials to make some useful things is also quite a tedious task. It has some chemical challenges and implementation at such a large scale may be difficult.

❖ CAPTURING THE EXHAUST GASSES AND CONVERTING THEM TO USEFUL ELEMENTS:

In the implementation of this idea, we will have some constraints that we would need to resolve in order to make our idea happen so here what design issues we may face are as follows:-

- ★ This capturing system of exhaust gases may be a bit complex to fit in an automobile. First of all a catalytic converter, then an adsorption chamber, then a separator and then the chemical reaction chamber for individual gases. Since individual gases will need their own isolated compartment, it

will take a large chunk of space in automobiles which might decrease the efficiency of vehicles.

- ★ The economic load of this system will be very high since now a lot of things have been installed over vehicles. All this system will add up a lot to the overall cost of the vehicle which makes it less affordable and hence it may not be within reach of commoners.

EXPERTISE OF EACH STUDENT TO CONTRIBUTE

❖ AYUSH SINGH:

Being a computer science student, I can help in the AI/ML part of our Idea for implementation. Also, I have some knowledge about the compressing technology for gases, and how they can be liquified upon exerting high pressure, that's why I was able to devise such a solution to compress the exhaust gasses. I was also able to determine some of the problems and issues which we will be facing when trying to implement our idea and thus I've mentioned all these things in our reports presented for this course. Air pollution is a major problem for our earth, and I tried to identify this problem by looking at various research papers, statistics and data to get a glimpse of the severity of this complex issue and to understand where our country stands in the world if we compare it with different countries and regions.

❖ DILEEP KUMAR KANWAT-

I am a computer science student and having a background in computer science allows me an upper hand in working with artificial intelligence and machine learning related projects. So here we have provided an AI/ML solution to the carbon emission issue in vehicles.

So I have expertise in working on programming related projects and hence I will be king of comfortable working with data science and AI/ML. Also, I studied Capturing the exhaust gases and converting them into useful elemental state solutions and was able to frame a solution for our carbon emission capturing problem in vehicles.

❖ RAHUL GOYAL-

I am a chemical engineering student. I have expertise in the chemistry-related solutions here we have proposed capturing exhaust gases and converting them to useful elements solutions. Having knowledge of chemical processes I have an upper hand in this solution and that is why I will be quite helpful in carrying out this solution in the real world.

EXPECTED OUTCOMES

- Use of AI and ML techniques in the vehicle has given us a way to control and stop the vehicles which are producing more and more harmful gases. Nowadays it is compulsory to carry a pollution certificate with you. As RTO is also working on these techniques to help to reduce air pollution. With the help of data which is collected from the exhaust of a vehicle, AI can predict the malfunctioning in the engine system of the vehicle and based on the regular exhaust analysis, it may also tell how much it can work and when the engine needs to be replaced. We can remove the vehicle which is not eligible for running on the street
- Use of the Scroll type compressor is also helping us to capture the gases like nitrogen and carbon dioxide which harm nature. Due to this technique, we can help the living organism stay safe from the harmful gases which are released from the vehicle.
- The Capturing of gases from the environment helps society to get many objects and helps the environment also to get pollution free. We get many things by the help of capturing things like Carbon we get

PLAN OF ACTION FOR UTILISATION OF OUTCOME

We use multiple plans of action for utilisation of outcome to reduce pollution from vehicles and engines:-

Fewer miles driven means fewer emissions

1. Use a bike or walk for a small distance.

2. Use of bike-sharing can be used in big cities or towns
3. Use of public transportation.
4. Sharing of car for going office etc. instead of going alone
5. Plan ahead to make the most of your trips and “trip chain.” If your grocery store is near other places you need to visit, do it all at once

Way of driving can reduce emissions from our vehicles

Drive Effectively:- lesser use of gas pedals and brakes

Maintenance of Car:- Follow proper maintenance schedule by manufacturer and use good quality oil.

3. Catalytic Converter

We can use a catalytic converter in the emission control device so that it can convert the toxic gases that are produced from the exhaust of internal combustion engines into less- toxic pollutants. The emission control system in automobiles is applied to limit the discharge of noxious gases from the internal-combustion engine and other components

4. Research and Companies

We can contact different automobile manufacturers' companies to design the vehicle's engine in the new techniques so that it will produce less air polluting gases and do less harm to the atmosphere.

CONCLUSION:

In this report we can conclude that there are many ways to control air pollution through vehicle emission capture techniques such as using AI and ML techniques we can detect the emission of carbon from a vehicle with the help of this we can stop the vehicles which are producing more and more pollutants which is causing air pollution in the environment. Another way that we can use the scroll type compressor by which we can compress the exhaust gases which are coming out from the vehicle such as CO₂, HC and CO which are harming the environment as well the living beings. One the way can be capturing the exhaust gases such as carbon and converting them into useful items such as graphite, artificial diamond and other useful industrial applications.

As living in good society the air pollution is the major issue and it is increasing mainly from the gases such as sulphur dioxide, carbon dioxide and other carbon gases which are emitted from the vehicle. So it is important to control the harmful gases that's why we have found out some ways in our report to control it. By the help of our above ways we are controlling the air pollution but also we are providing some useful industrial items from it that helps the society.

CONTRIBUTION OF EACH STUDENT:

1. AYUSH SINGH (2020CSB1079):-

- a) Abstract of the report
- b) Problem Statement
- c) Identification of the problem
- d) Detailed description of the problem
- e) Current developments in the domain
- f) Need and significance of resolving the problem
- g) Objectives to minimize the gap
- h) Tools and techniques used
- i) Detailed Working Plan [(B) part]
- j) Constraints to Implementation and Design Issues
- k) My expertise to contribute to the implementation of the design ideas.

2. DILEEP KUMAR KANWAT (2020CSB1085) :-

- a) Report template and styling
- b) Table of contents
- c) Detailed Work plan [except (B) part]
- d) Innovation of the proposed intervention.
- e) Approach to implement the proposed intervention.
- f) Constraints to implementation and design issues.
- g) Expertise to contribute to the implementation of the design ideas.

3. RAHUL GOYAL (2020CSB1085):-

- a) Expected Outcomes
- b) Plan of Actions for utilization of outcomes
- c) Conclusion
- d) Expertise to contribute to the implementation of the design ideas.

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❖ Approach to implement proposed intervention

- Using Ai and ml to monitor and analyse the vehicle emission- [An IoT based system for magnify air pollution monitoring and prognosis using hybrid artificial intelligence technique](#)
- Capturing the exhaust gas and convert them to useful elements
 - Adsorption of exhaust gas-
<https://pubs.acs.org/doi/10.1021/acs.energyfuels.1c00339>
 - Converting carbon dioxide to solid carbon
<https://www.sciencedaily.com/releases/2022/01/220119121411.htm>
 - Converting sulphur dioxide to solid sulphur
<https://www.sciencedaily.com/releases/2020/10/201028171423.htm>

❖ Design issues

- Scroll type compressor disadvantages
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