

CASE STUDY

TOPIC: EFFECT ON ENVIRONMENT DUE TO DIESEL ENGINE



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1. Introduction:

Today, Diesel engines play a crucial role for different types of applications in vehicles, heavy transport trucks, ships and so on. It contributes to a large percentage of transportation of goods and services, generates electricity, and is used for many agricultural, construction and industrial activities. Also, diesel engines are more economical and have low fuel consumption than any other internal combustion engines.

However, diesel is and will remain, one of the major contributors to environment pollution problems world-wide, with significant increase anticipated in the population of vehicles. The exhaust of the diesel engine contains a higher amount of particulate matters and NO_x is emitted into the atmosphere causing environmental problems. Diesel emission causes human health related issues like cancer, breathing difficulties and pollution of air, soil, and water. Also, there is a possibility it might contribute to climatic changes. Examples include formation of Acid rain and Ozone layer depletion.

This case study analyzes and summarizes the basic thermodynamic cycle of diesel engines. It also reviews the information on diesel emission from published journals, its effects on environmental and human health. It suggests ways to reduce the emission rate of toxic gas to the environment.

2. Description of the thermodynamic process of diesel engine:

➤ Working

In the internal combustion diesel engine, the air is compressed at a high temperature inside the cylinder to ignite the diesel fuel. Then the fuel burns and produces sufficient energy to move the piston inside the cylinder. So, here in this process the chemical energy is directly converted to the mechanical energy and this energy is directly transmitted to the wheels of the vehicles or trucks.

In an Ideal diesel cycle undergoes a series of four processes. (1) Isentropic compression process (2) Isobaric Expansion (3) Isentropic Expansion (4) Isochoric decompression. Which is shown in the figure 1.

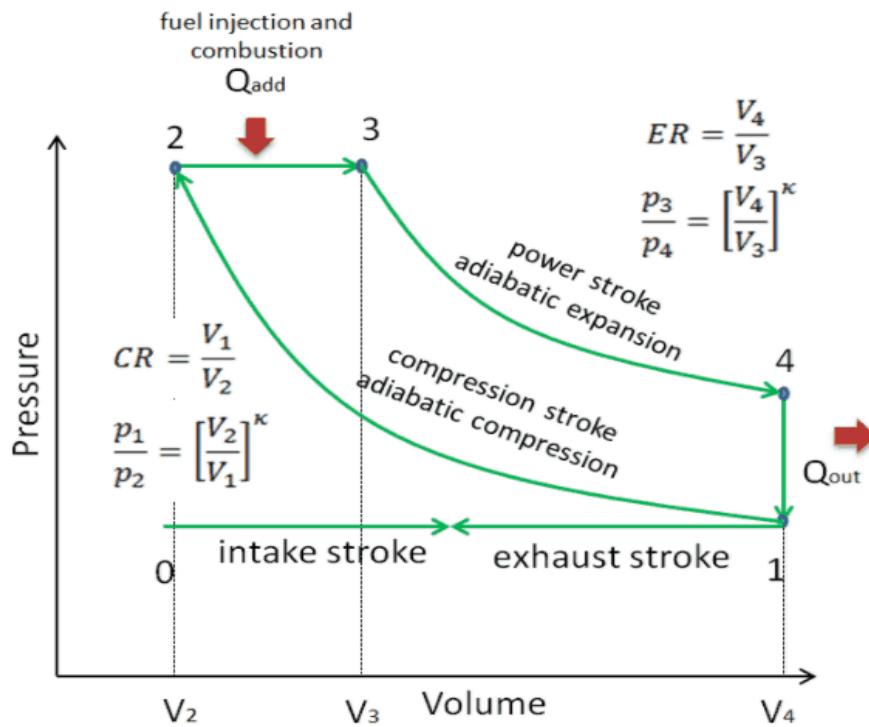


Figure 1: Pressure volume graph of diesel engine

Table 1 Pressure volume

	PROCESS
1-2	Isentropic Compression
2-3	Constant pressure heat addition
3-4	Isentropic Expansion
4-1	Constant volume heat rejection

a) Isentropic compression

It is also known as the compression stroke. So, in the compression stroke the air is compressed adiabatically from the point 1 to point 2, which is shown in the Figure 1 pressure volume graph. At the point 1 the piston is in the bottom dead centre (point 1) and then the piston moves from bottom dead centre to top dead centre (point 2). Here in this process the volume is reduced, and pressure increased. Here the volume ratio (v_1/v_2) known as compression ratio.

b) Isobaric Expansion

It is also called as the ignition process; in this phase the diesel fuel is injected and heat is transferred from air to the diesel fuel, then the fuel ignites and the piston

moves to v_3 (point 2 -3). Which is shown in the figure 1. Also, here in this process the pressure remains constant and energy enters to the system as Q_{add} .

c) Isentropic expansion

The third process is known as the power stroke, when the gas expands adiabatically from the point 3 to point 4, piston moves from v_3 to bottom dead centre. So, here the gas works in the piston and loses a quantity of internal energy equal to the work left by the system. Here in the process the volume ratio is v_4/v_3

d) Isothermal Decompression

Isothermal Decompression is also known as exhaust stroke. In this process, the heat is rejected by opening the exhaust valve at point 4. As the piston moves from bottom dead centre (point 1) to top dead centre (point 0) with the exhaust valve opened, the gaseous mixture vents into the atmosphere.

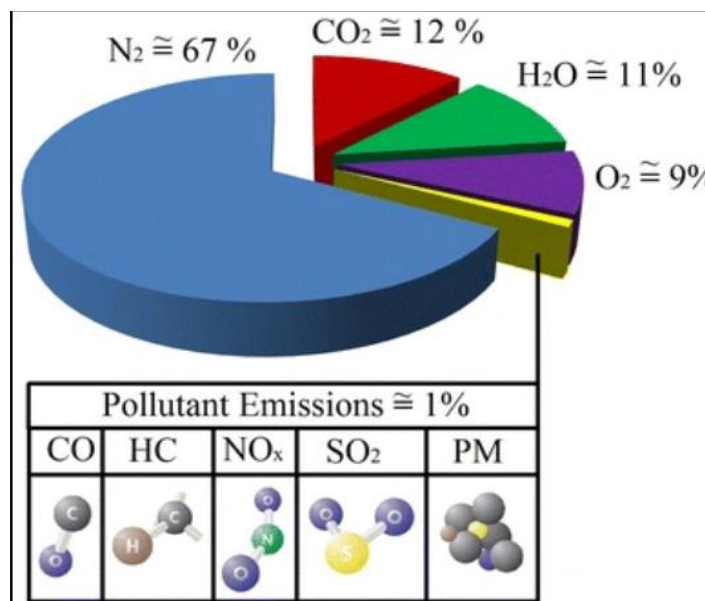


Figure 2: percentage emission of gases

In an ideal thermodynamic equilibrium, only carbon dioxide and H₂O are developed in the combustion chamber, after combustion of diesel fuel. However, due to air-fuel concentration, combustion form, temperature, initiation timing causing several harmful gases will be developed during the time of the combustion. The most common type of harmful gases is carbon monoxide (CO), Hydrocarbons (HC), Nitric oxide (NO) and particulate matters (PM).

In the above pie chart show the percentage of emission of harmful gases from the diesel engine. So, here highest percentage of gas emitted is the nitrogen, about 67% is emitted. Carbon dioxide and H₂O is almost similar, the rate of emission of particulate is less than 1 percentage.

3. Environmental impact

A. Global Climatic change

The earth absorb energy from the sun as visible light and sent energy to space as invisible radiation in infrared. The transport sector currently account for 26% of greenhouse gas emissions in the united states and is projected to be one of the fastest growing sources of greenhouse gas emission in the near future, due to increase demand for gasoline and diesel fuel .Which are emitted to the atmosphere and effects the earth radiation balance. When the toxic gases emitted into the atmosphere, absorbs the solar radiation, and causes an increase in the temperature of the atmosphere. Also, by the emission of the particulate matters from the diesel exhaust effects the size of the distribution of the cloud droplet. Hence it alters the radiative properties of the clouds and leads in the change in rainfall pattern.

B. Soil, water, and air pollution.

When the diesel fuel leaks from the tanks and if they mix with the water bodies such as rivers, lakes etc. Causing the decreased growth rate, mortality and increased infected and non-infected disease for the aquatic organisms as well as it also effects to the plans and animals.

If the particulate matters which is emitted to the atmosphere from the exhaust diesel fuel, which is contaminates both the soil and water. When the exhaust gas emitted indirectly by dry or wet deposition over the surface of the soil. Hence, the soil will be contaminated, and these chemicals will penetrate downward through rainfall causing soil pollution.

Also, when the diesel particulate exhaust gas emitted to the atmosphere is mix with air and this air inhaled by humans causing the breathing problems and other disease.

4. Methods for reducing the emission of harmful diesel exhaust gas

- ✚ Modify the existing diesel engine by following the diesel emission standards, rather than removing the pollutants from the exhaust stream.
- ✚ In diesel fuels there are some percentage of sulphur contents will be developed after combustion. So, by reducing the fuel aromatic content helps to reduce a huge percentage of so₂ and particulate matters. In united states the rate of sulphur dioxide reduced by 95% and total particulate matters reduced by 25%.
- ✚ Advanced combustion techniques, exhaust gas regulation, and shaping the rate of fuel injection system helps to reduce the rate of emission from diesel engines.
- ✚ Using Exhaust gas recirculation process: - it is a common technology, which is used for dropping the rate of NO_x emission during the time of the combustion process. Here, in this process a part of an emission gas will be returned to cylinder through intake system and this gas is mix with the fresh air inside the cylinder. Hence, it will lower the percentage of chemical reaction, which reduces the formation of NO_x gas.

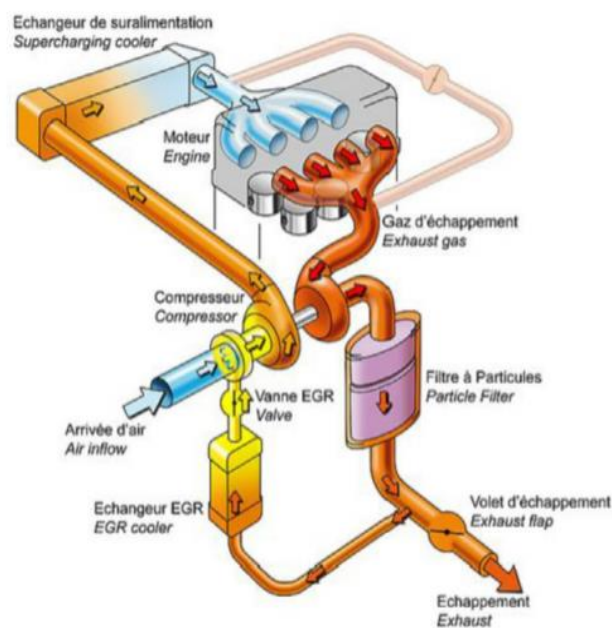


Figure 3: Exhaust gas recirculation system

- ✚ If we use electric vehicles, instead of internal combustion engine offers clear advantage like they do not emit pollutants emission into the atmosphere. Also, it helps to reduce a huge percentage of harmful gases in the urban areas.

- ✚ Combine diesel engine with electric motor. Because they often use only electric motor at low speed, and their regenerative brakes turns kinetic energy into electric power, making them more economical and environment friendly for usual stop- start driving mostly urban areas. As a result, the rate of emission of harmful gas from the diesel exhaust can be reduced.
- ✚ If we could be able to encourage the use of hybrid and electric vehicles by reducing the tax rate will helps to increase number of the hybrid or electric vehicles.
- ✚ Installing DeNox exhaust aftertreatment process manufactured before 2015, it consists of selective catalytic Reduction (SCR) and NO_x traps in the exhaust pipes, which helps to reduce the emission of NO_x from the diesel vehicles. In the SCR system contain pure de- ionized water in a special tank.so, here the main function of this technology is that the rate of NO_x gas which is emitted from the cylinder is converted into N₂.

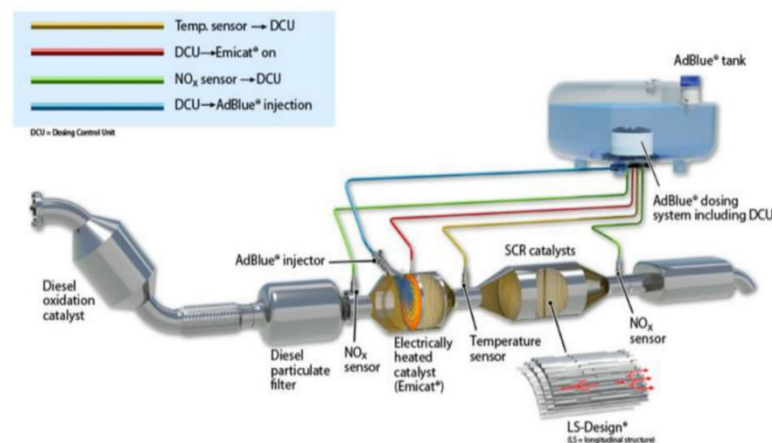


Figure 4: SRS catalytic convertor

- ✚ Install Diesel particulate filter in the older engines, which helps to remove 99% of particulate emitting from the exhaust diesel engines.

5. Conclusion

Here in this case study explains the impact on environment due to diesel engines. Moreover, diesel engine is more efficient than any other fuel. Therefore, it is very difficult to replace the diesel engine it into the any other fuel, especially in the field of transportation. So, several manufacturing companies are trying to improve the efficiency as well as to reduce the rate of emission. Now a days, the countries like United states, Europe are trying to replace the diesel engines it into the electric vehicles, mostly automobiles which travels in the urban areas. Also, the governments are started to encourage the use of hybrid vehicles, by reducing the tax rate. Hence, this type of plans will help to reduce the rate of emission of toxic gases in the future.

6. Reference

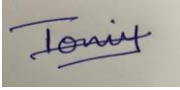
- Nuclear Power. n.d. *Thermodynamic Processes In Diesel Cycle*. [online] Available at: <<https://www.nuclear-power.net/nuclear-engineering/thermodynamics/thermodynamic-cycles/diesel-cycle-diesel-engine/thermodynamic-processes-in-diesel-cycle/>> [Accessed 20 August 2020].
- Diesel Information Hub. 2017. *How Modern Diesel Engines Are Helping Reduce Motoring's Impact On Local Air Quality*. [online] Available at: <[https://dieselinformation.aecc.eu/how-modern-diesel-engines-are-helping-reduce-motorings-impact-on-air-quality/#:~:text=Diesel%20Particulate%20Filters%20\(DPFs\)%20remove,the%20engine%20including%20ultrafine%20particles.&text=DeNOx%20exhaust%20aftertreatment%20systems%20such,NOx%20emissions%20of%20diesel%20cars.](https://dieselinformation.aecc.eu/how-modern-diesel-engines-are-helping-reduce-motorings-impact-on-air-quality/#:~:text=Diesel%20Particulate%20Filters%20(DPFs)%20remove,the%20engine%20including%20ultrafine%20particles.&text=DeNOx%20exhaust%20aftertreatment%20systems%20such,NOx%20emissions%20of%20diesel%20cars.)> [Accessed 20 August 2020].
- Chow, J., 2001. Diesel Engines: Environmental Impact and Control. *Journal of the Air & Waste Management Association*, 51(9), pp.1258-1270.

7. STUDENT DECLARATION

I have not copied any part of this report from any other person's work, except as correctly referenced.

Collaboration: No other person has written any part of this report for me.

Student Name: Tony Pauly

declaration of the above: _____  _____ (signature) Date:

20/08/2020