3rd Laboratory

Engine Emissions

Objective

To identify the emission gases, study how to control them and to study more about catalytic converter.

Discussion

- What are the most common emission gases?
- How can we control emissions?
- What is the catalytic converter?

Engine Emissions

In cities across the globe, the personal automobile is the single greatest cause of pollution, as emissions from billion vehicles on the road add up to a planet-wide problem.

Driving a private car is a typical citizen's most air polluting activity. The negative effects of automotive emissions are maximum when you sit in traffic surrounded by other vehicles with their engines idling. Everyone sitting in the traffic jam is getting poisoned.

The combustion of gasoline and diesel fuels which consist of a mixture of hydrocarbons mixed with oxygen with small percentages of Sulphur and nitrogen occurs to produce exhaust emissions.

Typical engine combustion:

Fuel + Air → HC + NO_x + CO_2 + CO + H_2O + N_2

- **Nitrogen Oxides (NO_x)**

Under high pressure and temperature conditions in an engine, nitrogen and oxygen atoms react to form nitrogen oxides. Catalytic converters in car exhaust systems break down heavier nitrogen gases, forming nitrogen dioxide (NO_2) which is 300 times more potent than carbon dioxide as a greenhouse gas.

NO_2 makes up about 7.2 percent of gases that cause global warming. Vehicles with catalytic converters produce nearly half of that NO_2. NO_2 also originates from nitrogen based fertilizers and manure from farm animals.

- **Carbon Monoxide (CO)**

Carbon monoxide is a colorless, odorless, poisonous gas and a product of incomplete combustion of hydrocarbon based fuels. Two thirds of the carbon monoxide emissions come out from transportation sources, with the largest contribution coming from cars.

In urban areas the passenger vehicle contribution to carbon monoxide pollution can exceed 90%.

- **Carbon Dioxide (CO_2)**

U.S. Environmental Protection Agency (EPA) originally viewed carbon dioxide as a product of perfect combustion, but now views CO_2 as a pollution concern. Carbon dioxide is a greenhouse gas that traps the earth's heat and contributes to global warming.

- **Evaporative Emissions (HC)**

Hydrocarbon pollutants also escape into the air through fuel evaporation especially in hot days. There are several ways for evaporative emissions to occur.

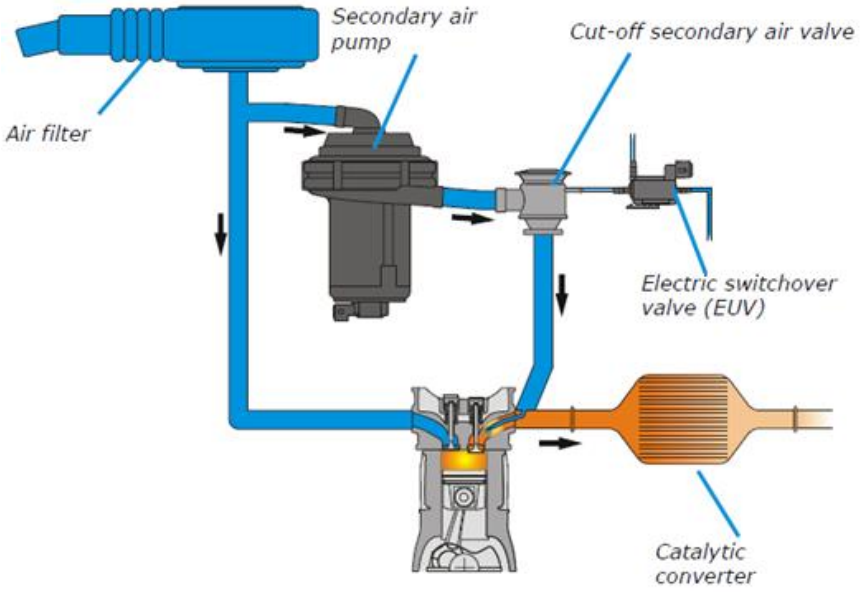
Emission Control

Engine efficiency has been steadily improved with improved engine design, more precise ignition timing and electronic ignition, more precise fuel metering, and computerized engine management.

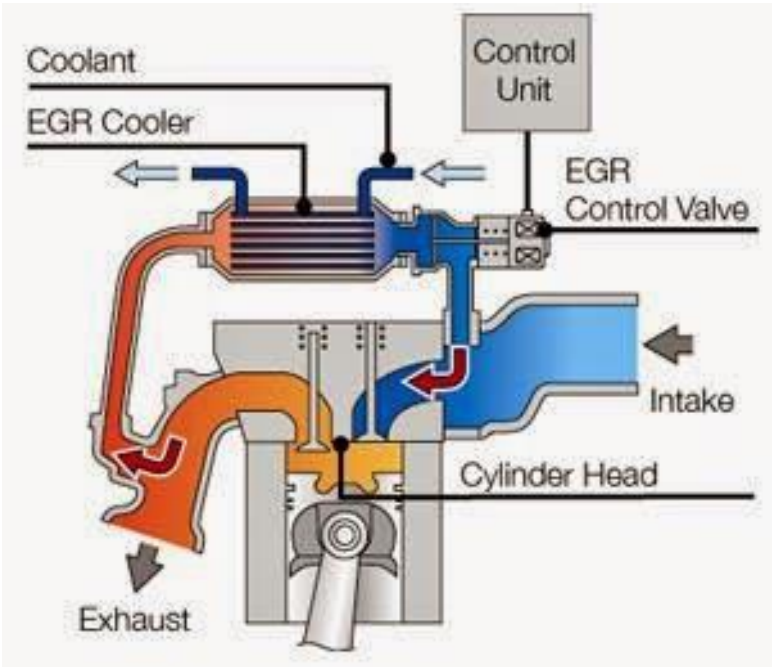
Advances in engine and vehicle technology continually reduces the toxicity of exhaust leaving the engine, but these alone have generally been proved insufficient to meet emissions goals. Therefore technologies to detoxify the exhaust are an essential part of emission control.

What are the most common ways for emission reduction and control?

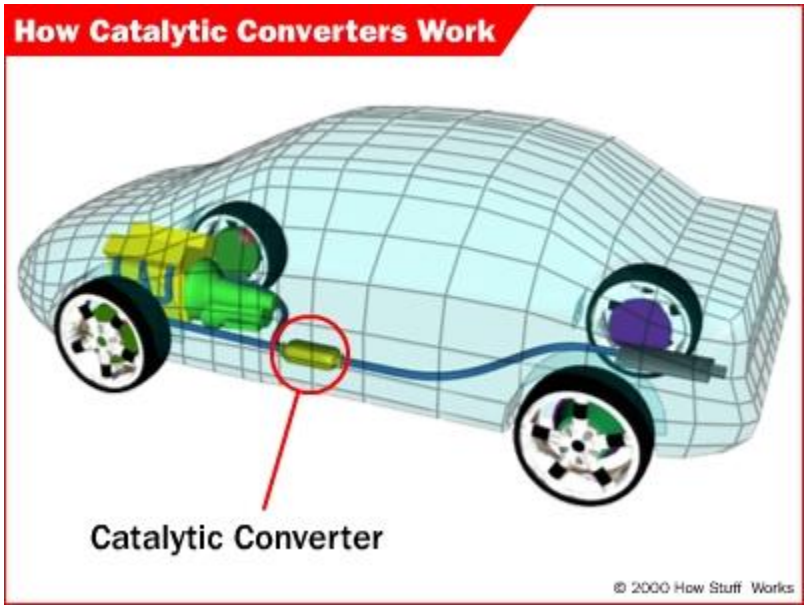
- **Secondary air injection**
  - It is one of the first developed systems which injects secondary air into the engine's exhaust ports to provide oxygen for the unburnt gases.



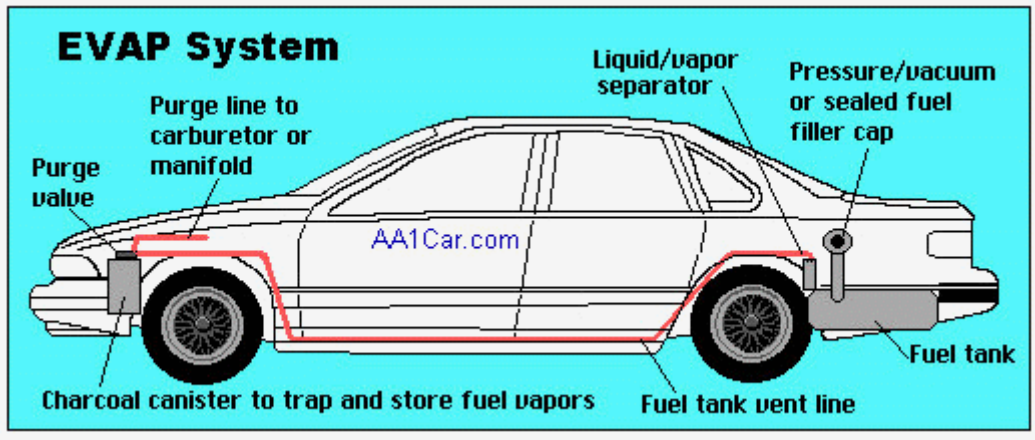
- **Exhaust gas recirculation (EGR)**
  - It is a system that meters a specific amount of exhaust and redirects it back from the exhaust port into the intake again to reduce the combustion temperature and reduce NO_x emissions.



- **Catalytic converter**
  - It is a device placed in the exhaust pipe that converts the hydrocarbons, carbon monoxide and NO_x into less harmful gases by using a combination of catalytic precious materials like platinum, palladium and Rhodium.



- **Evaporative emission control**
  - Since 1971 most vehicles don't vent their evaporative emissions into the atmosphere. In a typical system all evaporative emissions are passed into a duct passing into a charcoal canister to absorb all of those gases and reinject them again into the engine when the engine starts.



Experiment

Steps:

1- Start the engine and wait till it warms up.
2- Turn on the gas analyzer and wait till it performs the self-calibration.
3- Place the analyzer's probe into the exhaust pipe and take the readings from the analyzer's screen.
4- Increase the speed (1000 – 1250 – 1500- 1750 – 2000) and every time record the reading of the NO_x, CO, CO_2 and HC in the following table

RPM	NO_x	CO	CO_2	HC
1000				
1250				
1500				
1750				
2000				

Requirements:

- Plot the relation between the rpm and each of the recorded emissions in a separate chart.
- Report on
    - The effect of each emission on humans.
    - Any type of the emission control system (2 to 3 pages)