Air Pollutant Controlling Equipment

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Settling Chamber

The settling chamber is the simplest type of equipment used for collection of solid particulates. It consists of a chamber in which the carrier gas velocity is reduced so as to allow the particulates to settle out of the moving stream under the action of gravity.

The carrier gas velocity must be sufficiently low (less than 3m/sec) and as a result, the solid particles present in that carrier gas, settle under the influence of gravity on the base of the chamber, from where they are removed through hopper.

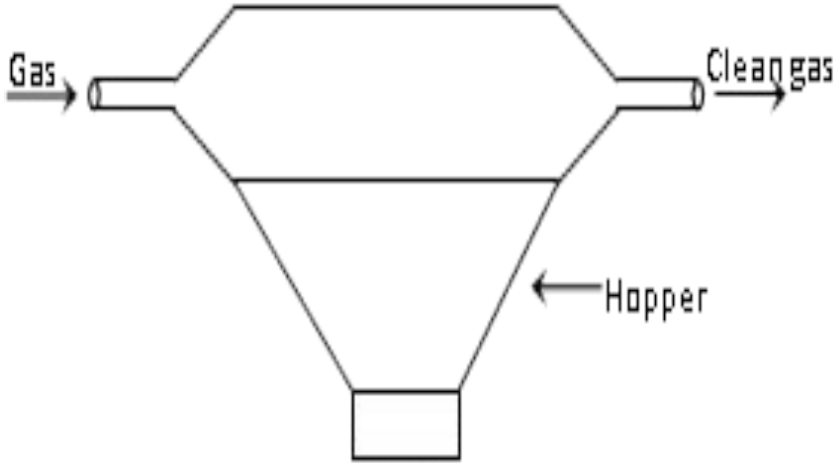


Fig: 3.27 Settling Chamber

Advantages:

- Low initial cost
- Simple construction
- Low maintenance cost
- Low pressure drop
- Dry and continuous disposal of solid particles

Disadvantages:

- Large space requirements
- Comparatively large particles can be collected only

Cyclone separator

Cyclone separator utilize a centrifugal force generated by a spinning gas stream to separate the particulate mater from the carrier gas. The centrifugal force on particulate matters in a spinning gas stream is much greater than gravity; therefore, cyclones are effective in the removal of smaller particles than the settling chamber. The efficiencies of cyclone separator can be above 90% for the particles larger than 5 μm and drop rapidly for the small particle sizes.

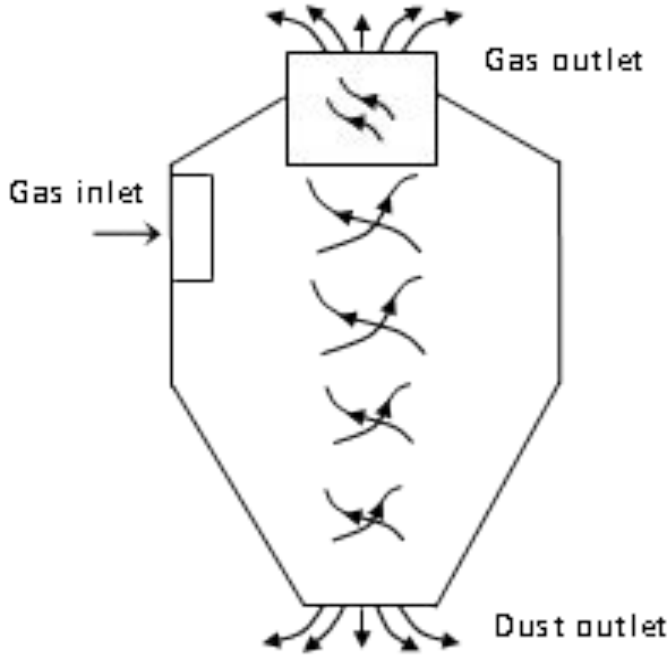


Fig: 3.28 Cyclone Separator

Advantages:

- Low initial cost
- Simple construction & operation
- Low pressure drop
- Low maintenance
- It has no moving parts
- Continuous disposal of solid particles

Disadvantages:

- Low collection efficiency for the particles below 5μm in diameter
- Equipment is subjected to severe abrasive deterioration

Baghouse Filter

The baghouse filter is also known as **Fabric filter**. This system typically consists of a tubular bag which suspended or mounted in such a manner that the collected particles fall into a hoper when dislodge from the fabric. The structure in which the bags hang is known as **baghouse**. Generally, particle-laden gas enters the filter from the bottom and passes through the fabric / bag. At that time, the particles are deposited on the surface of the bag. The cleaning of bag is accomplished by shaking at fixed intervals of time and dusts are collected at the bottom.

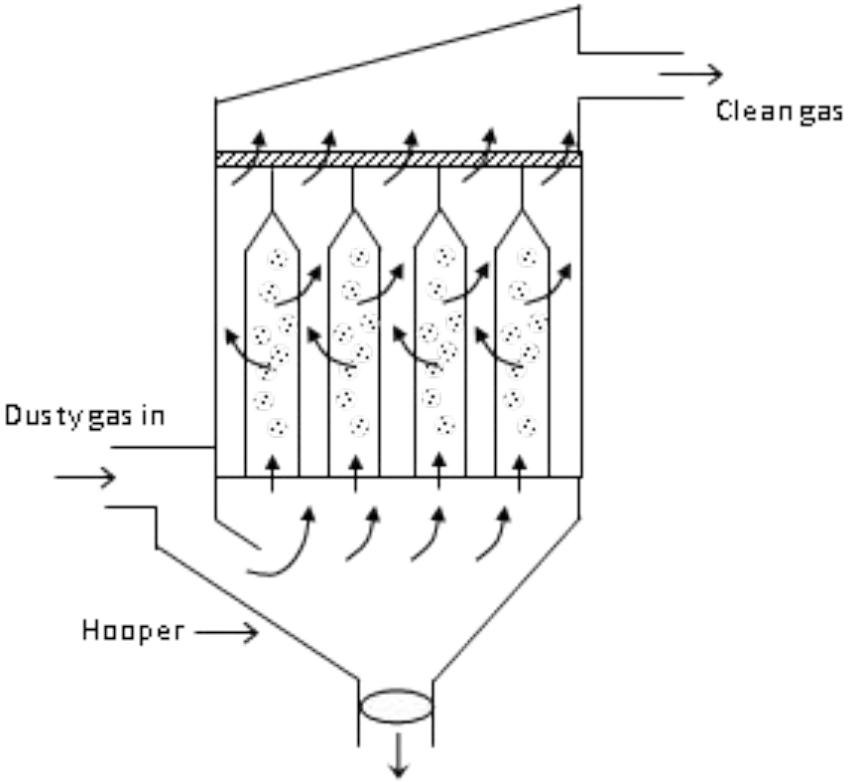


Fig: 3.29 Baghouse Filter

Advantages:

- Very high efficiency
- Retention of fine particles
- Collection of particles in dry form
- Relatively low pressure drop

Disadvantages:

- Large space require
- High construction cost
- Operation can be possible when the temperature of the carrier gas is below 28.5^0C

Electrostatic Precipitator (ESP)

Electrostatic Precipitator (ESP) consisting of vertical wires placed in between parallel plates. A strong electric field is created between wire and the plates by impressing a high negative voltage on the wires (as more as 1KV to 50 KV). The intense field created near the wire causes **corona discharge** ionizing gas molecules in the air stream. The negative ions and free electrons thus created move towards the plates and on the way some attach themselves to the particulate matter. The particles now carry a charge, which causes them to move under the influence of the electric field to the surface of the plates. They are removed from the collection electrode either by gravitational forces or by flashing the collecting plates with liquid.

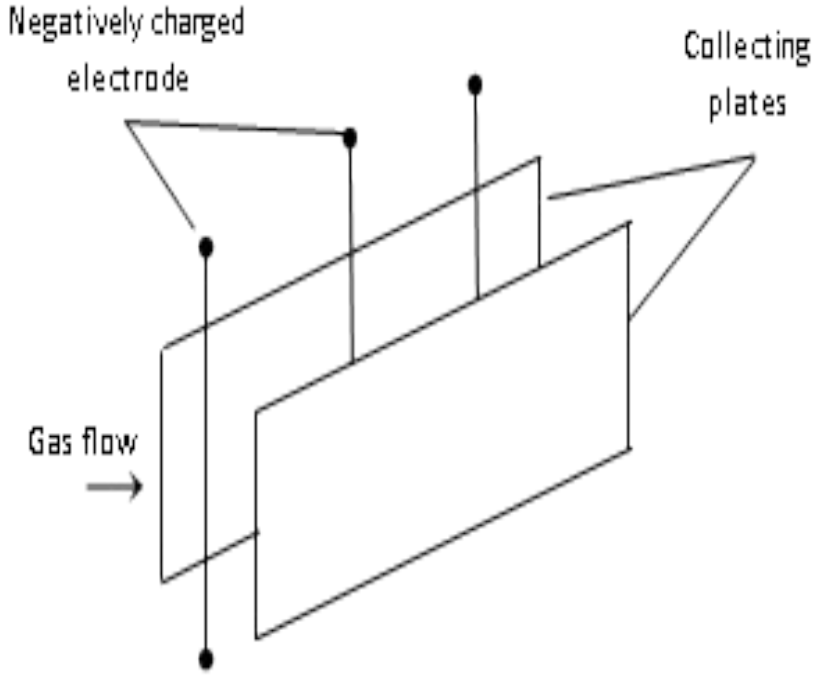


Fig: 3.30(a) Electrostatic Precipitator

Advantages:

- Power requirement is less
- Economical & easy to operate
- 99% efficiency is obtainable
- Very small particles can be collected in wet or dry forms

Disadvantages:

- High initial cost
- Large space require
- Safeguard of operating person from high voltage is necessary

Catalytic Converter

Most modern car equipped with "**three-way catalytic converter**". The 'three way' refers to that the device (catalytic converter) converts three harmful compounds in car exhaust into the harmless compounds. These harmful compounds are carbon monoxide (CO), volatile organic carbon (VOC) and Oxides of Nitrogen (NOx).This conversion takes place with the help of two different types of catalysts – **reduction catalyst** and **oxidation catalyst.** Usually, **platinum, rhodium** and **palladium** are used as catalysts.

Catalytic Converter

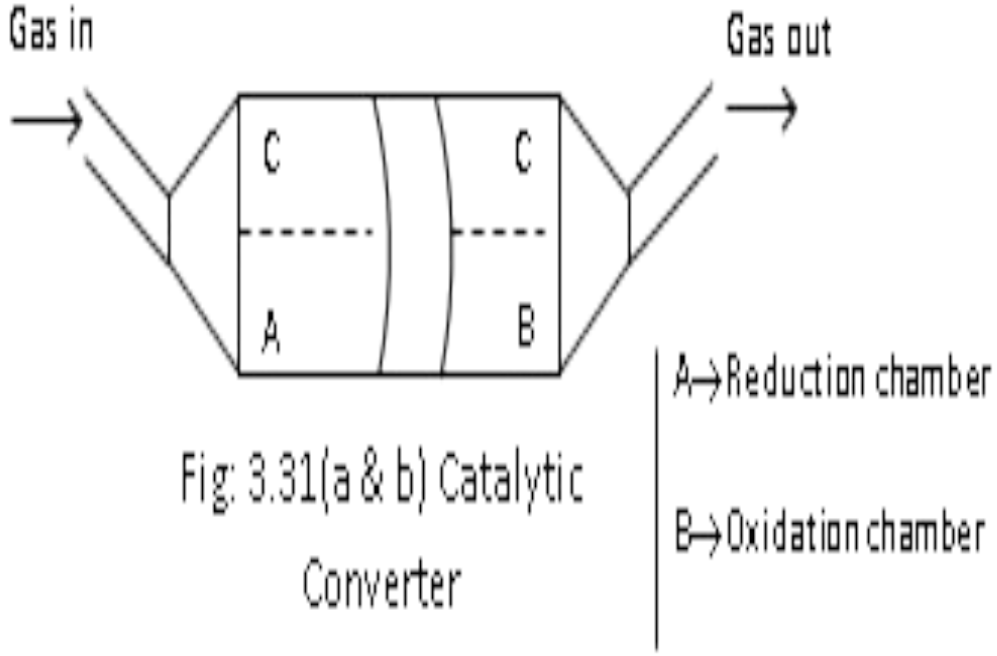
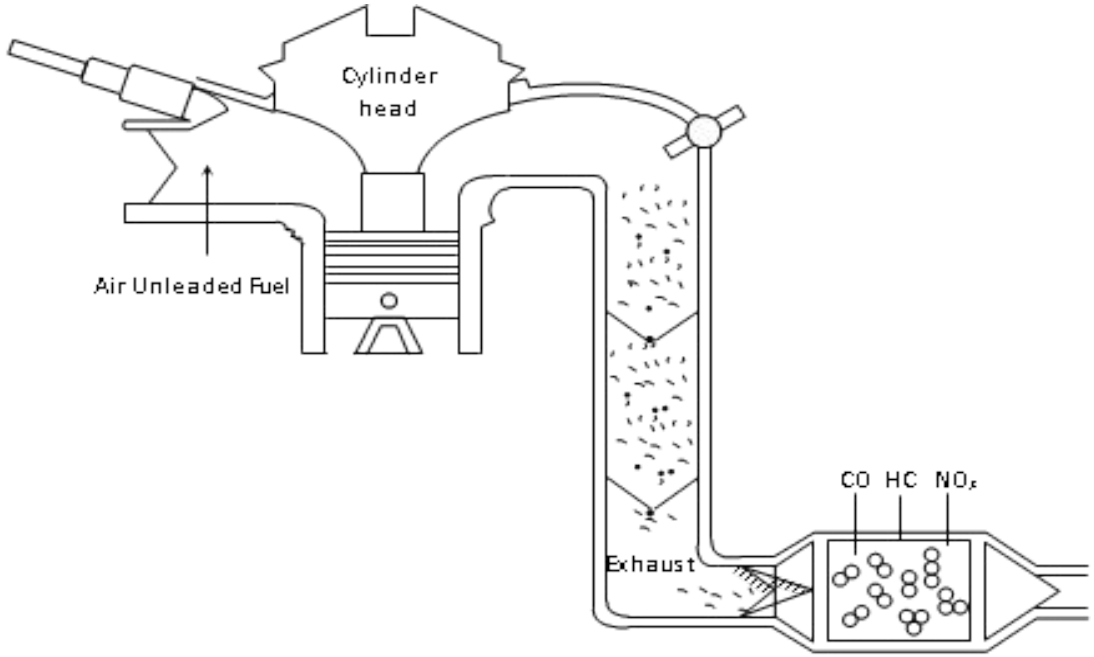


Fig: 3.31(a & b) Catalytic Converter



Reduction

The first step is the reduction step. Here, platinum and rhodium are used as catalyst. In this step, oxides of nitrogen specially nitric oxide (NO) and nitrogen dioxide (NO2)are converted to harmless molecular nitrogen (N2).

$$2NO \rightarrow N_2 + O_2$$

$$2NO_2 \rightarrow N_2 + 2O_2$$

Oxidation

The second step of the conversion is oxidation step. Here, **platinum** and **palladium** are used as catalyst. In this step, carbon monoxide (CO) and volatile organic carbon (VOC) are converted to carbon dioxide (CO2).

$$2CO + O_2 \rightarrow 2CO_2$$

$$HC + O_2 \rightarrow CO_2 + H_2O$$

Control System

The third stage of the catalytic converter is control stage. In this stage, **air to fuel** ratio is controlled with the help of **oxygen sensor**. This sensor is placed at the upstream of the catalytic converter and provide signal to the engine about the concentration of oxygen present in the exhaust. The engine then increases or decreases the oxygen concentration in the exhaust by adjusting air-to-fuel ratio.

Advantages:

- Reduce the concentration of polluted gas emitted from the car engine.
- Small size and easily accommodate inside the car.

Disadvantages:

- High cost
- Maintenance cost is also high
- High temperature is required for the proper operation
- At the time of starting (of car), it does almost nothing to reduce the pollution in the exhaust.

Ventury Scrubber

It is a high energy wet scrubber with a good efficiency. In this device, the particulate laden stream is directed through a ventury tube at a velocity of 60 − 100 mt/sec. Water sprays are introduced just ahead of the throat of ventury scrubber.

Through the throat of the ventury scrubber the scrubbing liquid is injected to the inward direction. The velocity of this liquid (usually water) is low as compare to the velocity of gas containing particulate matter. Due to the velocity difference between the particles and the droplets of the water (scrubbing liquid), the particles are impacted against the slow moving droplets. Then the gas-liquid mixtures are collected at end part of the Ventury Scrubber. After that, this collected mixture is directed to a separation device such as cyclone separator where particulate matters are separated from the gas stream.

Advantages:

- Low initial cost
- High collection efficiency
- Applicable for high temperature
- Able to separate both gas & particulate

Disadvantages:

- High power consumption
- High maintenance cost
- Wet disposal of the collected material

Ambient air Quality Standard Prescribed by Central Pollution Control Board

Sl. No.	Category	Limits in µg/NM^3			
		SPM	SO2	NOx	CO
1.	Industrial area	500	120	120	5000
2.	Residential area	200	80	80	2000
3.	Sensitive area	100	30	30	1000