

# Wet Scrubbers

L-29

Wet scrubbers

**Air Pollution and Control  
(Elective-I)**



# Wet Scrubbers

## Scrubbers

- Scrubbers are devices that remove particulate matter by contacting the dirty gas stream with liquid drops. Generally water is used as the scrubbing fluid. In a wet collector, the dust is agglomerated with water and then separated from the gas together with the water.



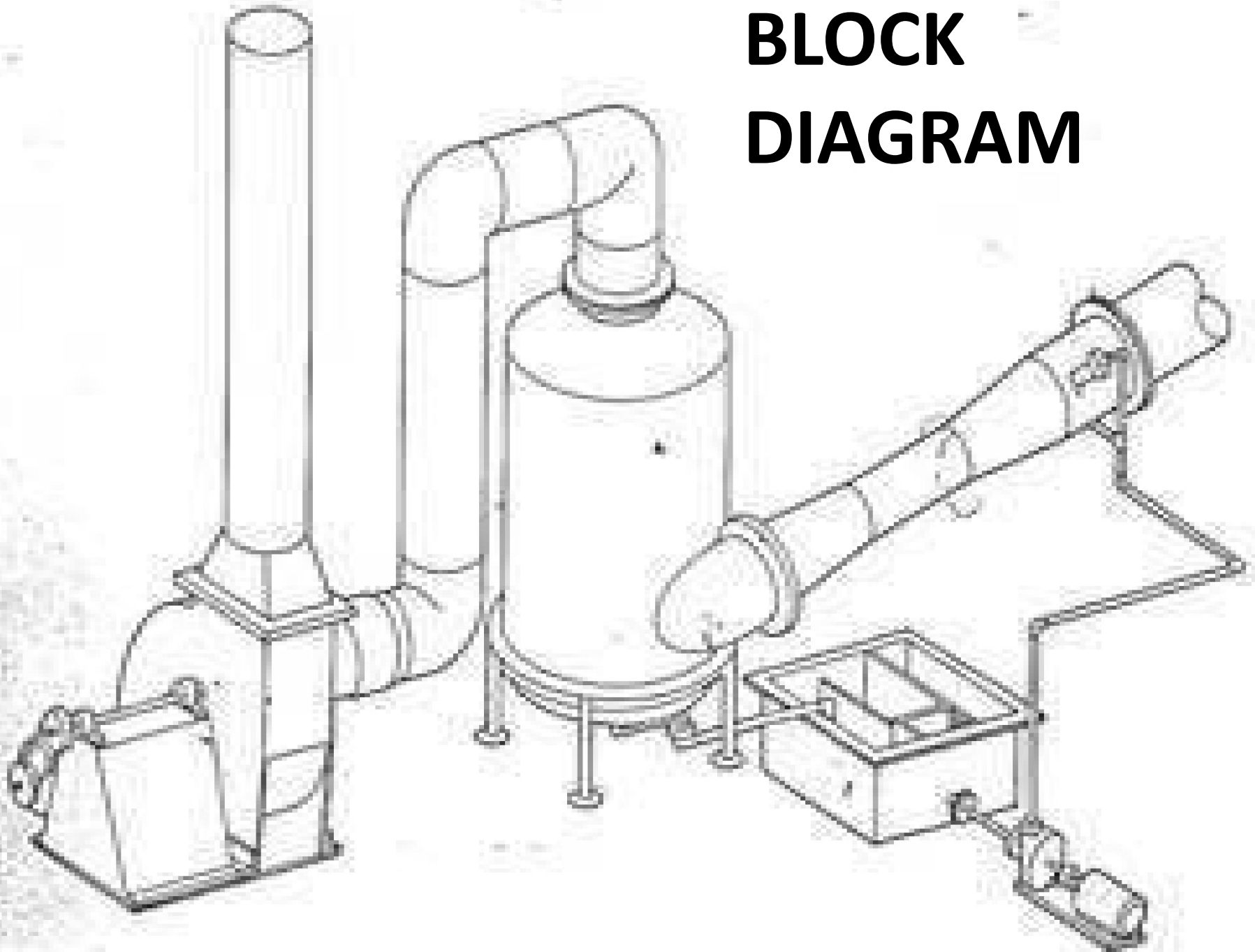
- The mechanism of particulate collection and removal by a scrubber can be described as a four-step process.
  - i) **Transport** : The particle must be transported to the vicinity of the water droplets which are usually 10 to 1000 times larger.



- **ii) Collision :** The particle must collide with the droplet.
- iii) Adhesion :** This is promoted by the surface tension property.
- iv) Precipitation:** This involves the removal of the droplets, containing the dust particles from the gas phase.
- Collection mechanism consists of combination of many mechanisms



# BLOCK DIAGRAM



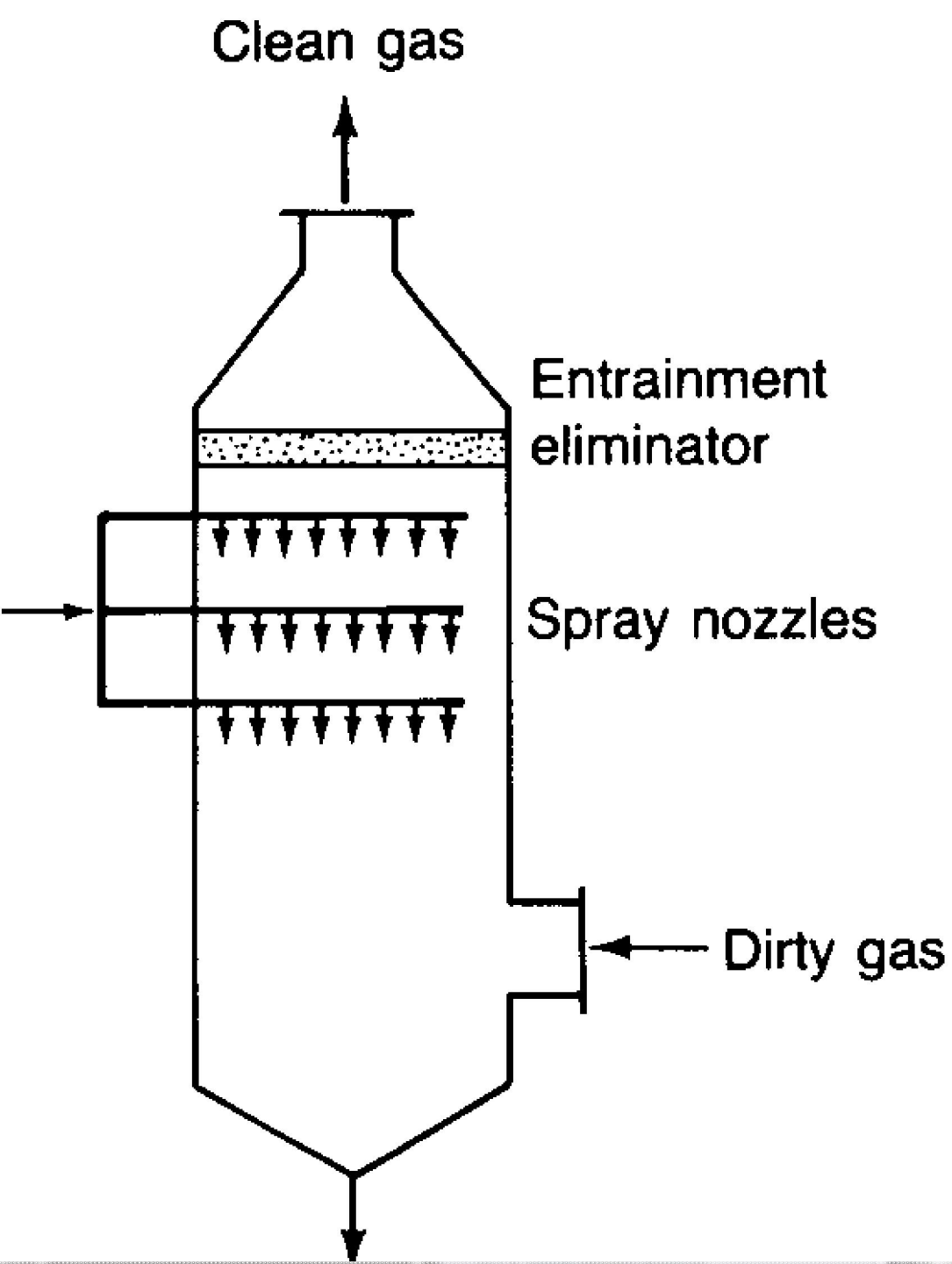


# Wet Scrubbers

## Types of scrubbers

- i) Spray towers.**
- ii) Venturi scrubbers.**
- iii) Cyclone scrubbers.**
- iv) Packed scrubbers.**





# 1. Spray Tower

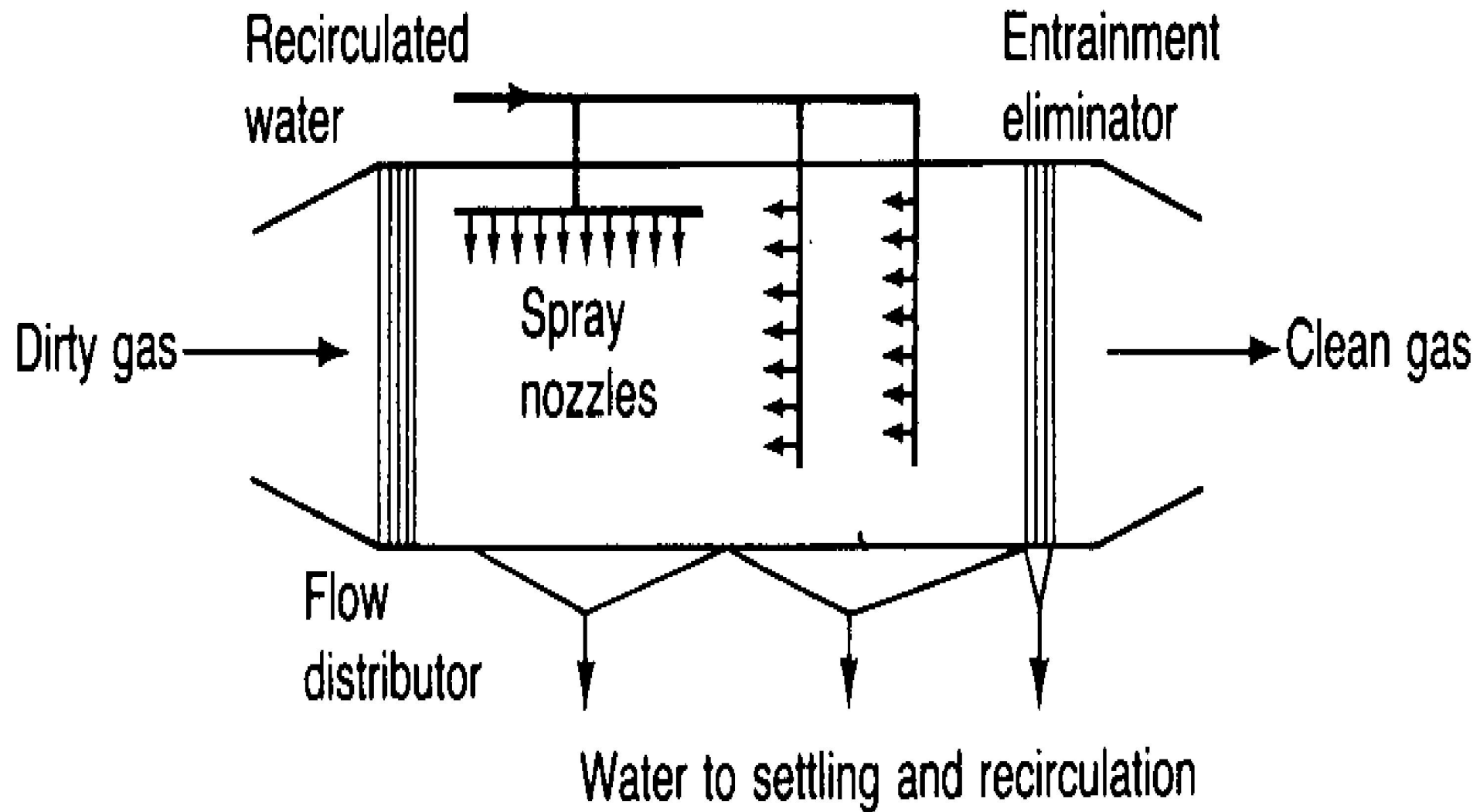




- Can be used for removing both particulates and gaseous contaminants.
- Less pressure loss.
- Can handle large volume of gases
- Gas flows upwards, entrained particles colloid with droplets sprayed across the flow passage and liquid droplets containing the particles settle by gravity to bottom of the chamber.



# Horizontal Flow Spray Tower



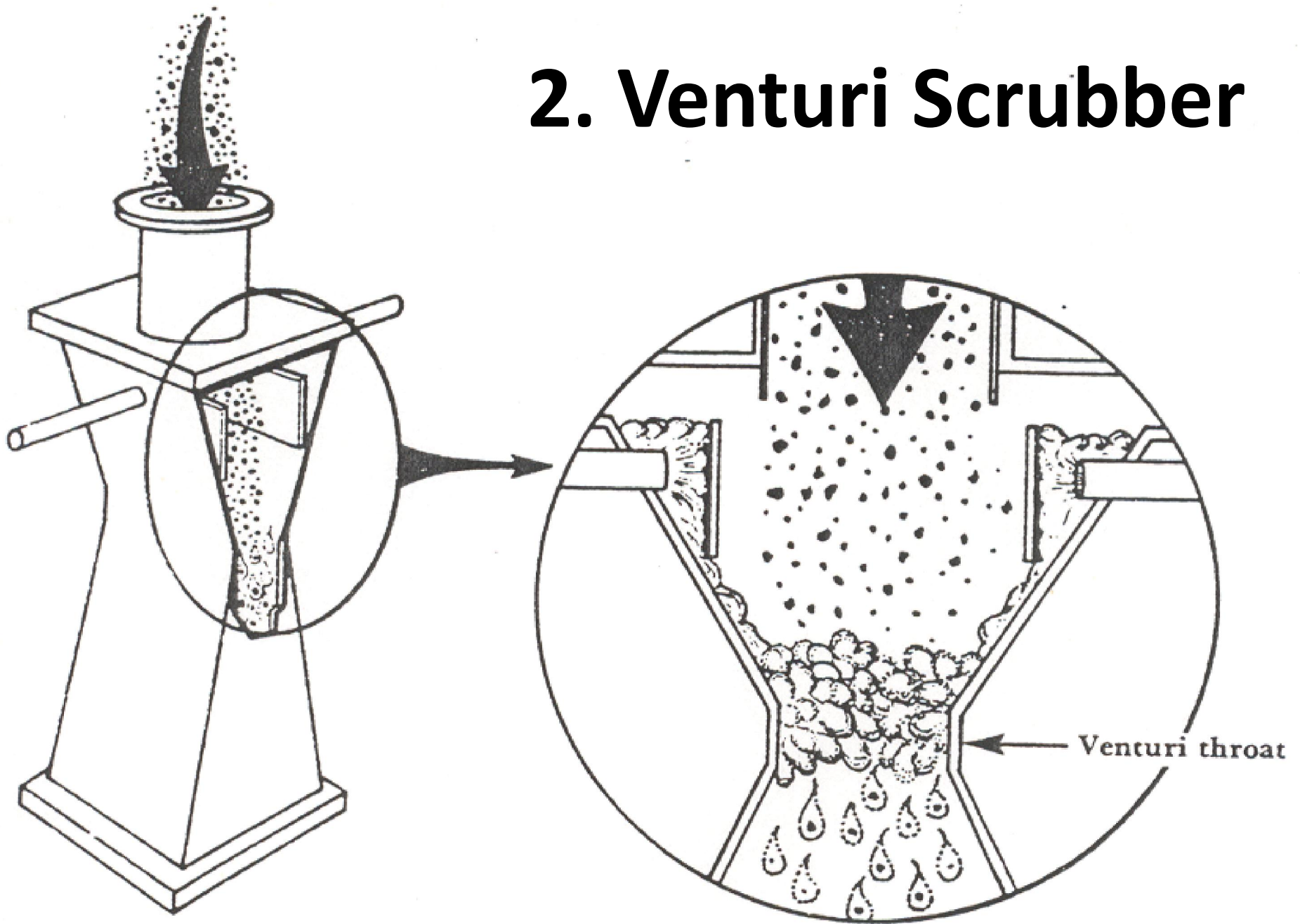
(b) Horizontal spray chamber (cross-flow)





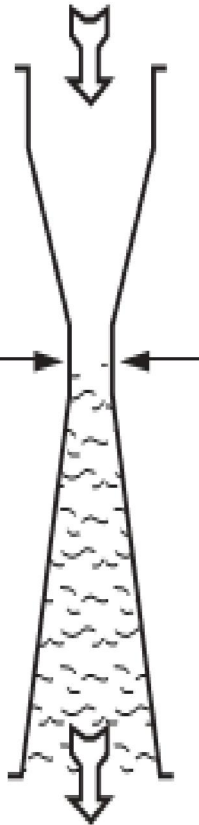


## 2. Venturi Scrubber





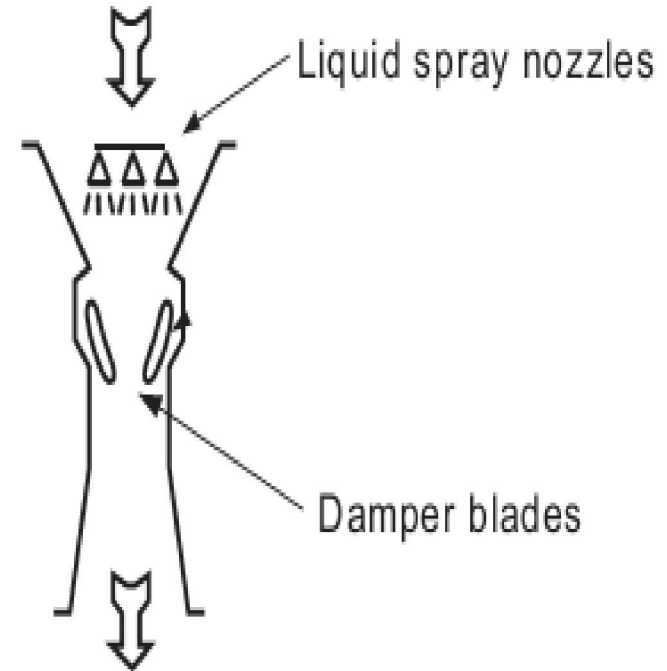
Dirty gas in



Gas and liquid  
to entrainment  
separator

Fixed Throat

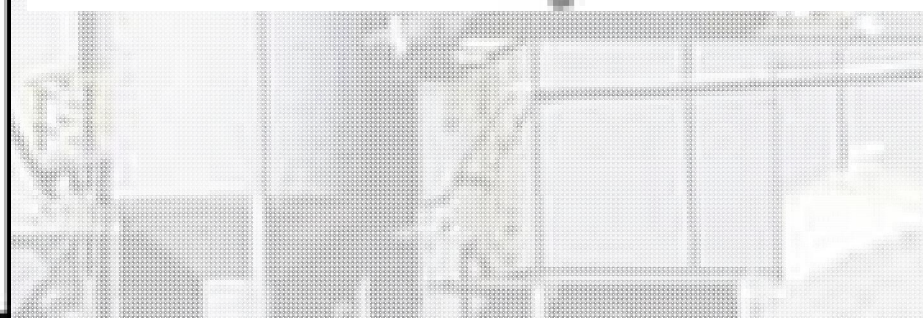
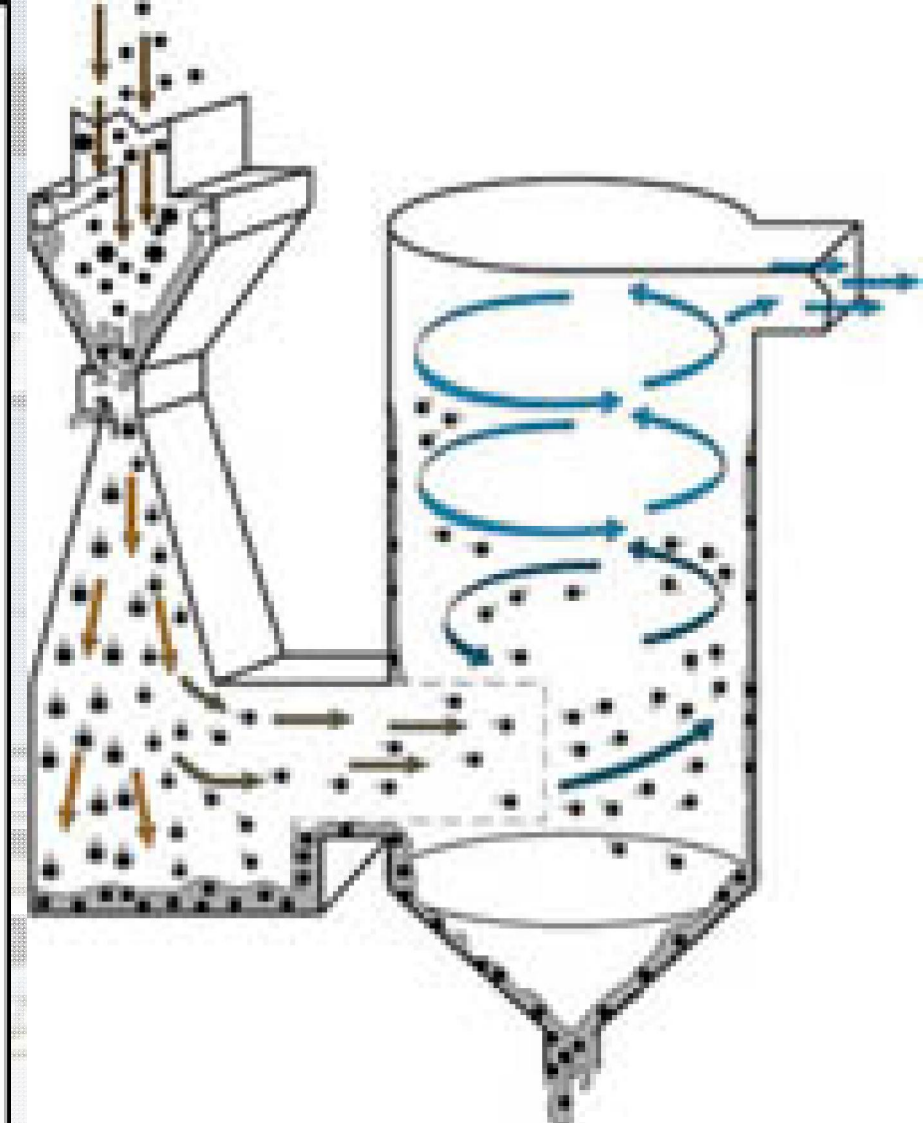
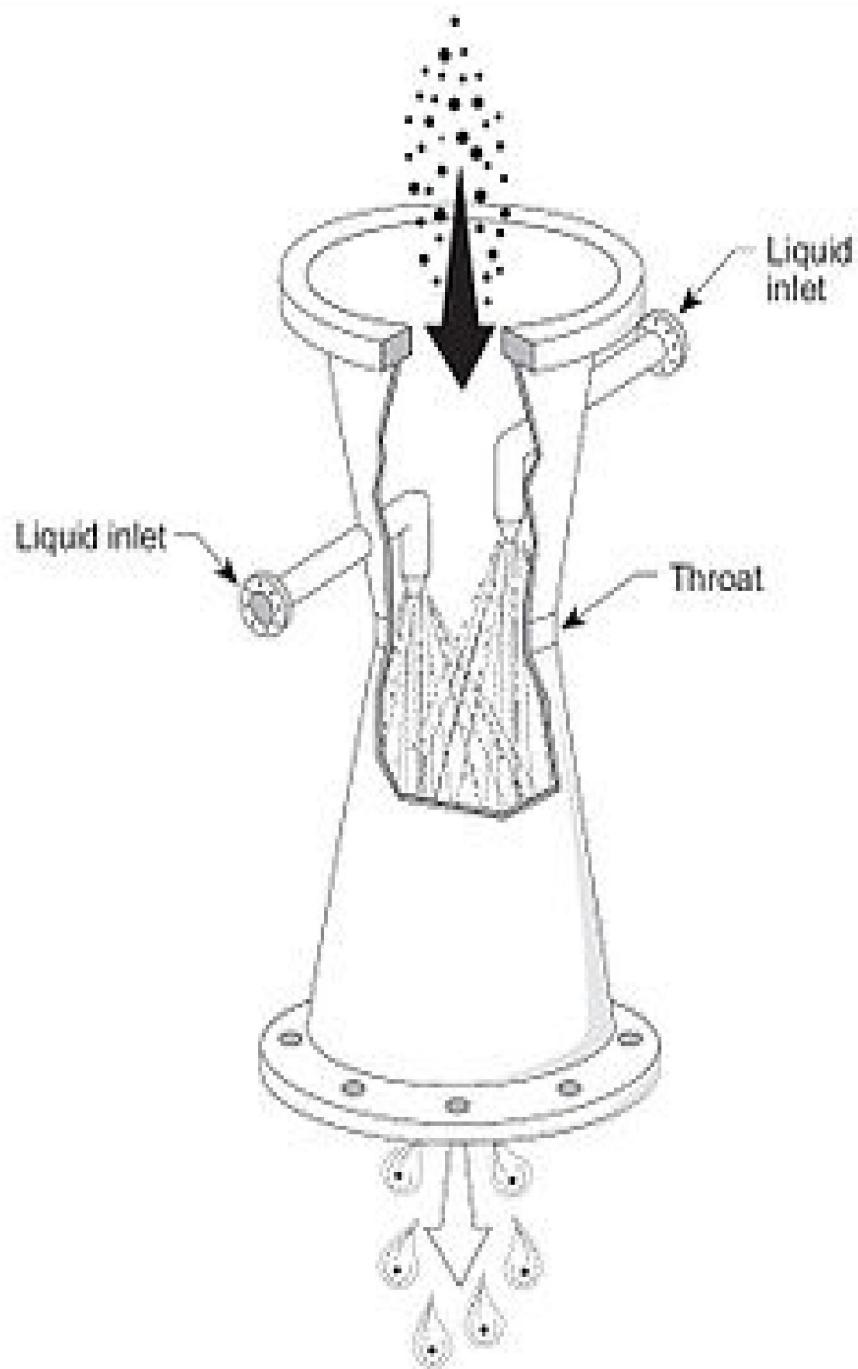
Dirty gas in



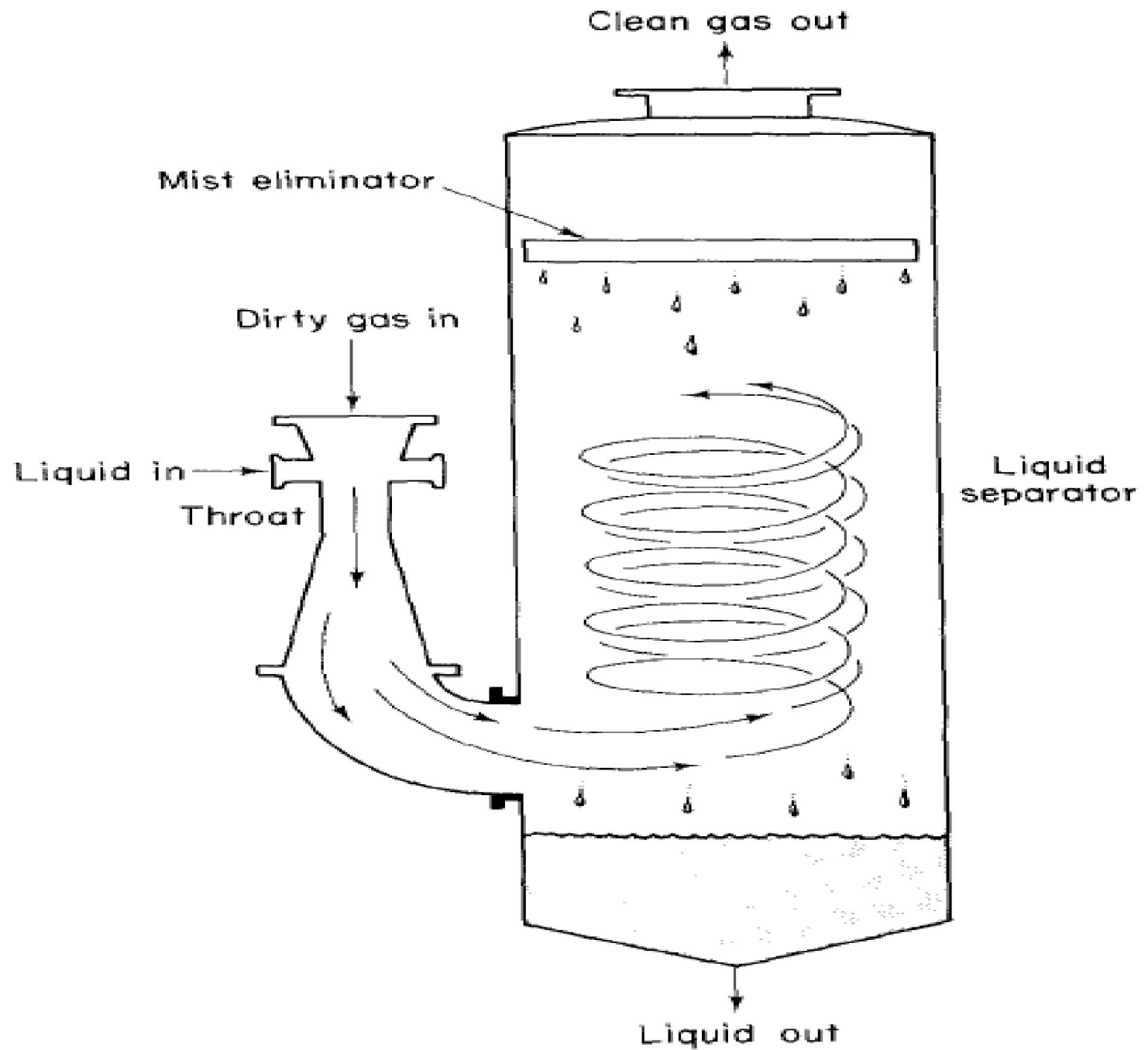
Gas and liquid  
to entrainment  
separator

Variable Throat with Dampers











# ***Vertical Venturi Scrubber***

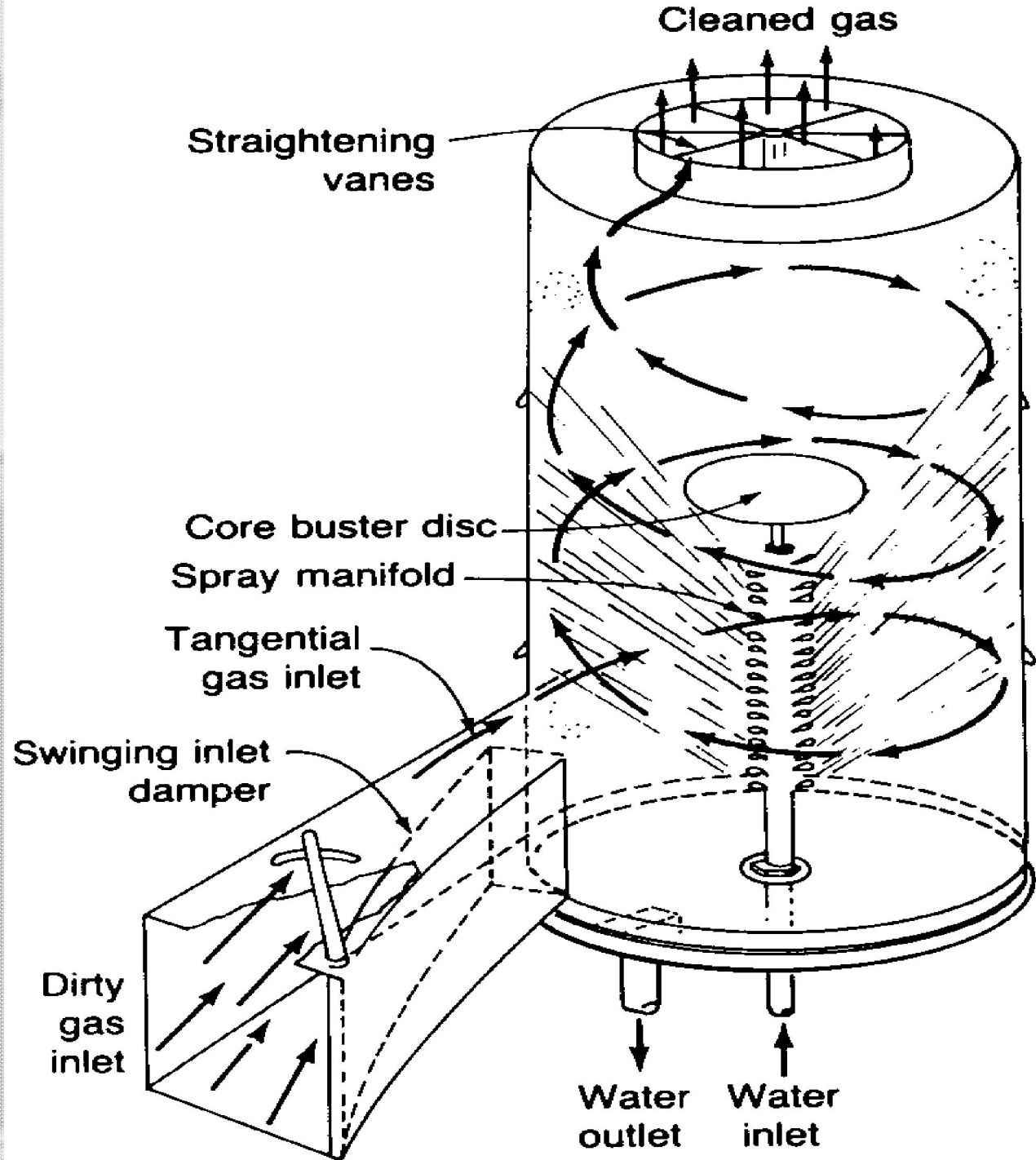




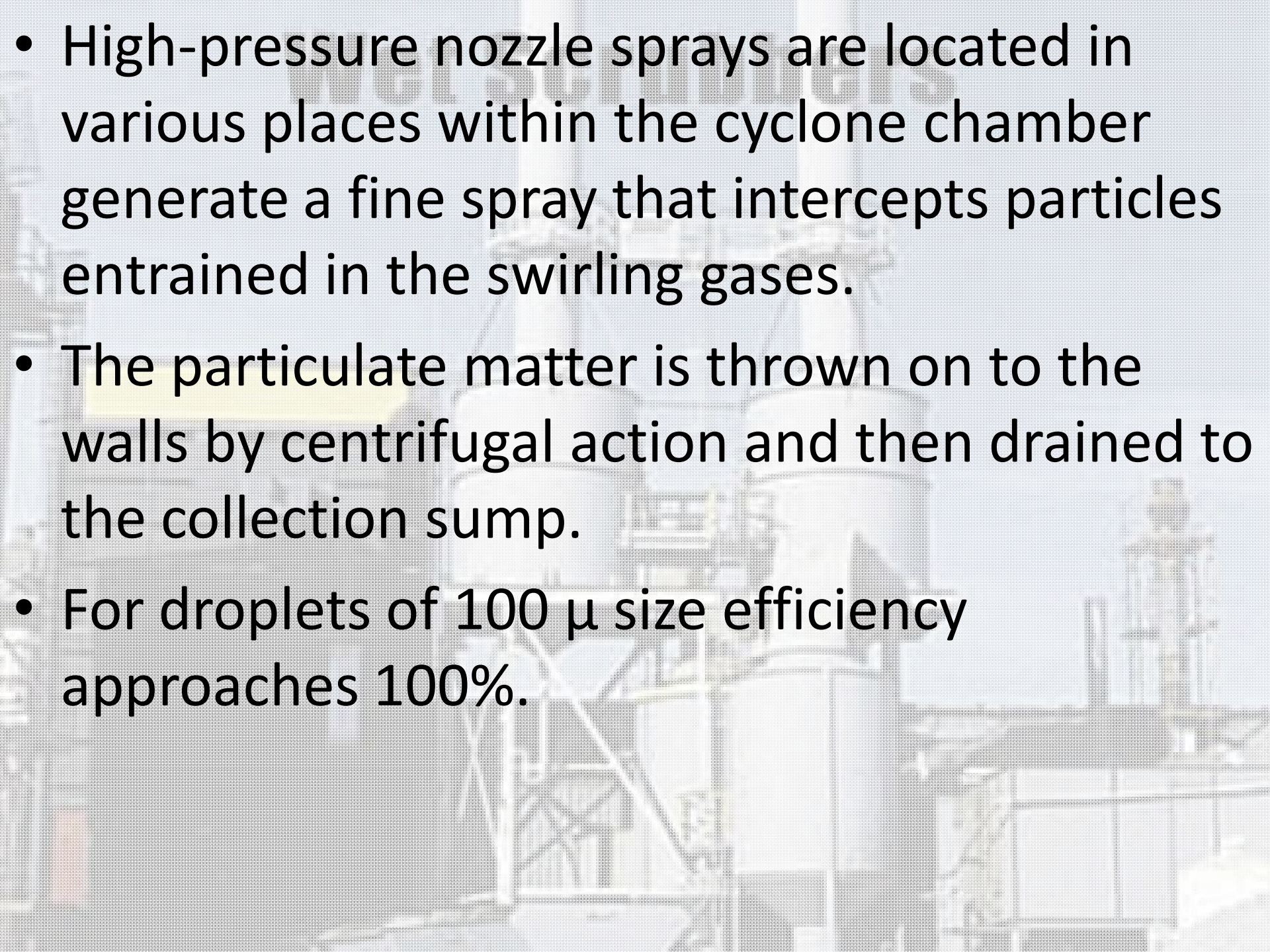
- Most efficient in removing particles in the range of  $0.5\ \mu$  to  $5\ \mu$ , that makes them specially effective in removing submicron particles associated with smoke and fumes.
- A coarse water spray is injected into throat, which gets atomized by high gas velocities.
- Liquid droplets colloid with particles in the gas stream and water particles fall down for later removal.
- Highly efficient for submicron removal i.e. 90% efficient.



# 3. Wet Cyclonic Scrubber





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- The background of the slide shows a large industrial facility, likely a power plant or refinery. A prominent feature is a tall, cylindrical cyclone separator, which is the central component of the system being described. The structure is made of metal and has various pipes and walkways attached to it. The sky is overcast, and the overall scene is industrial and somewhat hazy.
- High-pressure nozzle sprays are located in various places within the cyclone chamber generate a fine spray that intercepts particles entrained in the swirling gases.
  - The particulate matter is thrown on to the walls by centrifugal action and then drained to the collection sump.
  - For droplets of  $100\ \mu$  size efficiency approaches 100%.



# 4. Packed scrubber

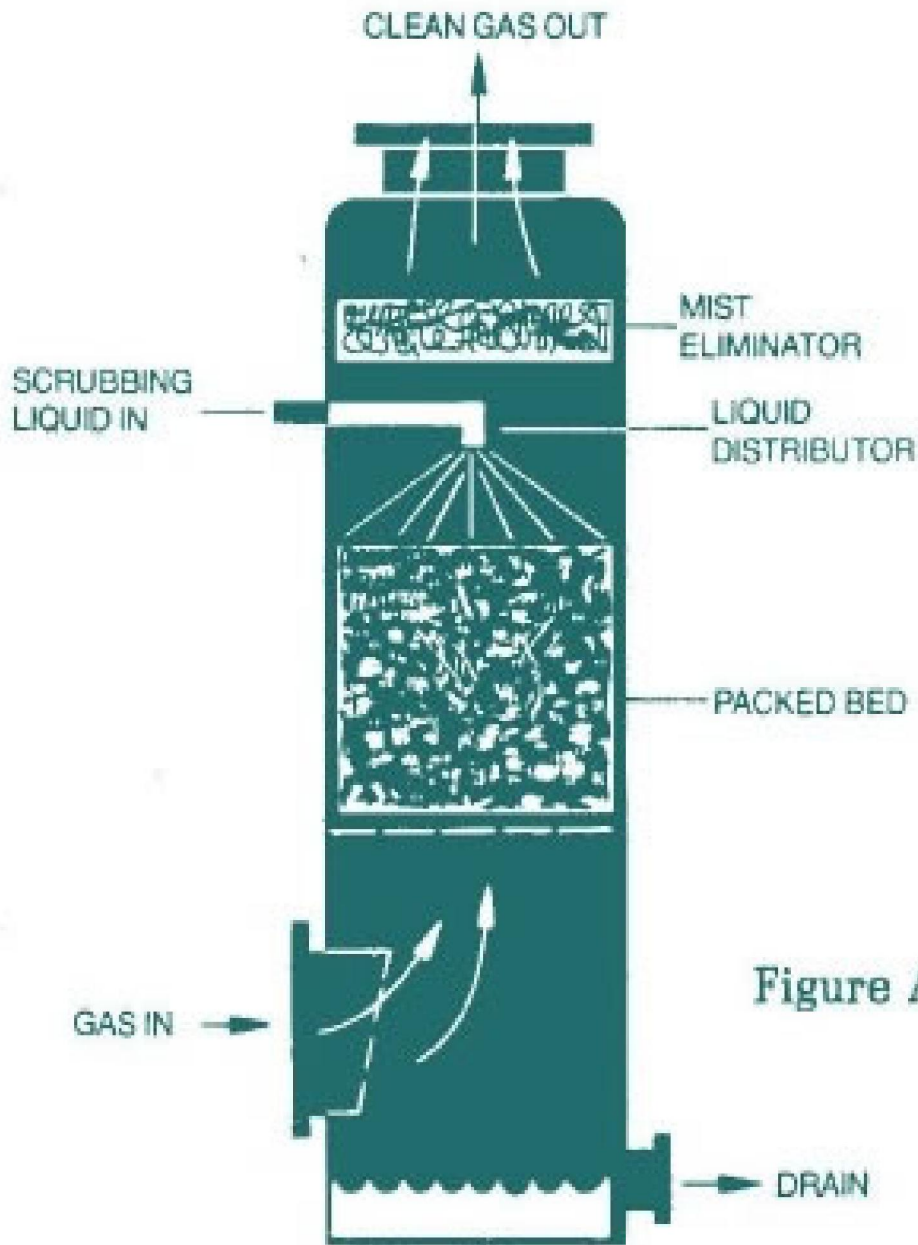
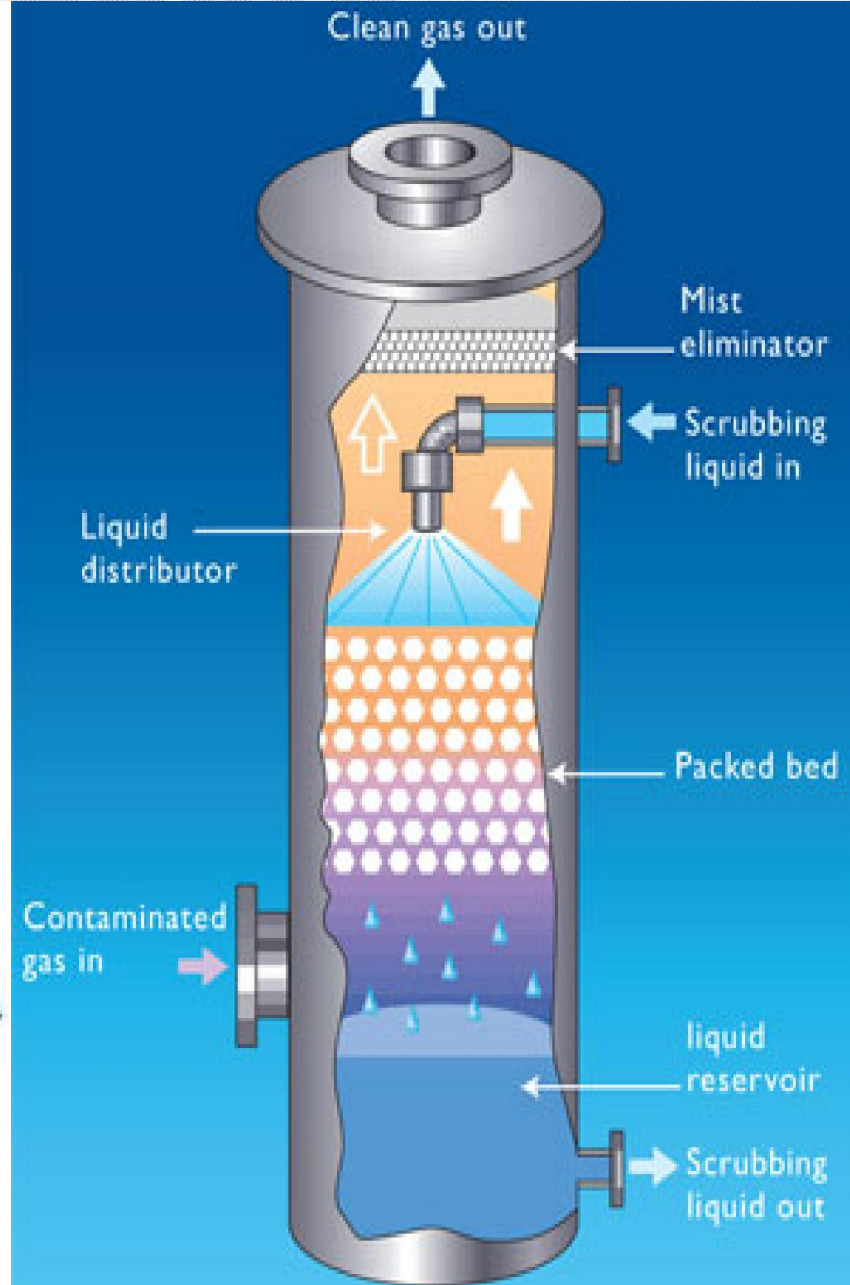


Figure A





# ***Packed Bed Scrubber***





- The exhaust stream being treated enters the bottom of the tower and flows upward over the packing material.
- Liquid is introduced at the top of the packing by sprays or weirs, and it flows downward over the packing material.
- As the exhaust stream moves up through the packing, it is forced to make many winding changes in direction, resulting in intimate mixing of both the exhaust gas and liquid streams.



# Wet Scrubbers

## Scrubbers

### 13.11.5 Advantages of Scrubbers

1. Low initial cost
2. Moderately high collection efficiency for small particles
3. Applicable for high temperature installations
4. They can simultaneously remove particulates and gases
5. There is no particle re-entrainment



# Wet Scrubbers

## 13.11.6 Disadvantages of Scrubbers

1. High power consumption for higher efficiency
2. Moderate to high maintenance costs owing to corrosion and abrasion
3. Wet disposal of the collected material.



# Applications of Scrubbers

- i) They're particularly useful in the case of a hot gas that must be cooled for some reason.
- ii) If the particulate matter is combustible or if any flammable gas is present, even in trace amounts, in the bulk gas phase, a scrubber is preferred to an electrostatic precipitator.



- **iii) Scrubbers can be used when there are waste water treatment systems available on the site, with adequate reserve capacity to handle the liquid effluent.**
- iv) Scrubbers are also used when gas reaction and absorption are required simultaneously with particulate control.**



# Theory Questions

Q1. *Write short notes on*

➤ Advantages and disadvantages of scrubbers

Q2. Explain working principle of scrubbers and explain spray tower.

Q3. *Draw sketches for*

1. Venturi scrubber.

2. Cyclonic scrubbers.