CHAPTER 4

WET SCRUBBERS

Introduction

- Gas-particle mixture is contacted with a liquid (water) and thereby particles are removed from gas stream…
- Wetted particle can easily be removed from gas stream, because;
  - Its terminal settling velocit is increased because of increased mass of particle,
  - It can easily settle down as captured in larger water droplets,
  - It can easily agglomerate since it is wetted.
  - It can easily stuck on the inner surface of the equipment thereby being separated from gas stream…

Larger contacting surface area between particles and water droplets is needed for higher efficiency

Types of Wet Scrubbing

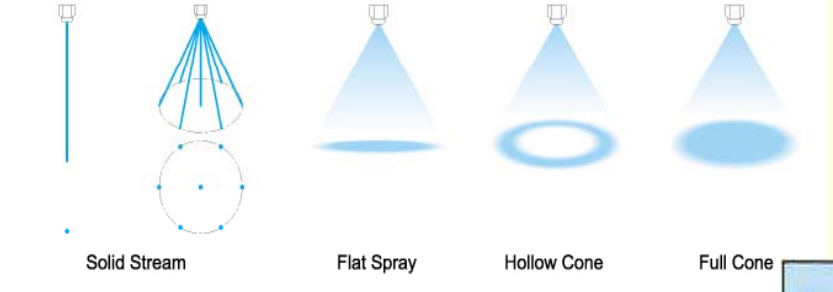
- Collecting media for particles is water droplets
  - **Target** is the water droplets or wetted surfaces
- Various solid materials or plate surfaces may be used as the collecting wetted surfaces in
  - **Packed towers** or
  - **Plated Towers**.

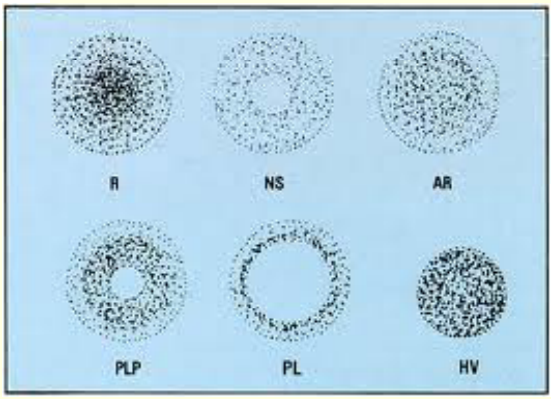
Targets (water droplets) in wet scrubber

- Water phase is divided into millions-billions-trillions of small **water droplets** and injected into gas-particle volume…
- Each particle is allowed to collide a water droplet so that it is captured in that water droplet and separated from gas phase…
- Then water droplets are separated from gas phase via a unit called **mist eliminator**…

Targets (water droplets) in wet scrubber

- Spray Patterns

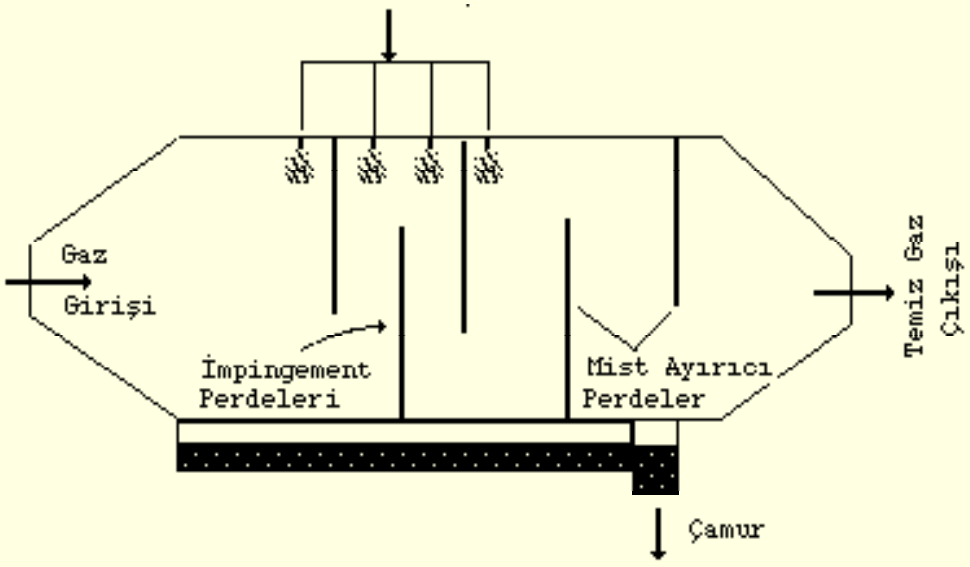




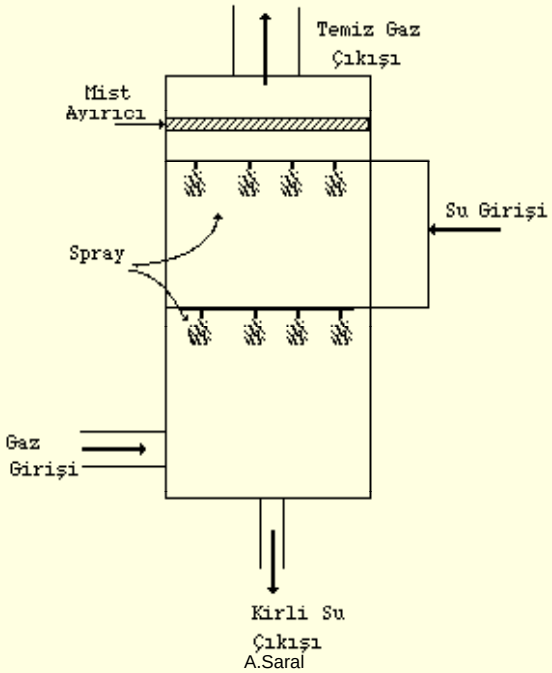
Types of Wet Scrubbers

- Spray wet scrubbers
- Venturi type wet scrubbers
- Packed tower wet scrubbers
- Cyclone type wet scrubbers

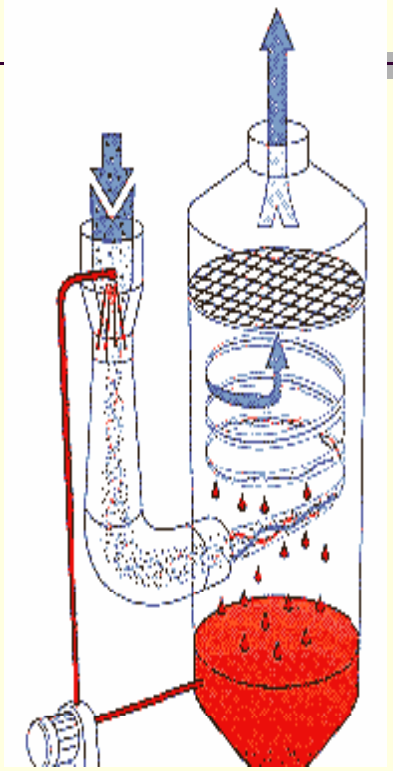
Spray type wet scrubbers



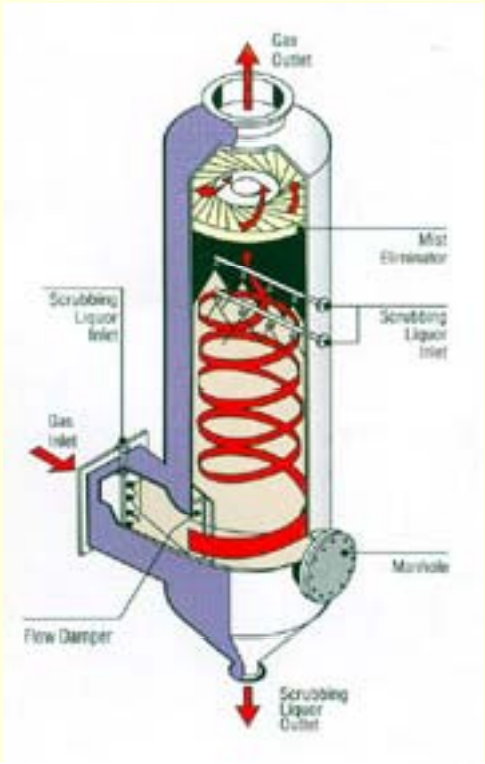
Packed tower type wet scrubbers



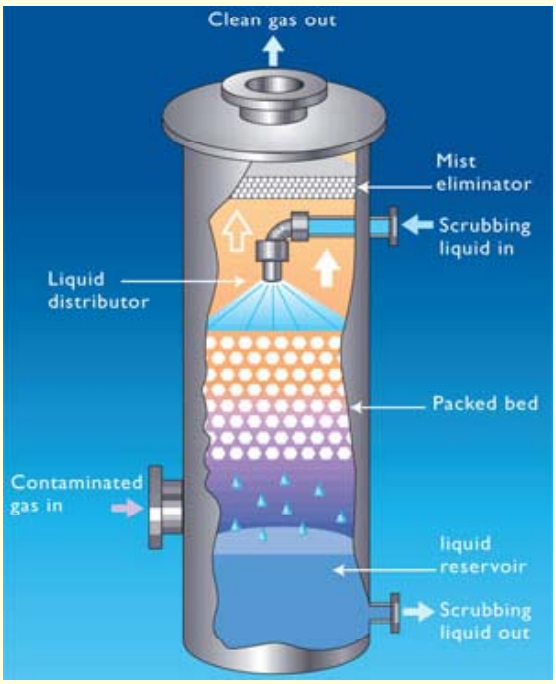
Venturi type wet scrubbers

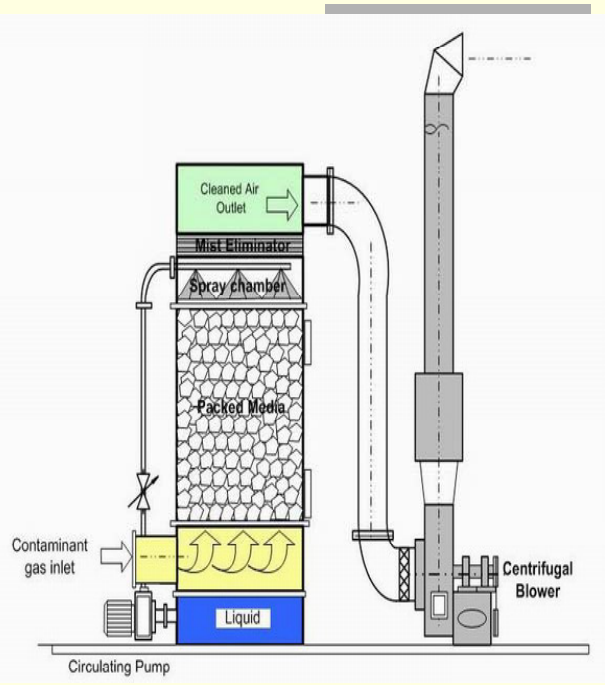


Cyclone type wet scrubbers



Packed tower wet scrubber





General Properties

- Energy is needed both for gas and liquid phase motions
  - Fan blower for gas phase and
  - Pumping for water phase
- Dust sludge is to be handled,
- Water phase must be injected into gas as small droplets as possible, thereby as higher number of droplets as possible

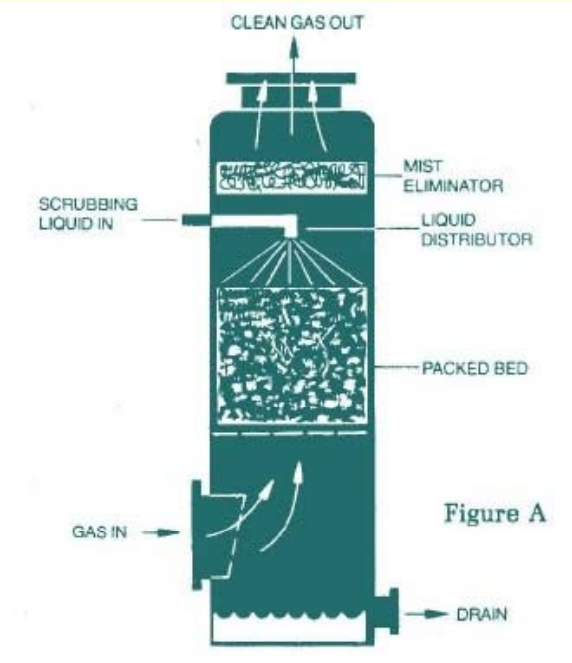


Figure A

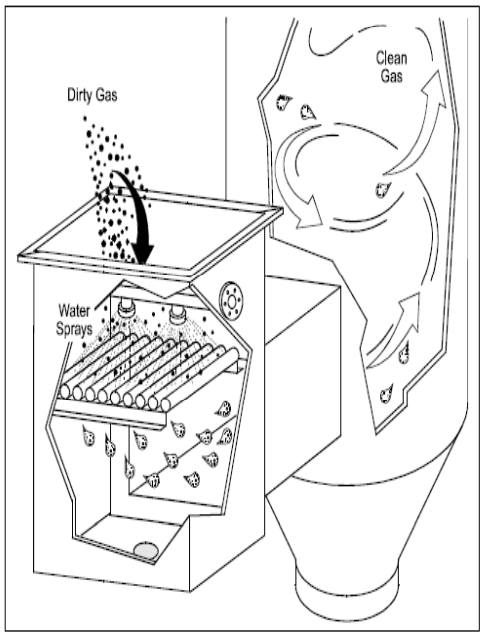


Figure 3-7. Venturi-rod scrubber

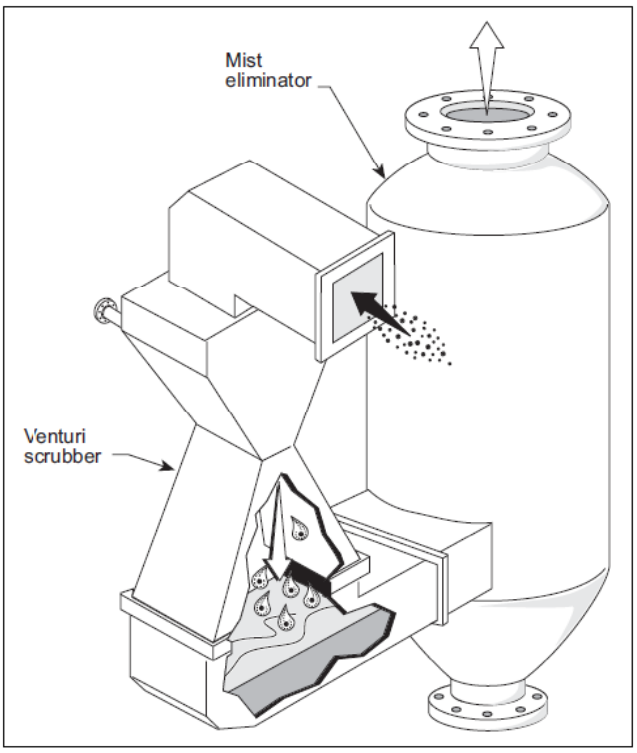


Figure 1-1. An example of a venturi scrubber design

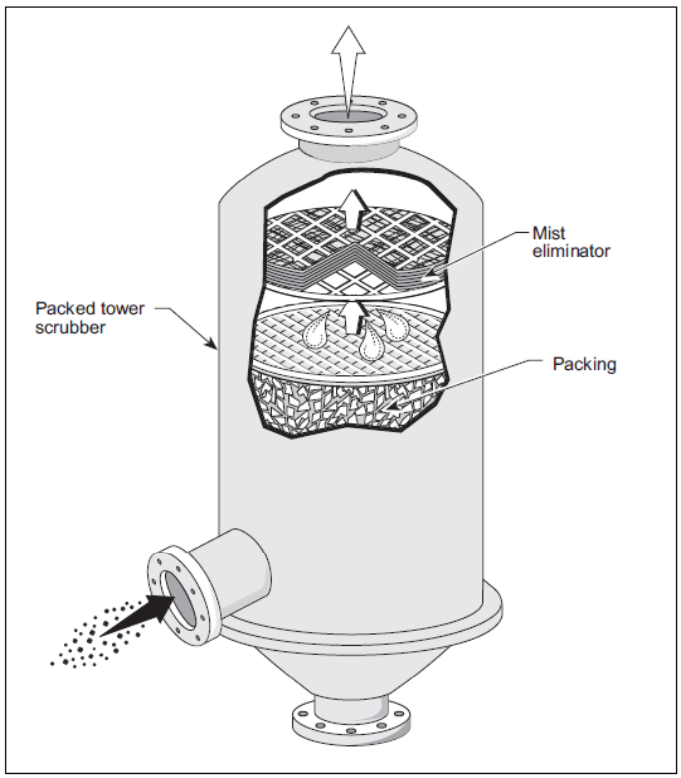


Figure 1-2. An example of a tower scrubber design

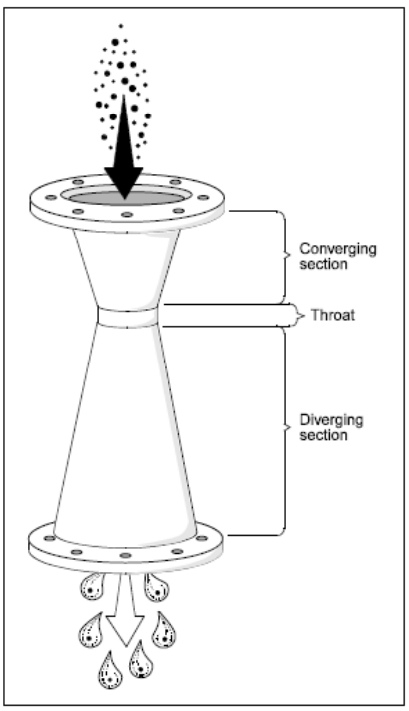


Figure 3-1. Venturi configuration

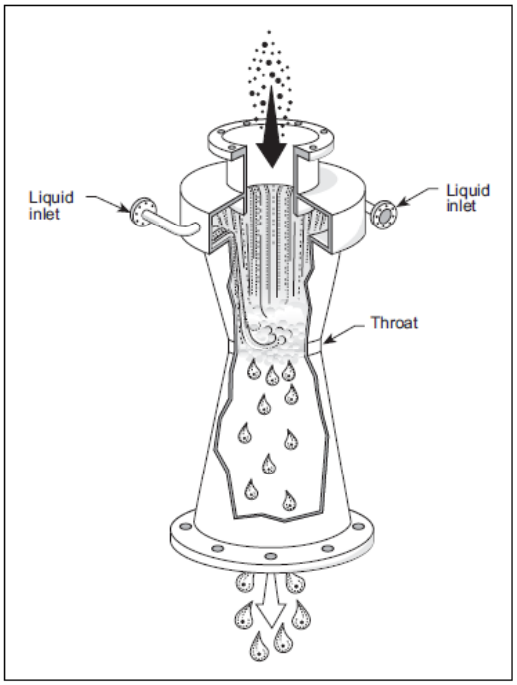


Figure 3-2. Venturi scrubber with a wetted throat

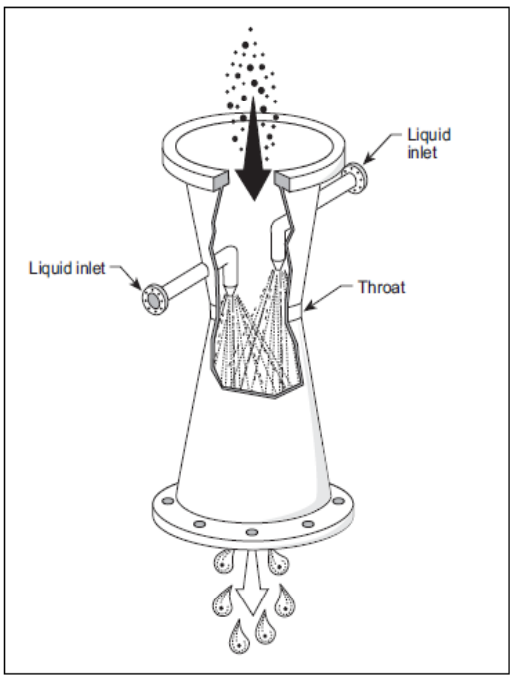


Figure 3-3. Venturi with throat sprays

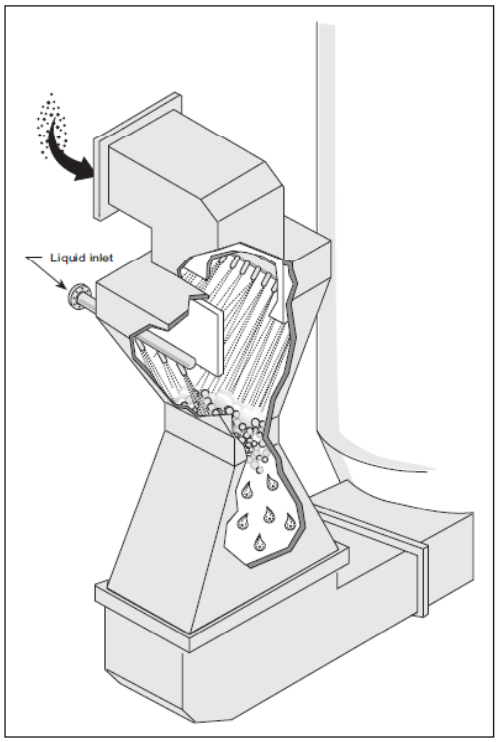


Figure 3-4. Spray venturi with rectangular throat

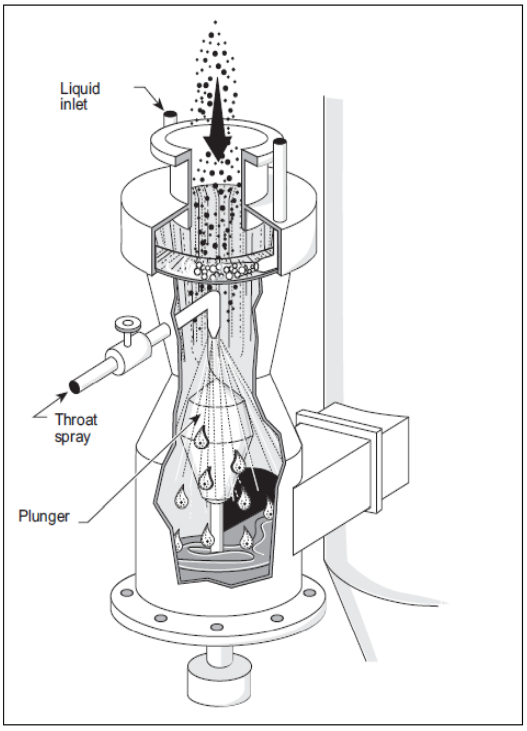


Figure 3-5. Adjustable-throat venturi with plunger

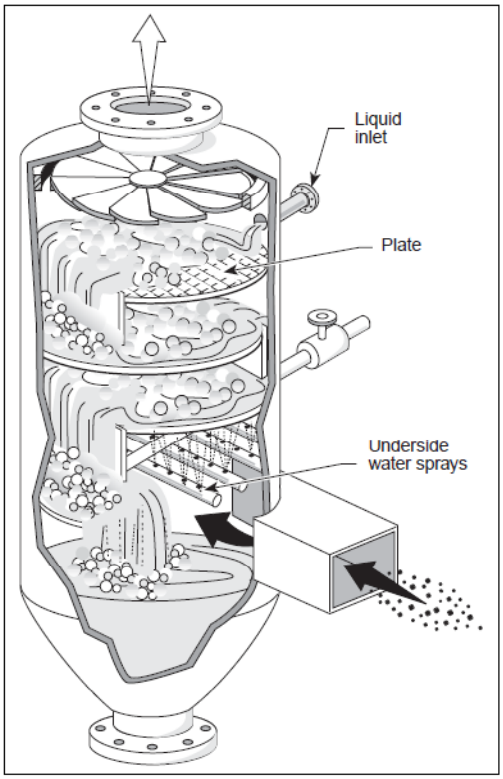


Figure 3-9. Plate tower

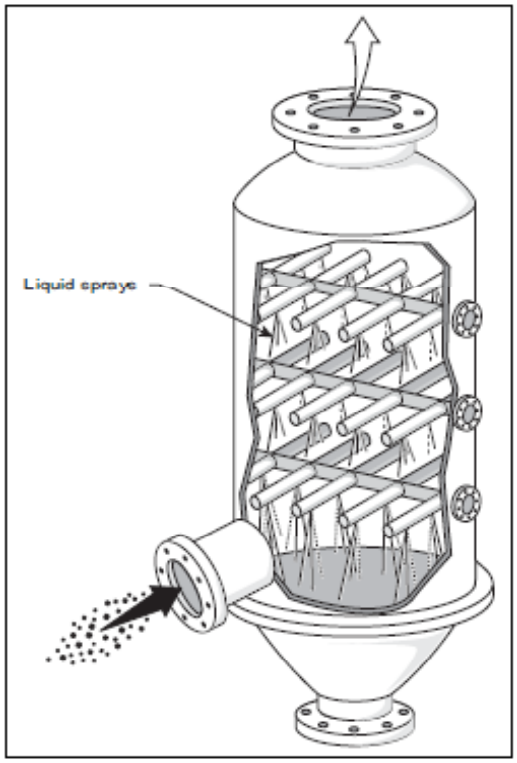


Figure 4-1. Countercurrent-flow spray tower

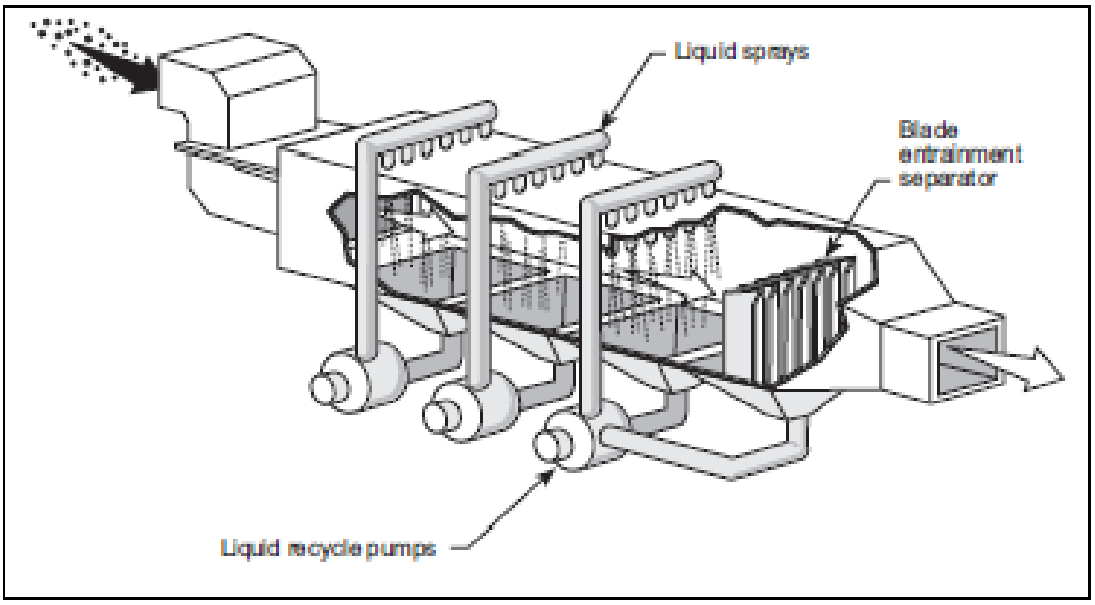


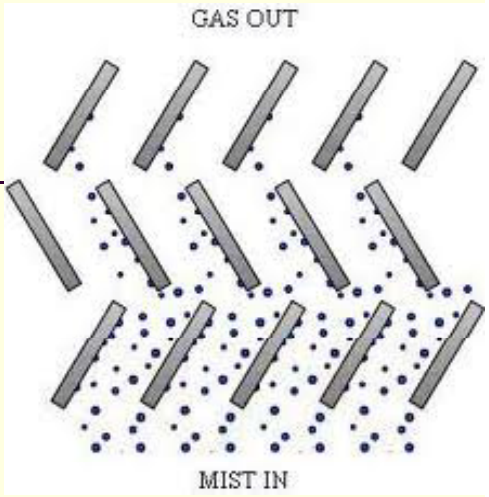
Figure 4-2. Crosscurrent-flow spray tower

So many different design geometries

- In all of different design geometries:
- **The principal aim is**:
- To bring the waste gas into contact with water phase in as large surface area as possible,
- For this to happen, we need a sufficient residence time and turbulence…
- After this id achieved, a second crucial step is to separate water droplets from gas stream…

Mist Elimination

- Plate Type Mist Eliminator:
  - for coarser droplets



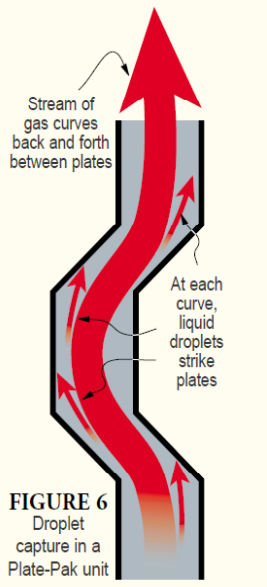
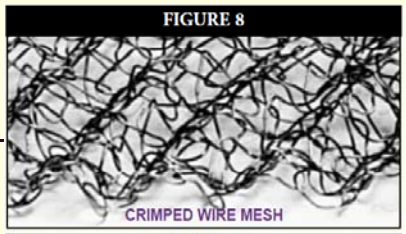
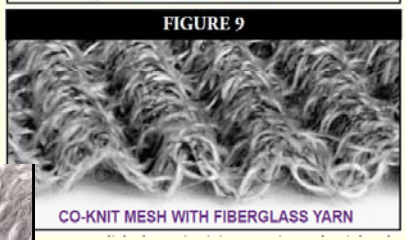


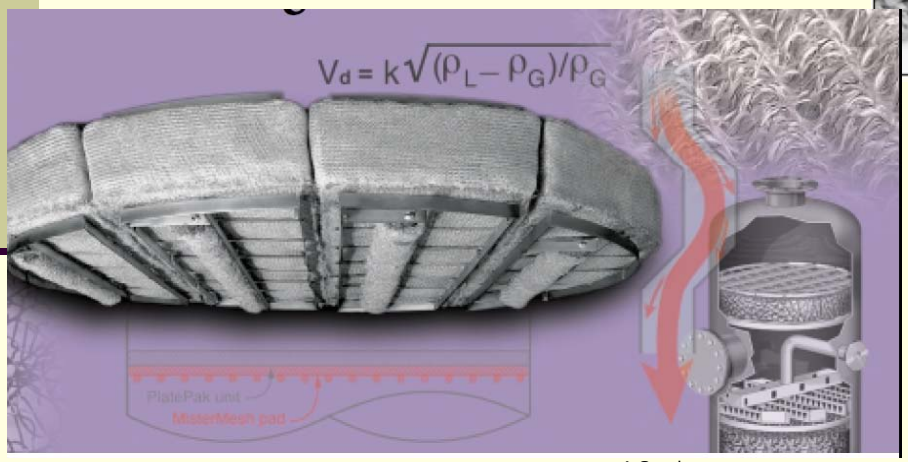
FIGURE 6 Droplet capture in a Plate-Pak unit

Mist Elimination

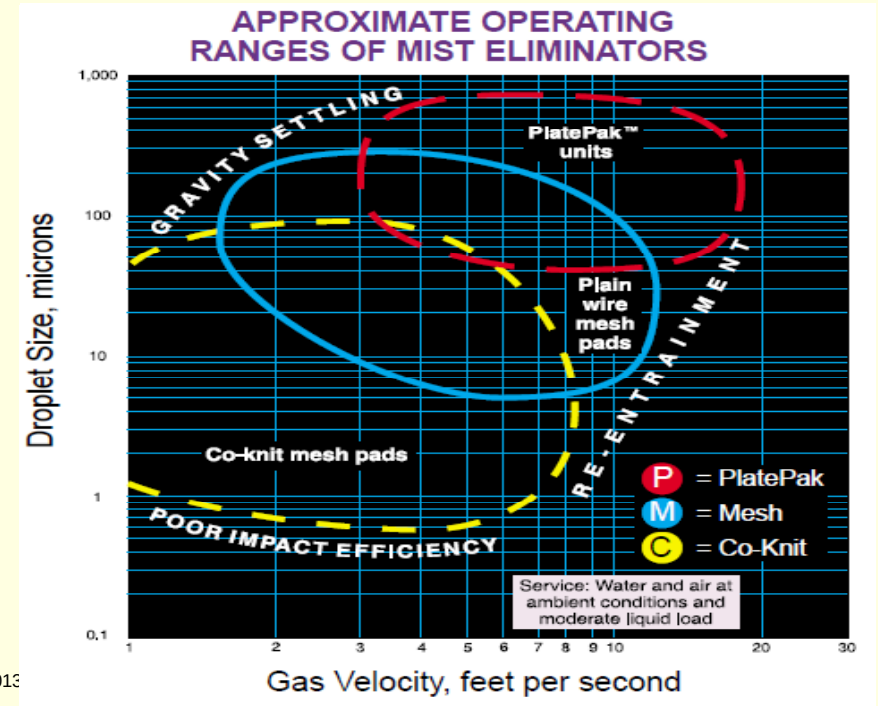
- Mesh Type Mist Eliminator:
  - for finer droplets



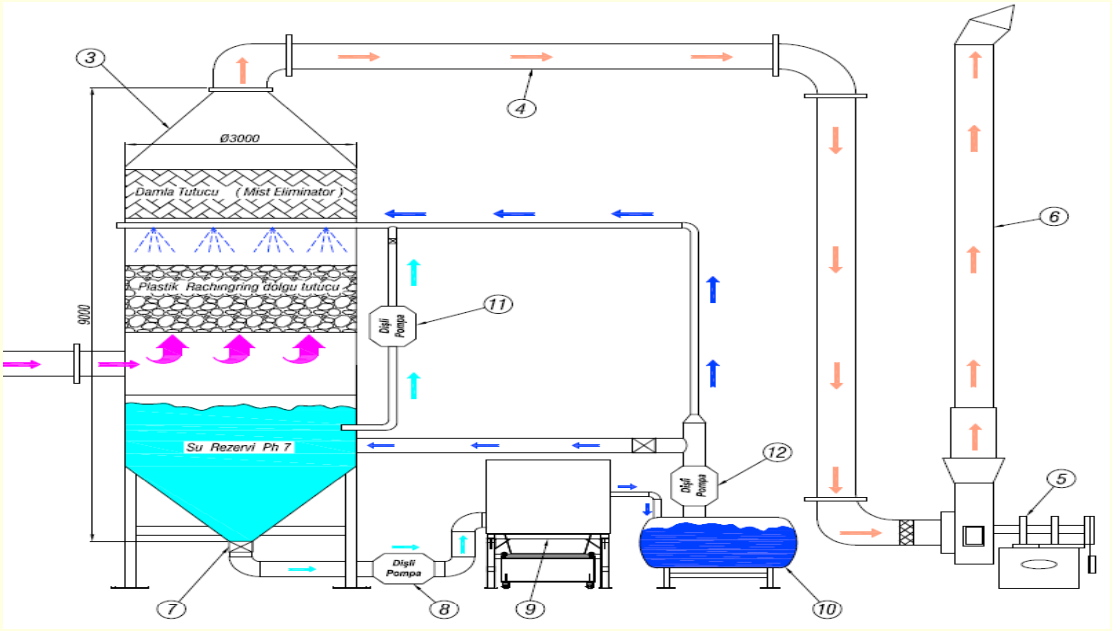




Mist Elimination



Sludge filtering and Removal process



Efficiency Modelling

- A particle may be captured when it collides a water droplet.
- Impaction between water droplets and particles is needed…
- But not all impactions mean capturing of particles…
- What we know,
- Increasing the number of impaction increases the chance of capturing particles

Impaction Number vs Efficiency

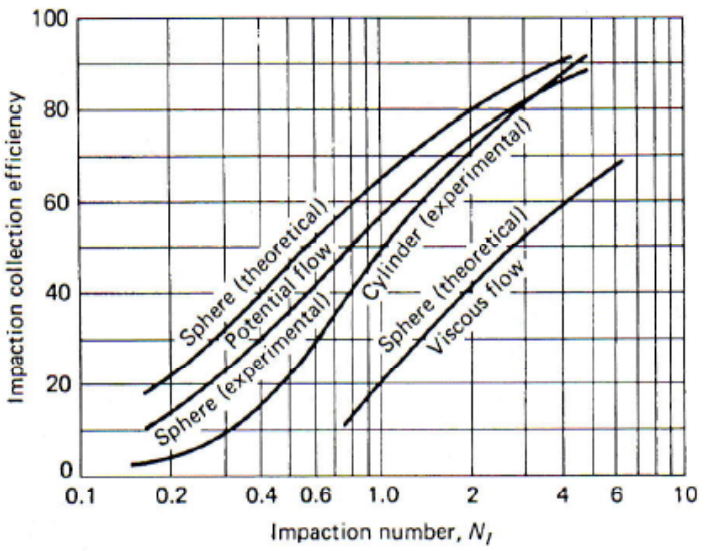


FIGURE 5-18 Theoretical and experimental impaction collection efficiencies for spheres and cylinders.

Size of Water Droplet vs Efficiency

- For a given amount of water flowrate into scrubber,
- As the water droplet size decreases… greater number of droplets are generated…Larger contacting surface area… Higher Efficiency…
- But much smaller droplets may behave like gas molecules in diffırion (brownian) motion…
- As the water droplet size increases… smallerr number of droplets are generated…smallerr contacting surface area… Lower Efficiency…

- Therefore **an optimum diameter for water droplets** is the case for a given particle diametyer

Size of Water Droplet vs Efficiency