Wet Scrubber Definition

A device that provides intimate contact between a contaminated air stream and a liquid stream to allow for transfer of gases, liquid, or solid contaminants from the air to the liquid.

Scrubber types are typically selected based upon achieving the highest contaminant removal while consuming the least amount of energy.

Reasons to use a Wet Scrubber

1. Captures Hazardous Air Pollutant (HAP) Chemicals
2. Soluble and/or reactive gases are present.
3. The pollutant cannot be easily removed in dry form.
4. Liquid droplets or mists* are present
5. Soluble or wetable particulates are present.
6. The pollutant will undergo some subsequent wet process (such as recovery, settling, neutralization).
7. The pollutants are more safely handled wet than dry (potential explosiveness)

Wet Scrubbing Process

Wet Scrubbing is a two-step process.

1. The first step is the capture of the gas and/or particulate in the liquid.

2. The second step is the separation of the scrubbing liquid droplets (entrainment) from the gas stream before leaving the scrubber.

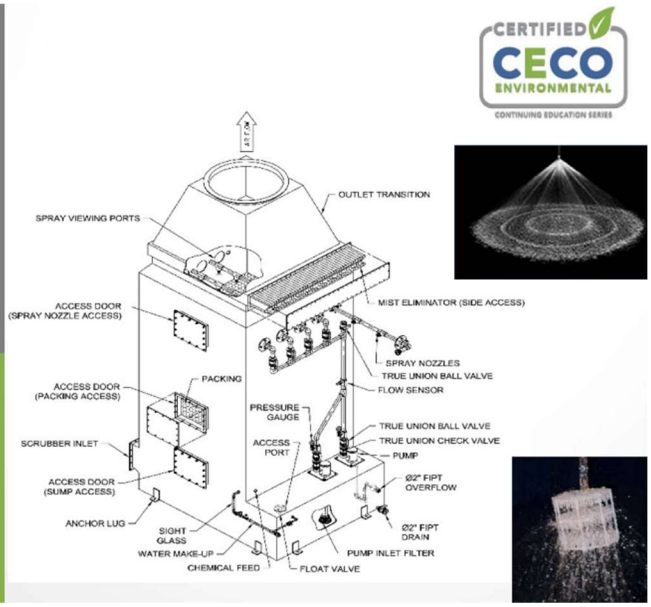
Scrubber Types

- Packed Bed Scrubbers
  - Horizontal
  - Vertical
- Venturi
- Tray Scrubber
- Spray Tower
- Emergency Scrubbers
- NOx Scrubbing
- Bioscrubber
- Hexavalent Chrome Scrubbing



Main Scrubber **Components**

- Packing Media
- Mist Eliminator
- Recirculation Pump
- Spray Nozzles
- Instrumentation and Controls



Theory of Operation

<u>Vertical Scrubber</u>

- Packing material
  - Large surface area
  - Multiple drip points
- Scrubbing liquid - bottom sump
- Pump – recirculates liquid
- Spray nozzles – distribute scrubbing liquid
- Air contaminants – absorbed into liquid
  - Solubility
  - Chemical reaction
- Mist eliminator – removes liquid droplets
- Horizontal scrubber

Treatment Methods

1. Water Only

Soluble and absorbed in scrubbing liquid

A. $HBr + H_2O \rightarrow H_3O^+ + Br^-$

Hydrobromic acid + Water → Hydronium ion + Bromide

B. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

Hydrochloric acid + Water → Hydronium cation + Chloride anion

Treatment Methods

2. Neutralization

Reaction with a chemical additive

A. $SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$

Sulfur dioxide + Sodium hydroxide → Sodium sulfite + Water

Acid + Base → Salt + Water

B. $HCl + NaOH \rightarrow NaCl + H_2O$

Hydrochloric acid + Sodium hydroxide → Sodium chloride + Water

C. $NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

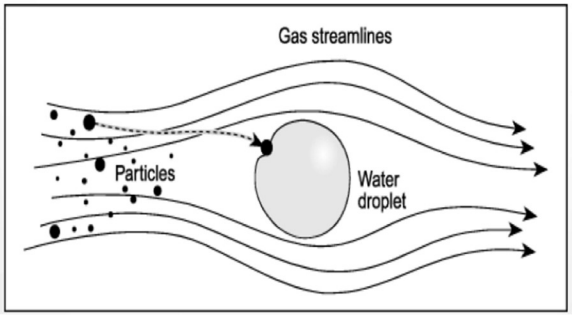
Ammonia + Sulfuric acid → Ammonium sulfate

Treatment Methods

3. **Mechanical Impaction**

Mist elimination

- Hydrogen peroxide (H_2O_2)*
- Sodium hydroxide (NaOH)
- Sulfuric acid (H_2SO_4)*
- Nitric acid (HNO_3)*
- Phosphoric acid (H_3PO_4)*
- Potassium hydroxide (KOH)
- Ammonium fluoride (NH_4F)



Treatment Methods

3. **Mechanical Impaction**

Mist elimination

- Hydrogen peroxide (H_2O_2)*
- Sulfuric acid (H_2SO_4)*
- Nitric acid (HNO_3)*
- Phosphoric acid (H_3PO_4)*

1. Remove +99% of mist or fume droplets 5 microns and larger
2. Can vaporize to fog droplets when heated
3. Nitric acid exception
4. Water alone – operating pH has no impact
5. Reporting mist droplets or fume concentrations and volatile chemicals of vapors or gases

Advantages of a Wet Scrubbing

- Often the most economical form of gas/particle separation
- Simple to operate and maintain
- No moving parts
- Severe Service Design:
  - High pressure/vacuum, High Temperature, Erosion, Corrosion, Explosive Dusts, etc.…
- No product contamination