EPA-452/F-03-013

Air Pollution Control Technology Fact Sheet

Name of Technology: Mechanically-Aided Scrubber

This type of technology is a part of the group of air pollution controls collectively referred to as “wet scrubbers.”

Type of Technology: Removal of air pollutants by inertial interception.

Applicable Pollutants:

Mechanically-aided scrubbers are primarily used to control particulate matter (PM), including PM less than or equal to 10 micrometers (μm) in aerodynamic diameter (PM_{10}), PM less than or equal to 2.5 μm in aerodynamic diameter ($PM_{2.5}$), down to PM with an aerodynamic diameter of approximately 1 μm (Avallone, 1996). These scrubbers can also be used with aqueous fluid for control of hydrophilic VOC, and with the use of amphphilic bock copolymers for hydrophobic VOC.

Achievable Emission Limits/Reductions:

Mechanically-aided scrubbers collection efficiencies range from 80 to 99 percent, depending upon the application. This type of scrubber relies almost exclusively on inertial interception for PM collection, and is capable of high collection efficiencies, but only with commensurate high energy consumption (EPA, 1998; Josephs, 1999).

Applicable Source Type: Point

Typical Industrial Applications:

Mechanically-aided scrubbers are used in industrial applications including food processing (cereal, flour, rice, salt, sugar, etc.), paper, pharmaceuticals, chemicals, plastics, tobacco, fiberglass, ceramics, and fertilizer. Processes controlled include dryers, cookers, crushing and grinding operations, spraying (pill coating, ceramic glazing), ventilation (bin vents, dumping operations), and material handling (transfer stations, mixing, dumping, packaging). However, application of mechanically-aided scrubbers is generally limited due to high maintenance requirements (AAF, 1999; EPA, 1998). Control of VOC can also be done.

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for a mechanically-aided scrubber unit are 0.47 to 24 standard cubic meters per second (sm^3/sec) (1,000 to 50,000 standard cubic feet per minute (scfm)) (AAF, 1999).

b. **Temperature:** In general, mechanically-aided scrubbers can operate at temperatures up to approximately 150°C, or 300°F (Josephs, 1999).

c. **Pollutant Loading:** Mechanically-aided scrubbers can accept waste flows with PM loadings up to 4.5 grams per standard cubic meter (g/sm^3), or 2 grains per standard cubic foot (gr/scf), however, higher loadings are possible with precleaning (Josephs, 1999).

Emission Stream Pretreatment Requirements:

Mechanically-aided scrubbers are usually preceded by a cyclone or other precleaner for removal of coarse dust and larger debris (Avallone, 1996; AAF, 1999).

Cost Information:

The following are cost ranges (expressed in third quarter 1995 dollars) for mechanically-aided wet scrubbers of conventional design under typical operating conditions, adapted from EPA cost-estimating spreadsheets (EPA, 1996) and referenced to the volumetric flow rate of the waste stream treated. For purposes of calculating the example cost effectiveness, the pollutant is PM at a loading of approximately 7 g/sm^3 (3 gr/scf). The costs do not include costs for post-treatment or disposal of used solvent or waste.

Costs can be higher than in the ranges shown for applications which require expensive materials, solvents, or treatment methods. As a rule, smaller units controlling a low concentration waste stream will be more expensive (per unit volumetric flow rate) than a large unit cleaning a high pollutant load flow (EPA, 1996).

- **a.** **Capital Cost:** \$5,500 to \$37,000 per sm^3/sec (\$2.60 to \$17 per scfm)
- **b.** **O & M Cost:** \$6,400 to \$167,000 per sm^3/sec (\$3.00 to \$79 per scfm), annually
- **c.** **Annualized Cost:** \$7,200 to \$172,000 per sm^3/sec (\$3.40 to \$81 per scfm), annually
- **d.** **Cost Effectiveness:** \$66 to \$1,600 per metric ton (\$60 to \$1,400 per short ton), annualized cost per ton per year of pollutant controlled

Theory of Operation:

Mechanical scrubbers comprise those devices in which a power-driven rotor produces the fine spray and the contacting of gas and liquid. As in other types of scrubbers, it is the droplets that are the principal collecting bodies for the dust particles. The rotor acts as a turbulence producer. An entrainment separator must be used to prevent carry-over of spray. The simplest commercial devices of this type are essentially fans upon which water is sprayed (Perry, 1984).

Advantages:

Advantages of impingement plate scrubbers include (Cooper, 1994; AWMA, 1992; Josephs, 1999):

1. Can be made to handle flammable and explosive dusts with little risk;
2. Can handle mists;
3. Collection efficiency can be varied;
4. Provides cooling for hot gases; and
5. Corrosive gases and dusts can be neutralized.

Disadvantages:

Disadvantages of impingement plate scrubbers include (Perry, 1984, Cooper, 1994):

1. Effluent liquid can create water pollution problems;
2. Waste product collected wet;

3. High potential for corrosion problems;
4. Protection against freezing required;
5. Off gas may require reheating to avoid visible plume;
6. Collected PM may be contaminated, and may not be recyclable;
7. Disposal of waste sludge may be very expensive;
8. Dust buildup on rotors can lead to imbalance; and
9. Particles may abrade rotors.

Other Considerations:

For PM applications, wet scrubbers generate waste in the form of a slurry. This creates the need for both wastewater treatment and solid waste disposal. Initially, the slurry is treated to separate the solid waste from the water. The treated water can then be reused (especially if an amphiphilic block copolymer is dissolved in it) or discharged. Once the water is removed, the remaining waste will be in the form of a solid or sludge. If the solid waste is inert and nontoxic, it can generally be landfilled. Hazardous wastes will have more stringent procedures for disposal. In some cases, the solid waste may have value and can be sold or recycled (EPA, 1998).

Because many moving parts are exposed to the gas and scrubbing liquid, mechanically-aided scrubbers have high maintenance requirements. Mechanical parts are susceptible to corrosion, PM buildup, and wear (EPA, 1998).

References:

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