EPA-452/F-03-008

Air Pollution Control Technology Fact Sheet

Name of Technology: Momentum Separators

This type of technology is a part of the group of air pollution controls collectively referred to as "mechanical collectors," or "precleaners," because they are oftentimes used to reduce the inlet loading of particulate matter (PM) to downstream collection devices by removing larger, abrasive particles by mechanical means. Momentum separators are also referred to as impingement separators, baffle chambers, and knock-out chambers.

Type of Technology:

Removal of PM by gravitational settling and inertial collection. The particles are separated from the moving gas stream by providing a sharp change in direction of gas flow so that momentum carries the particles across the gas stream lines and into a hopper (EPA, 1982; Avallone, 1996).

Applicable Pollutants:

Momentum separators are used to control larger sized PM, primarily PM greater than 10 micrometers (µm) (PM_{10}) in aerodynamic diameter.

Achievable Emission Limits/Reductions:

The collection efficiency of a momentum separator varies as a function of particle size and the momentum separator's design. Momentum separator efficiency generally increases with (1) increased particle size and/or density; (2) increased gas stream velocity; and (3) number of turns, baffles, or other sharp direction changes to gas flow. EPA (1982) presents a fractional collection efficiency curve for a momentum separator controlling flyash from a. Fractional collection efficiencies are 5 percent or less for a particle size of 5 µm, 10 to 20 percent for a particle size of 10 µm, and up to 99 percent for particle sizes of 90 µm or greater.

Applicable Source Type: Point

Typical Industrial Applications:

Momentum separators themselves are not adequate to meet stringent air pollution regulations, but they serve an important purpose as precleaners for more expensive final control devices such as fabric filters or electrostatic precipitators (ESPs). Momentum separators are used on a wide variety of processes in many different industries, and are generally constructed for a specific application from duct materials. Momentum separators have been replaced, for most applications, by cyclones, primarily due to the lower space requirements and the higher collection efficiency of cyclones (Josephs, 1999).

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for a momentum separator unit are 0.5 to 10 standard cubic meters per second (sm^3/sec) (1,060 to 21,200 standard cubic feet per minute (scfm)). Typical momentum separator capacity is 0.50 to 20 sm^3/sec per square meter of inlet area (100 to 3,900 scfm per square foot of inlet area) (Wark, 1982).

b. **Temperature:** Inlet gas temperatures are only limited by the materials of construction of the momentum separator, and have been operated at temperatures as high as 540°C (1000°F) (Wark, 1982; Perry, 1994).

c. **Pollutant Loading:** Waste gas pollutant loadings can range from 20 to 4,500 grams per standard cubic meter (g/sm^3) (9 to 1,970 grains per standard cubic foot (gr/scf)) (Parsons, 1999; Josephs, 1999).

d. **Other Considerations:** Leakage of cold air into a momentum separator can cause local gas quenching and condensation. Condensation can cause corrosion, dust buildup, and plugging of the hopper or dust removal system. The use of thermal insulation can reduce radiant heat loss and prevent operation below the dew point (EPA, 1982).

Emission Stream Pretreatment Requirements: No pretreatment is necessary for momentum separators.

Cost Information:

The following are cost ranges (expressed in 2002 dollars) for a momentum separator under typical operating conditions, developed using a modified EPA cost-estimating spreadsheet (EPA, 1996) and referenced to the volumetric flow rate of the waste stream treated. For purposes of calculating the example cost effectiveness, flow rates are assumed to be between 0.5 to 10 sm^3/sec (1,060 to 21,200 scfm), the PM inlet loading concentration is assumed to range from approximately 20 to 4,500 g/sm^3 (9 to 1,970 gr/scf) and the control efficiency is assumed to be 50 percent. The costs do not include costs for disposal or transport of collected material. Capital costs can be higher than in the ranges shown for applications which require expensive materials. 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.

a. **Capital Cost:** \$680 to \$6,600 per sm^3/sec (\$0.32 to \$3.10 per scfm)

b. **O & M Cost:** \$318 to \$6000 per sm^3/sec (\$0.15 to \$2.80 per scfm), annually

c. **Annualized Cost:** \$630 to \$11,000 per sm^3/sec (\$0.3 to \$5.1 per scfm), annually

d. **Cost Effectiveness:** \$0.01 to \$2.30 per metric ton (\$0.01 to \$2.10 per short ton), annualized cost per ton per year of pollutant controlled

Theory of Operation:

Momentum separators operate by forcing waste gas to sharply change direction within a gravity settling chamber through the use of strategically placed baffles. Typically, the gas first flows downward and is then forced by the baffles to suddenly flow upward. Inertial momentum and gravity act in the downward direction on the particles, which causes larger particles to cross the flow lines of the gas and collect in a hopper in the bottom of the chamber (EPA, 1998).

The design of momentum separators must provide sufficient volume to allow settling of materials separated from the high-velocity gas stream and materials of construction hard enough to survive high abrasion. As with all mechanical collectors, the design must include methods of sealing dust discharge from hoppers to prevent air leakage. The methods may include use of rotary air locks, flapper valves, or other positive sealing devices. Air leakage through the hopper or shell results in changes in the gas distribution, interferes with dust discharge, and may cause condensation or corrosion. Because of the high velocities used to separate the particles from the gas stream and the impaction of these particles on surfaces that direct the gas flow, the materials of construction must have high abrasion resistance. (EPA,1982)

Advantages:

Momentum separators share many of the advantages of other mechanical collectors (Wark, 1981; EPA, 1982; Corbitt, 1990; Perry, 1994; Mycock, 1995; and EPA, 1998):

1. Low capital cost;
2. No moving parts, therefore few maintenance requirements, and low operating costs;
3. Smaller space requirements than settling chambers;
4. Relatively low pressure drop (2 to 6 inches water column), compared to amount of PM removed;
5. Temperature and pressure limitations are only dependent on the materials of construction; and,
6. Dry collection and disposal.

Disadvantages:

Momentum separators also share the disadvantages of mechanical collectors (Wark, 1981; EPA, 1982; Mycock, 1995; and EPA, 1998):

1. Relatively low PM collection efficiencies;
2. Unsuitable for sticky or tacky materials;
3. Higher pressure drop than settling chambers; and,
4. High operating costs may result due to pressure drop.

Other Considerations:

The most common failure modes of momentum separators are hopper plugging and baffle plate erosion. Plugging of hoppers can be reduced by use of hopper level indicators. Erosion of baffle plates and collector shell can be reduced by the use of extra thickness in areas subject to abrasion. Periodic internal inspections of the collector is recommended to identify and correct areas of high abrasion and air leakage (EPA, 1982).

References:

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