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Troubleshooting Cyclone Dust Collectors

Close attention should be paid to deviations from original performance specifications

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Cyclone dust collectors are so named because they utilize a basic cyclonic effect to centrifugally separate dust from the carrying air or gas stream. The conveying gas stream enters the cyclone separator through an inlet opening at the top of the collector. The stream enters tangentially or involutely depending on equipment design (Fig. 1). The conveying gas and particulate spiral down against the outer wall and the dust is removed from the airstream by centrifugal force. Particulate is deposited on the cyclone wall where it falls into the receiver hopper under the force of gravity. The gas stream with particulate removed seeks the inner vortex and exits as clean air at the top (Fig. 2).

Design relationships between inlet, body, cone, outlet pipe, discharge hopper, and air lock determine specific unit efficiency.

The degree of removal (collection efficiency) is dependent upon many factors that individually, or in combination, create a significant variation from the original design efficiency. Collection efficiency is measured by comparing the weight of the particulate per unit time entering the collector to that leaving in the clean air discharge:

$$E = P_e/P_l \times 100$$

where:

E = efficiency, percent
P_e = entering particulate, lb/hr
P_l = leaving particulate, lb/hr

Efficiency is affected by changes in several parameters:

- Carrying air or gas volume (acfm)
- Temperature, pressure, and ambient humidity that affect gas density and/or viscosity
- Changes in the dust loading (lb/hr) or grain loading (gr/cu ft)
- Changes in aerodynamic particle size distribution of the particulate matter to be collected
- Installation factors.

Installation of cyclone dust collectors should follow industry-accepted criteria. To assure proper performance, intake ductwork must be designed so that sufficiently high velocities are maintained for particulates to remain airborne as they are conveyed to the cyclone.

For maximum cyclone efficiency, it is important that ductwork be properly engineered. When possible, elbows or bends in ductwork upstream of the cyclone should direct entering air in the same rotational direction as the cyclone itself (Fig. 3).

Static electricity buildup has detrimental effects on cyclone performance. Static charge buildup increases with grain load. Collectors must be properly grounded to eliminate dust buildup on their internal surfaces.

Installation should include a vortex-

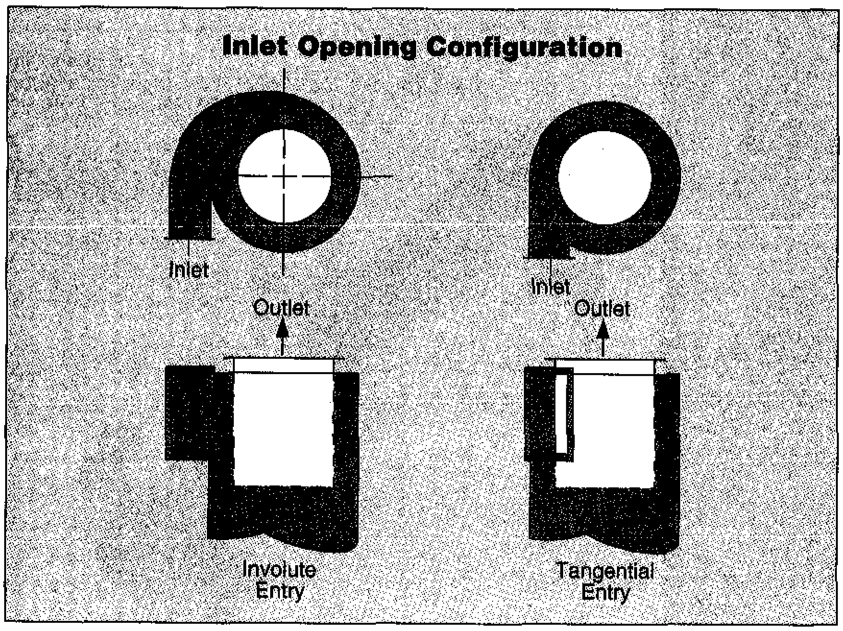

***Fig. 1. Design of inlet openings** influences both the smoothness of the transition of incoming flow and the amount of wear occurring on inlet and upper cyclone surfaces. Involute entry is a better choice for use with highly abrasive materials.*

breaking receiver hopper and air lock. This equipment balances the airflow leaving the top of the reverse flow cyclone with the entering airflow. Improper discharge conditions provide the potential for product reentrainment into the outgoing airflow.

Care should be taken during installation and operation to prevent damage to duct or cyclone walls. Dents have an adverse effect on collection efficiency.

Identifying Cyclone Problems

Since a cyclone dust collector has no moving parts to fail, identification of problems is relatively straightforward.

A cyclone that works well initially but deteriorates with time usually has a different set of problems than a cyclone that operates poorly from the offset. Poor initial operation is caused by one or more of the following problems.

- Poorly defined operating conditions. These conditions include lack of volume and lowering of inlet velocity, changes in the design conveying-gas density, specific gravity, or grain load.
- Foreign objects left inside the unit during installation. Flow patterns are adversely effected.
- Poorly or nonseated mounting bolts and gaskets. When these occur at flange joints or access doors, leakage and loss of efficiency result.
- Internal condensation. Buildup of particulate on walls quickly degenerates operating conditions.

Good initial operation that begins to deteriorate is caused by several conditions.

- Improper or degraded electrical grounding. Static electricity results in material buildup and deteriorating operation.

Buildup or bridging of material is also caused by changes in operating conditions. These conditions include changes in temperature and moisture content of the airstream. Internal surface conditions such as dents, crevices, welds, ledges, or other "dead" spots provide a site for these to build on.

- Air leakage due to wear or damage. Abrasive particulate causes clearances to increase between the rotor and housing of rotary lock valves. Worn or damaged access doors, equipment flanges, ports, and abrasion holes also degrade performance over time. Abrasion is magnified in the lower cyclone due to higher stresses occurring in this area caused by the weight of the air lock valve.
- Reentrainment of particulate.

Troubleshooting Tools

Basic tools of the trade are the eyes, ears,

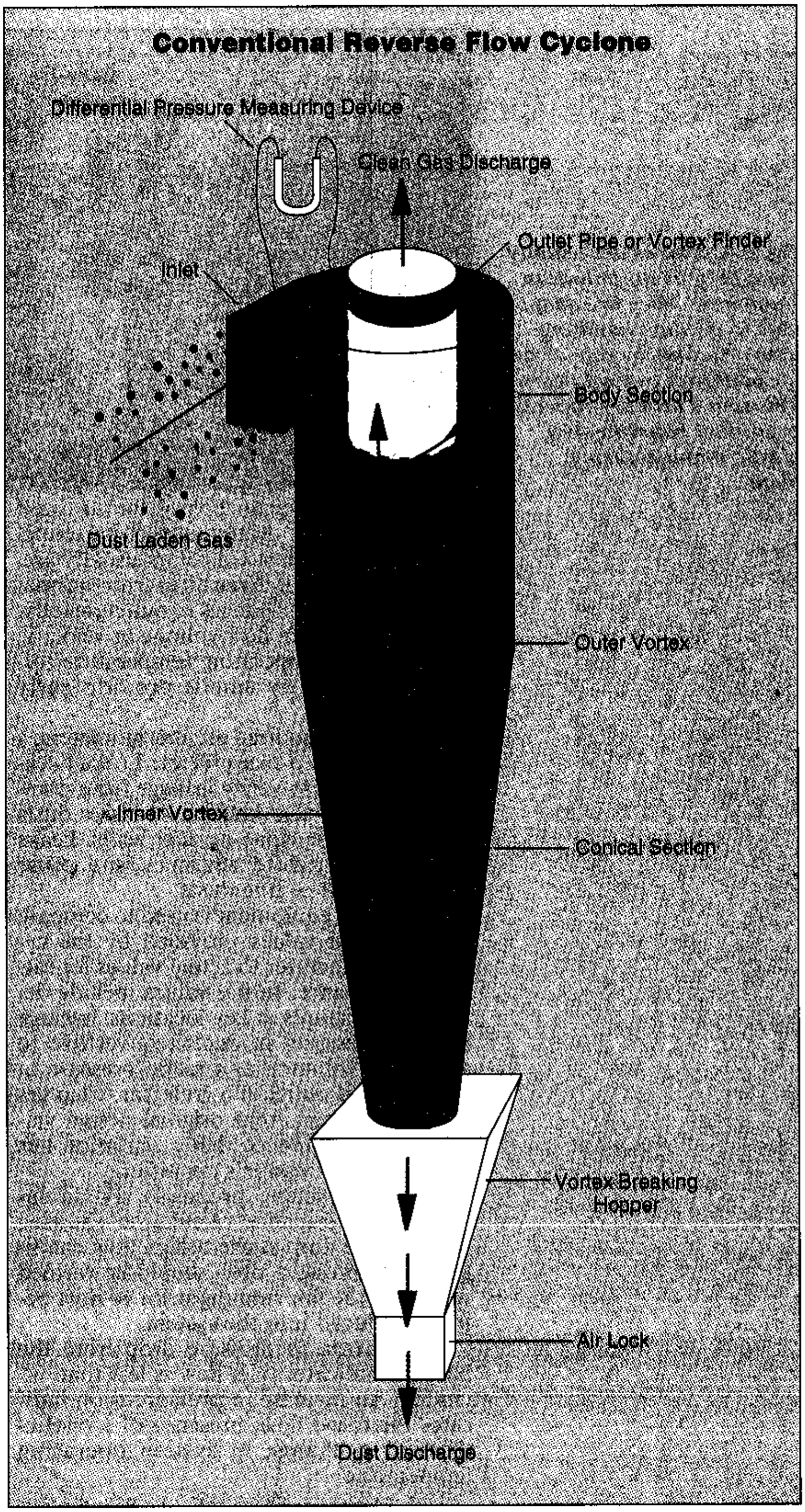

***Fig. 2. Conventional reverse flow cyclones** form a double vortex in the process of centrifugally separating material from the incoming airstream. Since the vortices are concentric, inlet and outlet are both located at the top of the unit.*

Departures from normal cyclone operation are often detectable through sight, smell, and hearing

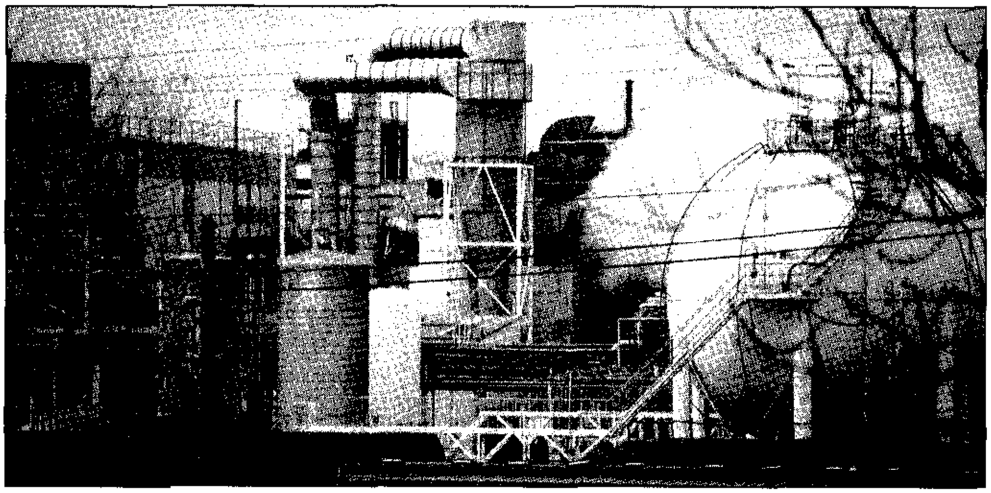

Fig. 3. Cyclones are usually thought of as air pollution equipment. They are adaptable to product handling with a secondary role as an air pollution control device. This unit's primary function is product handling at a plastic manufacturing plant.

and nose of the person looking for the cause of the problem. Maintenance personnel who work with dust collectors usually see, hear, and/or smell departures from normal operation. Visual changes in outlet opacity, audible changes in flow volume or velocity, and changes in operating temperature (often detectable by smell) provide early warnings.

Other tools required are thermometers, a pitot tube, and a manometer. Leak-checking equipment to verify leakage from damage or wear is also helpful. Abrasive dusts wear holes in cyclone or duct walls. Leaks of this type reduce efficiency and cause reentrainment of fine dusts.

Measuring equipment is used to compare initial design values provided by the cyclone manufacturer to actual values for rating performance. Initial values include design temperatures at key locations, average velocity pressures in ducts (convertible to actual air volume), and static pressure at the inlet and outlet of a collector. Changes in pressure drop from original design values provide evidence that a variation has occurred in a cyclone's operation.

Since all cyclone proposals should include a performance calculation showing the pressure drop at the design flow conditions, this pressure drop should be verified with only the fan running prior to dust being introduced into the system.

A reduction in pressure drop from the baseline indicates inlet flow is less than intended. An increase in pressure drop indicates increased flow, presence of a restriction, or a change in system operating temperature.

The outgoing clean air or gas stream should contain little particulate and appear clean. Leakage on the intake side of the system, material buildup, or bridging cause more particulate to be carried out with the clean gas. Deteriorating opacity usually indicates flow alteration.

Condensation and Other Problems

An uninsulated cyclone is a good heat exchanger. In hot gas operations, internal condensation can occur, causing certain materials to accumulate and bridge across the ductwork to restrict flow. Changes in color or stickiness, or clumping in discharged particulate, often indicate the presence of condensation. Some buildups due to condensation are avoided by insulating the equipment.

A cyclone that is prone to occasional buildup is also subject to occasional abuse. Well-intentioned workers often loosen buildup by banging on duct sheet metal with a hammer or other heavy object. Since this treatment often causes dents, which alter internal flow patterns, it should be avoided. Use of vibration equipment is preferable.

Some buildups are due to the sticky nature of materials handled. In these cases, interior polishing or application of special nonstick coatings prevent problems.

Proper cyclone selection is based on accurate definition of gas and particulate inlet conditions. Reliable manufacturers accurately predict the expected efficiency and pressure drop from this data. Accurate operating data determined at startup provides the benchmark for future assessment of system operation.

For more information . . .

The author will answer questions about this article. He can be reached at 502-776-1505.

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