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CARDOX

CO_2

Application Bulletin

Carbon Dioxide Fire Suppression —

Bag Houses

(Bag Type Dust Collectors)

The very nature and operation of dust collectors and fume control systems present possible fire and explosion problems. Effective fire protection against these hazards means more than just saving the collector and its components. In these days of strict environmental regulations and air quality standards, what's at stake is the continuing operation of vital production and process lines where dust collectors are required. A dust collector that is damaged by fire or explosion, and that cannot meet the air pollution guidelines, could cause a lengthy plant shutdown. Therefore, the nature and cause of dust collector fires, and the protection of production facilities from such fires, deserves serious consideration.

This bulletin was cross referenced in Industrial Facilities Bulletin #0785, Coal Grinding, Handling, and Storage Systems. While dust collectors on coal systems are more likely to be protected with carbon dioxide than those used on some other processes, coal handling is certainly not the only application for CO_2 dust collector fire protection.

The bags in dust collectors are usually thought of as combustible when either cotton, nylon, polyester, polypropylene, or acrylic is used, and noncombustible when fiberglass, Nomex or Tteflon is used. The CO_2 protected dust collectors are those operating at lower temperatures, usually with combustible dusts and combustible bags.

It is prudent to design dust collectors to prevent sparking at screw conveyors or airlocks, and to use a bag grounding system to help eliminate ignition sources where highly combustible dusts are collected.

In addition to being used for collection of a variety of dusts, bag type dust collectors come in a variety of physical arrangements. We have illustrated just one such arrangement on the accompanying drawing. The drawing shows an arrangement where the dust collects on the outside of the bags and, when removed, falls into the hopper below. The dust can be dislodged from the bags by reverse air flow, a pulse of compressed air, or by shaking the bags (not shown on the drawing).

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It is not prudent to allow combustible dust to accumulate in the bottom hopper; therefore, an automatic screw conveyor is often employed to remove same. In the case of coal dust, the collected dust is returned to the coal storage silos.

For systems where an accumulation of combustible dust, such as coal dust, can take place in the hopper, provision for inerting the hopper (any enclosed screw conveyors) with CO_2 vapor is good design.

For large bag houses, the dirty air inlet is manifolded to provide multiple inlets to evenly distribute the dust (shown on the attached drawing.)

In some installations, the clean air is exhausted to atmosphere. In others, heated air may be reused elsewhere to increase thermal efficiency and the cleaned air is returned to the building.

The air supply duct needs to be dampered to isolate the collector in case of a fire. Dampers in the exhaust may or may not be used for this purpose as discussed below.

The fan is shut down on fire detection.

Source of Fire Hazards in Dust Collectors

Dust collection systems present two possible fire problems. One is the rapid burning of suspended combustible dust particles, which can create explosive pressures and destroy the dust control system, and possibly create secondary fires or explosions outside the dust collector. This explosion potential is NOT dealt with by any installed CO_2 fire protection. It requires the use of a collector housing designed to contain an internal explosion, a unit with proper explosion vent panels directed safely away, or the installation of an explosion suppression system. (See NFPA Standards No. 68 and No. 69.)

The other fire problem is the ignition of the dust collector bags and accumulated dust by material which has been heated or ignited elsewhere and drawn into the dust collector equipment. Maintenance and repair procedures also have been known to start dust collector fires.

Carbon dioxide systems have been used for many years to extinguish such fires. This has been recognized by the National Fire Protection Association Standard No. 12, Carbon Dioxide Extinguishing Systems. (See Table on page 4.)

Carbon dioxide discharged on one side of the bags easily passes through to the portion of the enclosure on the other side since it is a true three-dimensional agent. Plus, carbon dioxide system detection devices generally are more sensitive than water system sprinkler heads. This means earlier actuation of the CO_2 system, less fire damage to the dust collector, and shorter shutdown of the production or process line than if sprinklers are the primary protection.

Among the reasons for using CO_2 over water as primary protection are:

- Desire to hold fire damage and clean up to an absolute minimum to allow restoration of operation as soon as possible. This involves the use of faster detection and a clean agent (CO_2).
- The three-dimensional characteristic of CO_2, which allows it to easily penetrate all parts of the bag house.
- Lack of water at sites remote from plant and municipal facilities.
- Faster fire suppression.
- The potential problem of the weight of the water discharge, in the event of an extended water application.

CO_2 Concentration levels

Carbon dioxide concentration levels are designed to be sufficient to extinguish stubborn, deep-seated fires. Dust collectors often contain material that is prone to deep-seated burning. In combustion of this type, the hot burning mass becomes buried in the combustible, leaving its ash and the unburned material to insulate it. As an extinguisher, water will penetrate directly into the mass and cool the hot spot; whereas a carbon dioxide/air mixture must extinguish the fire by circulating through the mass. This takes some time, even though open burning has been suppressed.

The carbon dioxide actually works with the combustion process to contain and fully extinguish these troublesome fires. As the percentage of carbon dioxide in the air supporting the burning fire increases, the fire is starved of oxygen; the combustion rate drops to a point where new heat generated from combustion is less than the natural heat loss from the burning material to the surrounding material or air.

At this point, actual fire extinguishment starts and continues to an inevitable, total extinguishment; this period is known as the soaking time. The higher the concentration of carbon dioxide, the shorter the required soaking time. The length of the required soaking period should be discussed with the authority having jurisdiction.

Carbon dioxide systems are designed to flood dust collectors with a carbon dioxide concentration of 75% by volume. A fire suppressing concentration of 30% is normally achieved in the first minute or two of agent discharge. Continuation of the discharge reaches the 75% level in less than seven minutes. This is the concentration of carbon dioxide found necessary to ensure extinguishment of a deep-seated fire in the collector in a minimal time period. (The higher the CO_2 concentration, the shorter the required soaking period.)

Dust Collector System Isolation

A fire in a dust collector is initially subject to a lot of air movement. Proper carbon dioxide extinguishment requires shut down of the fresh air supply and the elimination of carbon dioxide loss following the discharge. This is accomplished by shutting down the fans and closing the fire dampers which isolate the system. Fan shutdown is preferably done at the start of the carbon dioxide discharge — on fire detection. Dampers are released to self-close by pressure operated releases which are part of the CO_2 system piping.

When only part of the air system can be shut down and the equipment to be protected is isolated by dampers, it must be assumed that the dampers will not be 100% effective. Air pressure on the dampers will cause them to leak. Therefore, if you do not have a static condition for CO_2 flooding, all air pushed (or sucked) past the dampers must be inerted for the entire soaking period to provide proper protection. This complicates fire system design. The Chemetr on Fire Systems Applications Engineering group should be consulted for help in determining the additional quantity of carbon dioxide required in this case.

If a dust collector is isolated by an air tight enclosure after shutdown, the internal discharge of carbon dioxide could increase internal pressure in the housing and require pressure venting to prevent distortion or blow out of the vent panels. Certain ducts through which only a little carbon dioxide would be lost following a discharge may be left undampered to act as pressure vents. This is most often the clean air exhaust damper off the top of the collector.

Good fire protection requires that the entire hazard be protected. Any equipment that can lead the fire into an unprotected area or extend the fire outside the protected area must be protected. Therefore, an analysis of the dust system is necessary to determine if protection of ducts and/or cyclones may also be necessary. (We have already discussed added protection of accumulated dust.)

Placement of Discharge Nozzles and Fire Detectors

The volumes of most bag-type dust collectors protected by carbon dioxide fire suppression systems are not large enough to require a large number of discharge nozzles to distribute the CO_2. So the tendency to use just a few nozzles increases the discharge rate per nozzle, and thus the discharge velocity. This may stir up the dust, and under a fire condition, this could lead to a dust explosion. To reduce turbulence near each individual discharge nozzle, more nozzles should be used and concern given to the nozzle design used. Care should be exercised in nozzle placement as well.

Dust collectors pose unusual problems when it comes to fire detection. The very nature of the environment in which fire detection is needed causes problems for optical or combustion product smoke detectors. The high cost related to the use of flame detectors — due to the lens cleaning system used and their need for maintenance — limits their use.

We have found rate-compensated heat detectors to be reliable, adequately sensitive, maintenance free, and easy to test. The detector wiring enclosure is mounted outside the duct with the element protruding into the collector or duct. A flexible connector allows the element, with its box, to be pulled out and away from the duct for testing.

Blower and Exhaust Systems for dust removal are covered by NFPA Standard No. 91.

On the drawing accompanying this bulletin, we show a rectangular shell. For certain applications involving coal type dust collectors, it should be noted that these often must be designed to withstand an internal pressure of 50 psi in case of explosion. These units would be round, with a heavy wall thickness and incorporate other special design features.

In any design of coal handling system bag houses, the risk of bag damage is high from fire or explosion.

In an article in Pit & Quarr y, October 1981, titled ExplosionContainmentSpecsMandate New DesignThinking, the author states:

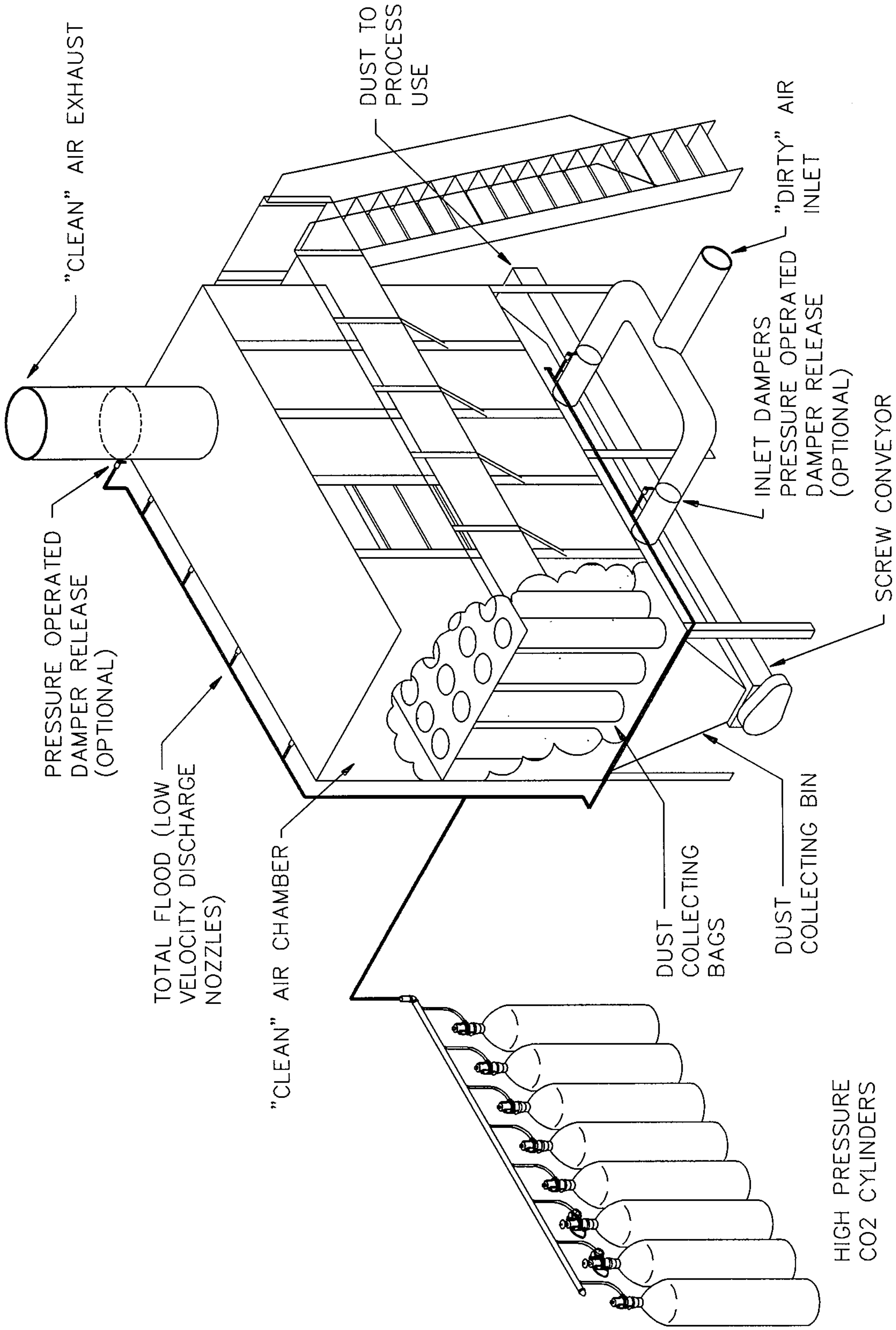
> Althoughany explosionwithinthebag housewill mostlikelywreckthebags, a CO_2 floodingsystem iswellworththeinitialcapital investment.Reason: It quellsinternalfiresquickly, reducingstructural damage from overheating and permitsquicker access following explosion.....A CO_2 systemcan save enoughin lost time and lost production to pay for itselfthefirst time an explosionoccurs.

With the variety of systems and equipment configurations used, Chemetr on invites inquiries as to recommended CO_2 system design requirements for any dust collection system under study.

NFPA Standard No. 12 - Table 2-4.2.1

CO_2 Flooding Factors for Specific Hazards

Design Concentration %	Flooding Factors				Specified Fire Hazard
	Ft.^{3}/ Lb. CO_2	M.^{3}/ Kg. CO_2	Lb. CO_2/ Ft.^{3}	Kg. CO_2/ M.^{3}	
50	10	0.62	0.100	1.60	Dry electrical hazards in general. (Spaces 0 - 2000 cubic feet)
50	12	0.75	0.083 (200 lb. minimum)	1.33 (91 kg. minimum)	Dry electrical hazards in general. (Spaces greater than 2000 cubic feet)
65	8	0.50	0.125	2.00	Record (bulk paper) storage, **ducts, and mechanically ventilated covered trenches**.
75	6	0.38	0.166	2.66	Fur storage vaults, **dust collectors**.



CO_2 Fire Protection for Bag-Type Dust Collector

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