CHEMETRON Fire Systems™

CARDOX

CO_2

Application Bulletin

CARBON DIOXIDE FIRE SUPPRESSION —

Fume Control Systems

Hazard Concerns

In other applications bulletins, such as those for aluminum rolling mills, rolling mills utilizing water based coolants, automated machining lines, heat treating, snack food cooking, coating lines, and printing presses (Flexographic and Rotogravure), the fume exhaust system was an important part of the hazard described. The recommended CO_2 fire protection included coverage of these fume systems as part of the overall protection scheme.

However, a proper discussion of the aspects of fume control system fire protection deserves a more detailed presentation. In addition, recent legislation and resultant technology have produced fume control systems for which CO_2 protection systems offer the best protection, even when the fume generating equipment is not protected. This bulletin is intended to provide the reader with information as to how CO_2 has been successfully employed on fume systems and to identify features of this protection as it relates to the above.

Even before the U.S. Clean Air Act and its Amendments, industrial processes were designed with a high measure of fume control. In the 1970's and 1980's, control technology guidelines defined reasonably available control technology for sources of VOC's (Volatile Organic Compounds) and HAP's (Hazardous Air Pollutants).

Control technology guidelines have been given for coating, can, automotive, metal furniture, magnet wire, appliance, and metal products industries. The control of the atmospheric emissions of such substances can be thought of as starting at the process generating the fumes. This control of fume emission to the atmosphere would include one or more of the following:

- More enclosure - adding sheet metal to capture and control emissions. An example of this is the metals rolling mill where the entire top of the mill, the spaces between mill stands of tandem mills and as much of the ends of the mill as possible are metal enclosed to trap fumes while the mill is operating (see Multi-Stand Mill Bulletin #0305).

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- Air curtains to block escape of fumes. (See revised (1994) Aluminum Mill Bulletin #0300).
- A decrease in the capture of material at the source. Obviously not the best alternative, but it does keep it out of the outside environment.

Once the vapors have been captured they are dealt with in a variety of ways, including:

- Solvent recovery systems, where solvents can be recovered and recycled.
- Incineration of vapors and subsequent control of combustion byproducts generated.
- Removal from air stream by (arranged least to most effective)
  - cyclone filters.
  - particulate filters.
  - heavy oil scrubbing for oil based fumes like mill coolant.

Protection Concerns

There are a number of factors that have been shown to be important when evaluating fire protection requirements for fume control systems. Among these are:

Identifying The Hazard: Equipment, which in itself does not appear to be of great concern from a fire standpoint, can generate a hazard from fumes created. For example: Vapors from water based materials, such as mill coolants containing approximately 95% water and 5% combustible material. When this type material accumulates, the water component evaporates and a sludge forms that may have the consistency of peanut butter. When this material is ignited, hot fires result; these fires have been generally hard to extinguish. A significant number of major fire losses are grim testimony to the severity of this hazard.

Access To The Hazard: If the fire plan is to deal with a fire in a particular system by manual fire fighting means, access by fire fighters to all portions of the system is essential. Fume exhaust systems are seldom arranged with such access. An internal fire in ducts and system components may be unfightable.

Multiple Arrangements Of Equipment: In one instance, a serious fire occurred on a protected piece of equipment when, for equipment maintenance, a portion of its hood and duct was swung out of position to gain access to the equipment. Although the equipment and its exhaust system had a protection arrangement suitable for periods of operation, when the exhaust was disconnected and the hoods and duct moved, a fire in the duct was not controllable.

Inability To Accomplish Desired Shutdowns: Good fire protection system design dictates that operation of the equipment generating the fumes, as well as all fume control equipment, be shut down in case of a fire. Sometimes this is not possible.

At one plant, a highly volatile solvent was being used in a process where, if the fans were shut down before the processing could be stopped, an explosive atmosphere of solvent vapor could be created at the equipment where the fumes originated. A fire in the exhaust system would have to be controlled with fans operating until such time as the solvent producing equipment could be deactivated (some minutes later).

Establishing The Limits Of A Hazard: It is important to ensure that the entire hazard is protected. Determining the scope of the entire hazard in a fume control system is not always easy.

Consider protecting a fume control system consisting of a hood, exhaust duct, mist eliminator, and stack.

Starting with the hood: Is it a hazard or not? If the fumes do not condense and accumulate on the hood surface, coverage of the hood may not be necessary. But, if there are condensate troughs at the edges of the hood, or if there are filters in the hood, as are found in a commercial kitchen hood, protection of the hood is necessary. Hoods with a coating of combustibles, even a thin one, need coverage.

Next, consider the exhaust duct. These are usually equipped with an isolation damper designed to close in event of a fire or fire protection system operation. With some CO_2 systems, the duct is flooded to the damper. To ensure that the fire doesn't get past the damper, CO_2 is discharged at the downstream side of the damper. Many systems have been installed with the CO_2 protection stopping there. However, if the duct continues to a mist or recovery system, it should also be protected. Protection should be afforded for the entire duct up to and including the elimination equipment.

The portion of the fume control system downstream of the mist elimination system consisting of duct and exhaust stack may require protection if there is any probability of an accumulation of combustible in ducts past the eliminator. Without built-in fixed protection, fighting a stack fire is extremely difficult.

Considering Equipment Internal Construction: In some hoods, internal baffles are installed to contour the vapor/air flow. These can create an internal configuration of isolated spaces needing detectors and nozzles, but they may not be arranged such that the detectors or nozzles can be installed to reach these spaces simply by penetrating the outside of the hood. A careful analysis of the internal hood configuration, cyclone filters, filter boxes, etc., to determine numbers and locations of detectors and nozzles is needed. Coordination with the hood designer at the CO_2 system design phase is important.

CO_2 Fire Extinguishing System Design

Where the hood itself requires protection, the CO_2 discharge would be calculated and discharged as a local application, rate-by-area, coated surface. However, if the operating equipment beneath is protected by local application CO_2, then figuring the assumed volume from the top of the hood to the floor and using rate-by-volume might be best. This would ensure complete coverage of the equipment below and the hood above.

Ducts require flooding to 65% CO_2 per NFPA Standard #12, Table 2-4.2.1 and para. 2-3.5.6. Seldom are we concerned with a deep-seated fire in ducts normally protected with a CO_2 system (for an exception, see Special Cases below). However, even a duct with a surface fire potential presents a concern as to how long the CO_2 discharge can be held. Even in a brief fire, sheet metal can be quickly heated, requiring some time for cooling to prevent reignition. (See NFPA #12 para. 2-1.2 Concentration Maintained For The Required Period Of Time To Ensure Complete And Permanent Extinguishment..)

If the duct system is piped to be discharged simultaneously with the CO_2 discharge providing local application protection for the associated operating equipment, the minimum 30 seconds discharge allowed may not be adequate to ensure necessary cooling. It may be appropriate to pipe the exhaust system separately with its own valve (CO_2 supply) so that although it is flooded simultaneously with the discharge on the equipment, the duct discharge can continue for 2 to 3 minutes to ensure the duct is properly cooled.

Although the ends of a duct are open, they are usually located at equipment where another portion of the CO_2 discharge is taking place. In this case it is not necessary to be concerned with the open ends and add compensating CO_2 to the duct itself per NFPA #12 para. 2-4.4.1.

It is good CO_2 design practice to consider every portion of the fume exhaust system, such as the mist eliminator enclosures, etc., to be an extension of the duct system and use the basic 65% CO_2 design concentration for all. When a dryer such as those found on gravure and some flexographic printing presses is also a part of the fume control system, we must remember to adjust CO_2 discharge quantities upward when temperatures are above 200°F (93°C) (NFPA #12, Para. 2.3.5.3).

Special Cases: In certain cases, a higher than normal 65% CO_2 concentration, or a longer holding time than the usual 2 or 3 minutes may be necessary for proper protection.

One example: In a system where activated carbon blocks are used for adsorption of the VOC's being controlled. We know that CO_2 can extinguish fires in this material if the proper concentrations are held long enough, remembering that the higher the concentration, the shorter the required holding time. When higher concentration and/or longer holding times are indicated, consult Chemetron Fire Systems Engineering for help.

Another example: In the case previously described where the air flow could not be shut down, it was necessary to inert the incoming air as well as the internal volume of the duct system and keep the CO_2 rate going to maintain the inert level until the solvent vapor flow could be stopped (again, consult Chemetron Fire Systems Engineering for help in determining proper design).

A typical mill fume exhaust system is illustrated on the accompanying drawing. Features of this protection system are:

- Proper distribution of the CO_2 gas. This involves a discharge nozzle installed every 20 to 25 feet along the duct.
- Proper spacing of detectors. We recommend rate compensated, heat actuated detectors on a similar spacing to that of the nozzles. Provision for installations in special atmospheres (i.e. water/oil vapors) is required where such conditions exist.
- Minimal impingement of detectors and nozzles in the air/vapor flow. This prevents material accumulations and flow distortions. Detectors should not extend more than ½" into the flow. We recommend nozzles be mounted as shown on the drawing.
- Proper nozzle mounting when necessary to pierce duct/hoods. A mounting method that deals with both aesthetic and environmental concerns is used. It is designed to minimize leaks. (A similar mounting of detectors is also recommended.) Mounting details are available from Chemetron Fire Systems Engineering. Coordination with the hood/duct manufacturers is important so that mounting connections can be included in equipment fabrication.

Obviously, the applications of this bulletin are many and varied, but hopefully, the principles outlined above will help ensure good fire protection.

Low Pressure Carbon dioxide Fire Extinguishing System for Rolling Mill fume Exhaust System