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CARDOX

CO_2

Application Bulletin

CARBON DIOXIDE FIRE SUPPRESSION —

Machining Centers

Part 1: Production Lines

Modern production methods, such as those used in the automotive and construction machinery industries to machine engine and transmission parts, present fire hazards for which fixed CO_2 protection has been proven to be particularly valuable.

Machining operations that use cutting and hydraulic oils present a potential for fire. Experience has shown the hazards requiring protection include the machining station, oil mist elimination system, and the chip removal system and oil recovery process.

Cutting oils, which lubricate and cool the cutting tools and pieces being machined, also flush away chips being produced. The type of machining and the speed with which it is done produce varying amounts of heat, which vaporizes the oil and raises oil temperature close to its flashpoint (usually 200°F to 300°F) (79°C to 134°C).

Loss of coolant at a particular machining station, a dull or broken tool, and insufficient cooling of the recirculated oil are among the principal reasons for fire ignition.

The close proximity of all segments of the operation (interexposing hazards), excess oil outside of normal retention equipment, and use of oil hydraulic equipment for material handling are factors that make defining the limits of the scope of protection difficult. While fires at the machining stations are fairly common and could be handled with local protection, the potential for fire spread defines the entire hazard that must be protected.

This bulletin describes how the fast, properly designed, clean application of carbon dioxide (CO_2) can prevent a major loss. The protection system shown in this bulletin covers multiple machining stations, the oil mist elimination system, the chip conveyor trench beneath the machines, and the chip oil recovery system where oil is recovered, processed, filtered, cooled, and recirculated to the machines.

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The work being machined enters the line and moves from station to station, where one or more machining operations are performed. The piece is automatically positioned for the operation programmed, while the proper tool is selected and moved into position to accomplish the required machining.

Fire protection of the facility starts with good housekeeping and proper maintenance, but even if everything operates as it should, Murphy's Law applies here too. The CO_2 fire protection system is intended to detect and extinguish a fire before it can significantly impact production. It is the first line of fixed protection.

Overall protection necessitates sprinklers to ensure against a catastrophic loss. This usually involves 286°F (127°C) heads with a water density as specified by the Authority Having Jurisdiction. Added to this would be sufficient water for one (1) hour application from hose lines.

When these facilities are protected by a Chemetron Low Pressure CO_2 System, the positioning of CO_2 hosereels on the perimeter of a machining line allows massive first aid application of clean, non-damaging CO_2. Projection capability [35+ ft (10.5+ m)], with a high discharge rate [250/350 lbs/min (113/158 Kg/min)], and the extended length of discharge available from the central storage unit makes this a superior fire fighting device. It allows the use of CO_2 to control fires on equipment that does not justify fixed protection.

But the most efficient protection is the use of fixed CO_2 protection — starting with the machine tool itself.

The machining is performed inside a partial enclosure which contains splashing oil and the associated oil mist created. The CO_2 protection recommended is local application using the rate by volume method of calculation. Adjustment of the discharge rate for the partial enclosure can be made. Since the hazard is three dimensional, use of the rate-by-area method of calculation is difficult to apply. The system, as shown, uses spot nozzles mounted in the tops of the partial enclosures.

The oil mist elimination system consists of the pick up ducts at each station, common ducts, and the mist elimination equipment. The ducts and the mist elimination enclosure are totally flooded to a 65% CO_2 concentration per Table 2-4.2.1 of NFPA Standard No. 12. CO_2 is discharged into the mist elimination system simultaneously with the local application of CO_2 on the machine tool. During system design, care should be exercised to ensure an overall discharge rate that is high enough for the ducts to get the proper amount of CO_2 during the shortened local application discharge period. Covered orifice nozzles are used for CO_2 flooding of the duct/equipment interiors.

The chip conveyor trench below is usually covered by the machine enclosure and deck plate on the floor between machining stations. When covered, the trench is also flooded to 65% CO_2, again per Table 2-4.2.1. If the trench has open grating, it must be treated by local application of CO_2 with nozzles mounted above, supported by the equipment and aimed to ensure coverage of the entire open trench.

Chips are conveyed by either sluicing or by mechanical conveyors. The trench moves chips with the flow of oil by gravity or by liquid injection along the length of the conveyor. Drag or push bar conveyors are often used for long runs. The type of chips produced is key to the method of chip collection. The ability to run the CO_2 piping in the trench is affected by the type collection method used. It may be necessary to run the pipe at floor level and drop to nozzles in the trench.

If cutting or hydraulic oil filtration and pumping equipment is located outside the machining enclosure, consideration must be given to including it in the local application coverage to ensure that the entire hazard is covered. Coolant filtration can be accomplished by a variety of methods with the selection based on material being machined, type and flow rate of coolant equipment layout, and coolant quality needed. Filters involving disposable media (usually with housing openings) or permanent, enclosed type filters need different CO_2 application methods. Analysis of same is needed to determine the most effective protection method.

The termination of the chip conveyor is a tank or pit generally installed below floor level. The oil and chips dump into the tank where the chips are separated and conveyed out to the reclamation. If the tank/pit is covered with a solid deck plate*, this is protected by total flooding with a 34% CO_2 concentration. If it is open (covered by open grating) it is protected by local application using the 4 lbs. per min. per sq. ft. (.18 Kg/sq. m.) recommended for open pits more than 4 ft. (1.2 m) deep.

NOTE

* In the system illustrated here, local application was used because the deck plate was not considered permanent and there was a fear of fire while plate(s) were off.

The chip conveyor from the tank to reclamation is partially enclosed and is protected by local application of CO_2, rate-by-volume calculation.

Oil processing equipment (filters, pumps, etc.) on the floor adjacent to the pit is covered by local application.

Some larger machine tools each have their own individual mist elimination and chip processing systems. They can be protected as one hazard.

An interesting fire protection concept has been used when machining magnesium. Since magnesium chips are reactive with water, care is exercised to prevent water contact with the chips, eliminating any consideration of water protection. CO_2 won't put out magnesium fires either, but an oil deluge will. Hence, a dual agent concept is used: Oil deluge to control the magnesium fire and CO_2 to control the oil fire. (CARDOX, Chemetron's predecessor, had a patent on this application method many years ago.)

It should be noted that in some machining operations, entire platforms move, in which case it may be necessary to mount the local application nozzles on the platform and then feed the CO_2 piping and nozzles through flexible connectors.

Some large machining centers include a central oil room where oil is stored, processed, and pumped to the machining center. This is protected as a separate hazard.

It should also be noted that the machining equipment, oil pumps, mist exhaust fans, etc., must be shut down upon operation of the CO_2 system. An emergency shutoff is usually provided and interconnected with the Chemetron CO_2 system control panel to automatically shut down the line upon system actuation.

Fire detection utilizes rate compensated heat activated detectors located on the machine enclosures, in the mist elimination system, the chip conveyors and oil/chip processing tank/pit.

A future application bulletin on machining centers will cover Electric Discharge Machining (EDM).

Low Pressure CO_2 System
Protecting an Automated Mchining Center