CHEMETRON™ Fire Systems

CARDOX

CO_2 Application Bulletin

CARBON DIOXIDE FIRE SUPPRESSION —

High Capacity Portable Protection with CO_2 Hand Hose Lines

Part 1

Protection Requirements: Agent Selection

In the modern industrial plant, such as an electric generating station, metals rolling mill, printing plant, etc., some potential fire hazards require fire protection where extinguishing requirements exceed the capacit y of portable or wheeled extinguishers, but are not such that fixed fire protection is justified, while dependence on plant or outside fire brigades for fire control is unacceptable.

The preferred extinguishant is also often a clean agent and one that is electrically non-conductive.

For decades, carbon dioxide (CO_2) has been used as this clean, non-conducting agent. However, it has certain drawbacks when used in a portable extinguisher.

The high vapor pressure of the CO_2 liquified in the extinguisher requires the use of a heavy spun cylinder for storage. The ratio of weight to extinguishing potential is high, limiting its use. And as a gas, it is hard to project the discharge the substantial distance that may be necessary to reach the seat of the fire.

Other clean extinguishants, such as Halon 1211, allowed the use of lighter weight units with greater projection capability. But now that Halon is no longer produced, alternative agents that are environmentally acceptable but still cost effective must be used.

CO_2 meets this test if its shortcomings can be minimized and its extinguishing capability enhanced.

CHEMETRON™ Fire Systems
A World of Protection

4801 Southwick Drive
Third Floor
Matteson, IL 60443
Telephone: 708/748-1503
Fax: 708/748-2847
email: info@chemetron.com

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Agent Requirements

The standard for Carbon Dioxide Extinguishing Systems (NFPA #12) recognizes the requirements of manually applied CO_2 in Paragraph 4.4.1 of Chapter 4, Hand Hose Line System:

4-4.1 Rate and Duration of Discharge. The rate and duration of discharge and consequently the amount of carbon dioxide shall be determined by the type and potential size of the hazard. A hand hose line shall have a sufficient quantity of carbon dioxide to permit its use for at least 1 minute.

If a hazard is such that fire control by CO_2 can be effected, the specifier, with help from those experienced in CO_2 systems design, must determine how much CO_2 is needed.

A factor in the amount of fire that can be extinguished by CO_2 is the rate at which the CO_2 can be applied. Generally, the faster it is applied, the more fire that can be extinguished with the same amount of gas. For example, 50 pounds of CO_2 will extinguish 20 square feet of fire in 12 seconds when applied at 3 to 4 pounds per minute per square foot, but will not put it out if applied at less than 1 pound per minute per square foot.

Another factor is for how long must the CO_2 be applied to ensure extinguishment. Fires involving deep-seated burning material can be controlled only with lengthy CO_2 discharges. Metal and other surfaces heated in the fire above the auto-ignition temperature of the fuels must also be allowed to cool below that temperature. An extended discharge would be necessary in these cases.

Still another factor is that automation has allowed plants to be operated by fewer people. Therefore, it is less likely that a fire will start when someone is close at hand to use an extinguisher. It follows that the fire can be expected to be larger when the extinguisher is actually used. Thus, the potential hazard size must be enlarged during planning.

A larger fire will also require greater projection of the gas to reach all burning areas. Projection must be adequate to reach all parts of the hazard for which protection is intended. Accessibility must be analyzed.

A fourth factor to be taken into consideration is that the people most likely to be called upon to provide first aid fire control are not likely to be trained fire fighters. Therefore, it should be expected that it will take some time for the operator to figure out how to apply the CO_2 with satisfactory results.

Meeting These Requirements

Providing CO_2 to meet these requirements —

- high discharge rate
- large coverage
- greater projection
- more forgiving

means analyzing the hazard and calculating expected requirements. Often, this indicates the need for a hand hose line system rather than an extinguisher or wheeled unit.

For the purpose of this bulletin, let us consider the modern steam-electric generating station. At these stations, the generators are cooled by a hydrogen gas atmosphere within the casing. CO_2 is provided to inert the air before the hydrogen is introduced into the generator, and to purge the hydrogen from the unit before it is opened for maintenance. This prevents mixing of hydrogen and air to create an explosive atmosphere (see Power Generation Bulletin #0035). Thus, CO_2 storage is required, with the low pressure system being the best choice.

Extending and expanding this system can provide for the fixed protection requirement, but for our purposes here, it is an ideal source of CO_2 to provide highly effective portable protection.

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Carbon dioxide is stored under pressure as a liquid. When it is released and expands to atmospheric pressure, it changes state to vapor and fine particles of dry ice. A cylinder discharged at 70°F will contain less than 20% snow in its discharge, while a discharge of 300 psi liquid CO_2 will contain over 45% dry ice snow. This dry ice snow will quickly change to vapor under normal temperature conditions, especially in the presence of a fire, leaving CO_2 vapor alone as a result. This feature — utilized in the low pressure CO_2 hose reel system — gives it unique fire fighting characteristics, especially important to the power plant or in other heavy industrial fire protection needs.

History of Development: The above described characteristic was first utilized extensively by the CARDOX aircraft crash fire fighting vehicles of World War II. Used throughout the world by the Army Air Corps and Navy, the vehicles used a specially designed discharge nozzle as a boom, a ground sweep, and on a hand hose line to quickly knock down the flames of a crashed aircraft to allow rescue of the crew.

The special nozzle, called the snow separation nozzle, or projection nozzle, used the principle of a centrifuge by forcing the CO_2 discharge around an arc so that there would be a separation of the heavier snow particles from the lighter vapor. These heavy particles could then be projected for some distance, plus they could penetrate high winds and strong thermal air currents caused by the fire.

This same nozzle is the basis of the Chemetron hose reel used on thousands of industrial applications.

Application Engineering Factors: Since carbon dioxide is readily available, the cheapest chemical fire extinguishant around and generally non-damaging, its use is desirable assuming that 1) it can be expected to do the fire extinguishing job, and 2) it doesn't create other serious problems in the process. A little application engineering is, therefore, in order to ensure that the fire protection job is properly done.

As outlined above, when determining whether low pressure hand hose lines are reasonable and appropriate for protection of certain equipment, a logical starting point is an analysis of the protection needs.

- What is the size of the potential hazard?
- Can the fire be quickly extinguished or will it possibly require a lengthy discharge?
- Is the hazard accessible?
- Will it require projection of the extinguishant discharge over a sizable distance?
- Will it require an indirect application of the gas?

The lower pressure of the Chemetron low pressure CO_2 system allows for the use of larger hoses (1" and 1½") than are used with extinguishers or high pressure CO_2 equipment. This allows for discharge rates up to 600/700 pounds per minute. Thus, larger fires can obviously be handled. Recommended training with the Chemetron 1" hose line (250/300 lbs. per minute) involves extinguishment of 400 ft^2 (20' x 20') lube oil fires.

The fire protection designer, with help from Chemetron, can estimate the protection requirements of the equipment to be protected and then estimate the number and size of hose line units needed to provide same.

The Chemetron hand hose line is contained on a hose reel holding up to 200 feet of hose. As much hose as is necessary to reach the fire is pulled off the reel when the unit is used. Control of the discharge is by a squeeze valve in the hand of the operator.

When maintenance welding and burning is being done — especially near combustible liquids — a common industrial practice is to pull out the hose and stand the playpipe on the floor near the job. When needed, it can be picked up and the valve squeezed to control a discharge. The CO_2 is so cheap that there is no reason not to use it, when and if, and in the quantities needed. No skimping is necessary.

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Safety Concerns: Since the hand hose line operating squeeze valve closes when released, release of same will stop the discharge. It would be very difficult for the operator to create a hazardous environment for himself while fighting a fire in the open plant.

When inhaled in very small amounts, CO_2 acts as a stimulant to breathing. This is an involuntary reaction and very apparent to the operator. Ignoring this and continuing to build up the CO_2 concentration inhaled would be very, very unlikely.

These hose lines are intended for use in open areas and not in small rooms. It is expected that the products of combustion of the material burning will create more potential hazard for the operator than will the CO_2 applied. This equipment can easily be used with air breathing apparatus and such is recommended.

Sizing CO_2 Storage

Increasing the size of the CO_2 storage unit to accommodate the use of hand hose lines may be appropriate where:

- The existing (or planned) unit is borderline in capacity for other uses (Chemetron Fire Systems can help evaluate.)
- Experience indicates frequent use may be expected.
- Installation is at remote location, thus making refill of a small portion of the unit's contents impractical.

Determining CO_2 Requirements

Chemetron Fire Systems is available to help determine the estimated CO_2 requirements.

Part 2 will discuss methods of calculating CO_2 requirements for a variety of hazards.