CHEMETRON Fire Systems™

CARDOX

CO_2

Application Bulletin

CHEMETRON Fire Systems™
A World of Protection

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CARBON DIOXIDE FIRE SUPPRESSION —

Thermal Fluid Heaters

When it is desirable to indirectly heat product in production, this can be done by means of a piping system that transfers heat to the product by means of thermal fluids that have been heated external to the process. Thermal Fluid Heaters (Furnaces), such as that shown on the attached drawing, are used. The applications for this type of system are commonly found in wood processing, food cookers, tar/asphalt storage, and in offshore reservoirs to fluidize heavy oils.

Except for variations in size, a thermal fluid furnace resembles a water boiler. It usually consists of a refractory lined fire box, internal coils through which the fluid to be heated can be circulated, a plenum and fume exhaust. The coils containing the thermal fluid [usually an organic combustible oil with a flash point in the range of 700°F (418°C)] allow the fluid to be heated and then piped and pumped through the product to be heated for the required heat exchange. This is a safer operation than direct heating since the product being produced is not directly exposed to a fire ignition source, such as a burner. In addition, finer control of the heating is possible.

In a typical installation, the temperature in the fire box can be very high - even in the range of 2,200°F (1,355°C), with the stack exhaust in the range of 800°F (480°C). The exhaust heat is either vented to atmosphere or used as a secondary heat source.

A problem occurs when the thermal fluid coil develops a leak in the fire box. The fluid, which is under pressure, has a fire point below the temperature of the internal surfaces. In addition, these surfaces can remain above the fluid auto-ignition temperature for a long time after shutdown. Thus, the leaking fluid can create abnormal burning for an extended time period. This necessitates production shutdown for however long it takes to enter the unit and effect repair.

Upon determination that abnormal burning exists, the burner is shut down and CO_2 is discharged into the fire box (usually at the point of exhaust) to inert and maintain the inert condition while the unit cools. This can materially reduce the downtime.

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The CO_2 system is normally designed to a 47% flooding concentration* in the fire box (with the calculation of CO_2 required adjusted for the higher temperature that will still exist after the burner has been shut off.) Burner shutdown upon CO_2 discharge is, of course, mandatory. (* See the listing for "Dowtherm" in NFPA Standard No. 12, Table 2-3.2.1.)

After the initial flooding, the CO_2 must be held in the unit to ensure total fire control. This holding time is related to the cooling required to allow the fluid coils to cool below 700°F (418°C) to prevent reignition, and permit the leaked thermal fluid to evaporate off any super-heated surfaces. (Consult Chemetron's Systems Application Engineering group and the "Authority Having Jurisdiction" for help in determining a reasonable CO_2 concentration holding time for a particular installation.) A typical holding time is 30 minutes.

NOTE

TO ASSIST IN THEIR COOLING, THE THERMAL FLUID IS NORMALLY KEPT CIRCULATING THROUGH THE COILS AFTER THE BURNER HAS BEEN SHUT DOWN. THUS, THE ADDED FLUID COULD CONTRIBUTE TO THE FIRE IF THE SPACE IS NOT INERTED.

Upon CO_2 system operation, depending on unit construction, the inert atmosphere can usually be maintained for an extended time period fairly easily as the CO_2 loss rates are typically low. The loss rate is directly related to the size of the dampered air inlets to the fire box and the rate of loss through the ducts. Dampering the exhaust, if done, must be interlocked to the fuel shutoff and tripped by the CO_2 system discharge.

These CO_2 systems are invariably of the high pressure (cylinder) type because of the limited amount of CO_2 required. The design starts with the calculation of the initial flooding (inerting) discharge to achieve the desired 47% concentration in a recommended one (1) minute's time. This calculation is based on the temperature within the protected space after shutdown. For larger units, this initial flooding is from a primary CO_2 cylinder supply (usually several cylinders). It is supplemented by an extended discharge (from separate cylinders) that continues over the cool down period, which is usually in the 30 minute range. For example, a loss of 5 lbs/minute would require an extended CO_2 discharge of 150 lbs. Note that initial and extended discharges require separate CO_2 piping and nozzles as shown on the drawing. Units with a heavy refractory lining will cool very slowly and provisions to retain the CO_2 in the fire box are especially important.

For smaller units, it can be more economical to have one single discharge that not only establishes initial inerting but also maintains the concentration. Units have been protected that require only 15 to 20 pounds of CO_2 for initial flooding (under 100 cu.ft. of protected volume). Thus, maintaining a continuous discharge for the cool down period still only requires a few cylinders.

Fire Detection

Because of the high operating temperatures, heat-based automatic fire detection can be difficult to use. A small leak and the resulting limited burning of fluid (the time at which you want to detect the fire and flood with CO_2) will probably not raise the outlet temperatures enough for normal thermal fire detection to be effective. (Sensitive thermal controls provided by the unit manufacturer and operated through a PLC may give satisfactory indication of abnormal burning, allowing the operator to actuate the system in the early stages of a fire.)

However, smoke will occur. Thus, "beam type" smoke detectors have been successfully used. They have been used with a coarse setting and provision made for regular cleaning to maintain their view pattern.

Chemetron strongly recommends that the supplier of the heater (furnace) control be brought into the loop in the development of methods and sequence of fire detection and CO_2 system operation. Chemetron's Systems Application Engineering group is available to consult on specific applications. We encourage that this be done during the planning stage.

NOTE

THERMAL FLUID HEATERS ARE COVERED IN NFPA STANDARD #664, CHAPTER 9, AND FMRC LOSS PREVENTION DATA SHEET 7-99.

High Pressure CO_2 System Protecting a Thermal Fluid Furnace

Schematic Mechanical Diagram