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CO_2

Application Bulletin

Industrial Processes Bulletin #0505

CARBON DIOXIDE FIRE SUPPRESSION —

Heat Treating Facilities

Part 2: Open Quench Tanks

In Part 1 we discussed the application of CO_2 to protect the oil quench equipment associated with enclosed (integral) quench tanks. In Part 2 we will discuss the protection of open or detached quench tanks.

At this writing the subject hazard is covered by Para. 9.1 of NFPA Standard No. 34 Dipping and Coating Processes Using Flammable or Combustible Liquids.

In one open quench tank configuration, the material is heated in the furnace as it is conveyed (by conveyor, pusher or shaker) to the end of the furnace, where it drops down a chute into the oil bath and onto a conveyor submerged under the oil. As the conveyor moves the material out of the oil, the oil drains off back into the tank while the material is conveyed to a tote bin. As required, the tote bin is moved with the material to the next production stage. This arrangement is illustrated on the accompanying drawing.

In another arrangement generally used for larger pieces, material handling equipment such as a crane, hoist, or manipulator picks up the heated piece and lowers it into the oil bath. At the end of the quenching cycle the piece is lifted from the oil, allowed to drain while hanging over the tank, and then moved to the next production stage. Photographs illustrate this arrangement.

The gun barrels of the Navy's battleships, such as the Iowa, were produced and oil quenched in such a manner in a facility protected by Low Pressure CO_2.

The oil in open quench tanks is usually kept at about 100°F to 200°F (38°C to 93°C) and is cooled by agitation, oil recirculation, or water cooling with submerged coils or external coolers.

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The same protective devices mentioned in Part 1 — overflow, temperature alarm, low level alarm and water detector — are needed.

External to the quenching system and not shown in either bulletin is a central storage reservoir of quench oil. CO_2 protection for this is usually not needed.

General area sprinklers for catastrophic loss protection are appropriate. While other types of special hazards fixed protection (dry chemical or foam) will provide fire suppression for quench tanks, the clean, dry, three dimensional characteristics of CO_2 give it a decided advantage in protecting the continuity of production.

Fire Hazards

An increased fire hazard in the oil can occur if the viscosity of the oil increases to a point where it overheats, or there is a loss of thermal stability in the oil and low flash point fractions are produced. For many quenching operations, special quenching oils are formulated. They are much more subject to contamination, and thus benefit even more from CO_2 fire protection. CO_2 will not contamina te the oil.

Water in the oil causes the same problem of frothing and boil over in open quench tanks as described for enclosed quench tanks.

When the hot metal is submerged in the oil, the oil surrounding the material is vaporized and rises to the surface. It will flame up, at least momentarily, if above the auto-ignition temperature.

In the type facility where the material is manually lowered into the oil, it is common for the surface oil to flame up around the piece as it is being submerged. Circulation of cooler oil to the surface will reduce this flare up. (Use of CO_2 to control flaming is discussed later.)

Most often, fires occur when the material hangs up and is only partially submerged, or when the oil temperature rises too high due to inadequate cooling or excessive production (production beyond that for which the system was designed).

If a sprinkler discharge were to occur when the oil temperature was over 212°F (100°C), any water that penetrated the oil surface would flash to steam and cause boil over. Therefore, the use of CO_2 as the primar y fire protection of the facility has significant advantages. However, the installation of a backup sprinkler system ensures against a catastrophic loss in case other fire prevention and protection methods all fail. They are both needed.

In older facilities the fumes driven off during quenching were allowed to rise and exit through the roof. In newer facilities the fumes are captured by hoods and exhausted properly. If the hood is located close enough to the oil quench tank so as to be considered a part of the tank hazard, the underside surface needs local application CO_2 protection and the exhaust system should be flooded with CO_2.

Protection System Arrangement

The protection system illustrated in the drawing on page 4 provides for CO_2 local application on the oil surface and on the drainboard. The oil coated material on the drainboard is protected by the drainboard discharge. CO_2 is calculated rate-by-area.

Nozzles are placed so as not to interfere with operation and maintenance of the quench tank, i.e., off to the side directed in at the tank.

In the illustrated system, the quench tank surface requires eight (8) spot nozzles for complete coverage. The conveyor, where it is more than two feet from the oil surface, requires two (2) more. The oil surface under the conveyor must also be protected and the system has nozzles that are placed to do so.

The oily pieces in the tote bin, as well as any oil accumulation on the bin bottom, are protected by local application. Calculation is rate-by-volume. The oil handling equipment (pumps, filters, etc.) is also covered by local application — either rate-by-area or volume, depending on configuration.

In the illustrated system, the quench tank is situated in an open pit. Open pits more than 4 feet deep are covered by local application at the rate of 4 pounds per minute per square foot.

The exhaust system (if part of the hazard) is protected by local application on the hood with total flooding in the ducts. (If necessary, the exhaust system could be treated as a separate hazard arranged for simultaneous discharge with the quench tank.)

The other configuration of an open quench tank, as illustrated by the photographs, presents some unique problems.

First, as the freshly quenched piece hangs over the oil, it constitutes part of the hazard and coverage by the CO_2 discharge is mandatory. If the piece extends more than 2 feet from the surface, it is usually calculated with the rate-by-volume method and requires additional nozzles. It will not be covered by the nozzles directed at the tank even though it would appear to be enveloped in a test discharge. The CO_2 to protect same must be calculated independently and nozzles provided to direct the CO_2 onto the material.

Next, the material handling is not a continuous fixed process that allows for selection and placement of the discharge nozzles near their most efficient location. Nozzles and piping must be completely clear of cranes or the material manipulator.

Therefore, in the photo illustrated systems, low pressure storage was selected so that projection nozzles could be used. These nozzles have the ability to discharge a significant distance — 25 to 30 feet — so they can be placed totally out of the way, as shown.

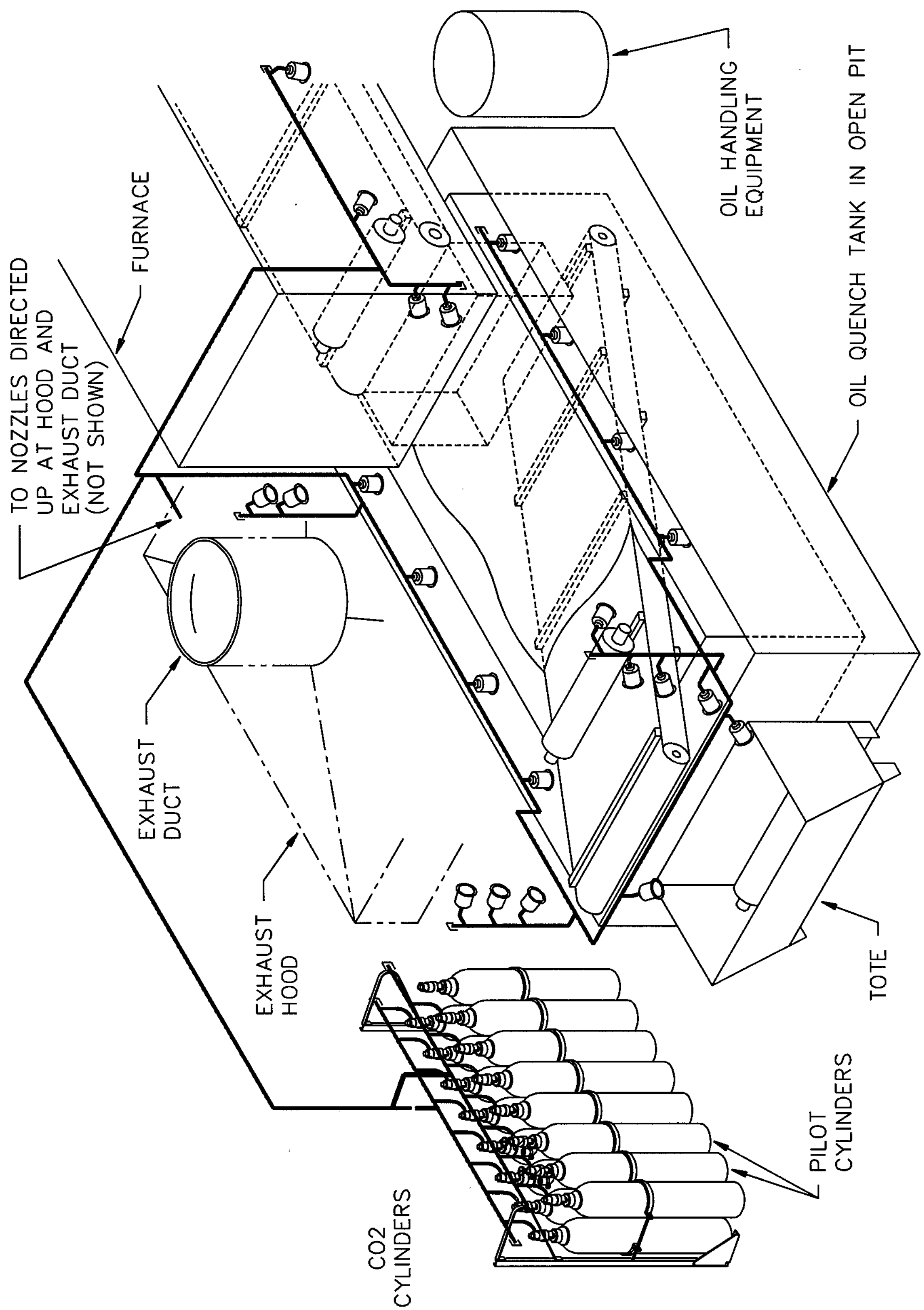
A low pressure system using overhead projection nozzles can also be very helpful in dealing with the problem mentioned earlier concerning the oil flaming up as large pieces are submerged. Several customers experienced excessive flaming due to elevated oil temperatures at the end of larger than normal production runs. Before each quench, they used the spurt feature of the CO_2 system to lay a blanket of heavy CO_2 vapor (held in by the freeboard of the tank) on the oil surface. This substantially reduced the flaming and resultant smoke.

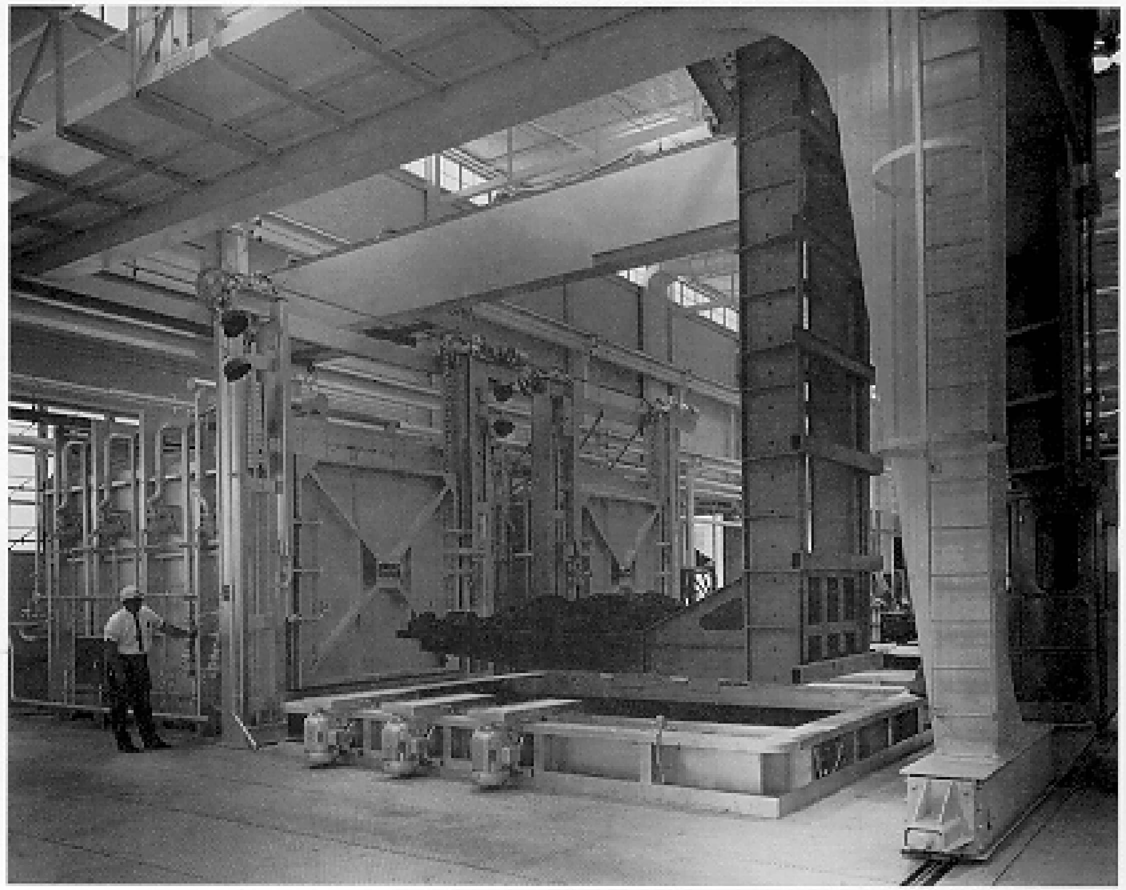
As indicated in Part 1, most of these systems are manually operated. If automatic operation is used, the actuation setting of the fire detectors must be slightly lower than that of any fire sprinklers in the same area, allowing the primary CO_2 protection system to discharge and suppress the fire before the sprinkler system activates.

It is good conservative design practice to set the CO_2 discharge time at longer than the minimum 30 seconds of equilibrium CO_2 flow to allow for additional cooling. (Remember, this would be natural cooling since the cooling capacity of the CO_2 in this type application is inconsequential.)

As mentioned in Part 1, the selection of either a high pressure system (as shown here) or a low pressure system (as shown in Part 1) is based on determining the protection configuration required and a cost/benefit analysis. Some quench facilities obviously call for one type or the other, but good CO_2 fire protection can be provided by either.

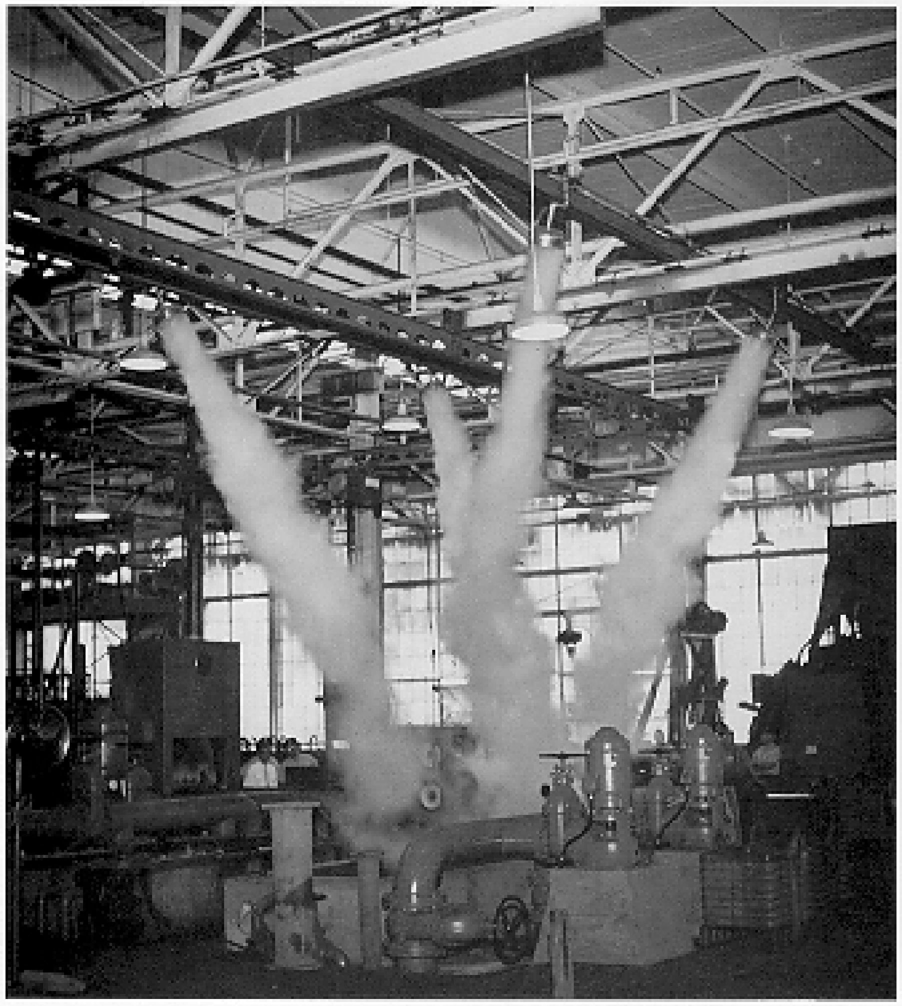
CO_2 Fire Protection for Heat Treating Facility with Open Quench Tank





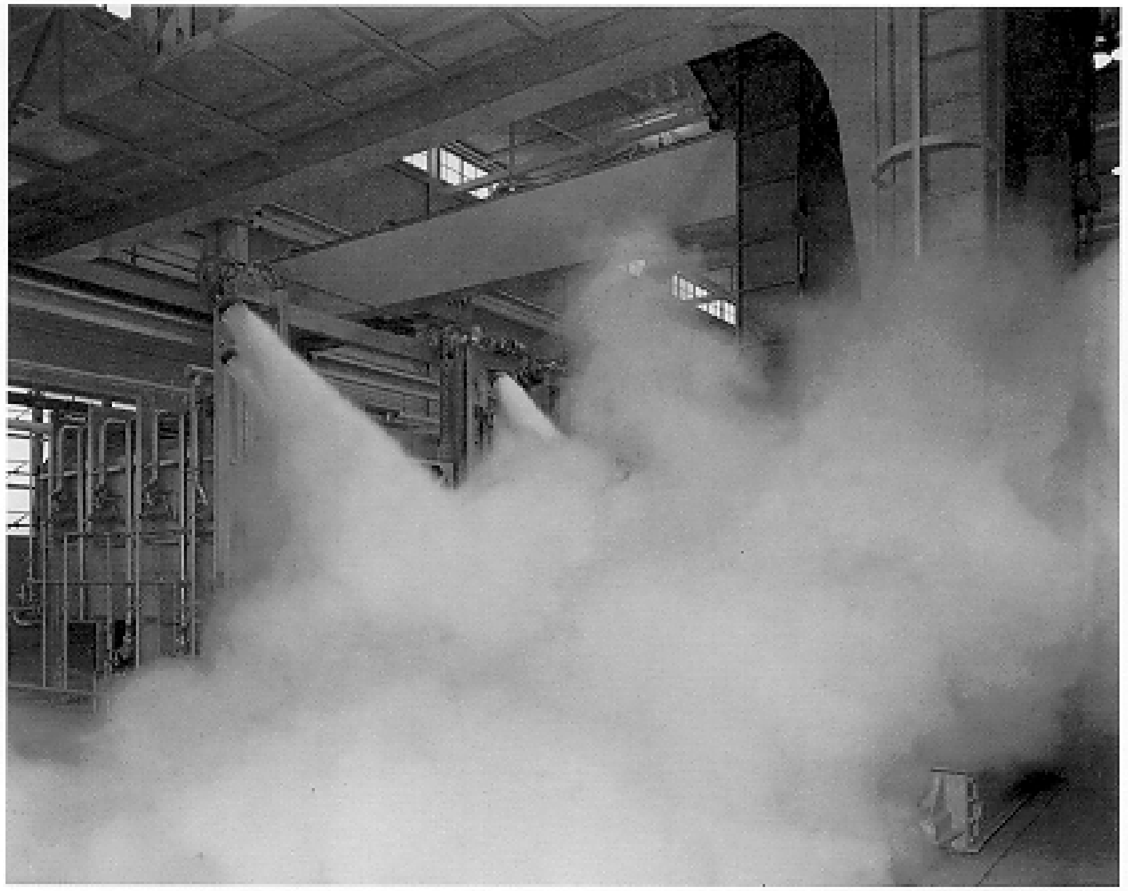
Manual System Actuation

Start of CO_2 Discharge



Start of CO_2 Discharge

Protection of Oil Quench Tanks utilizing *projection* nozzles to avoid interference with an overhead crane (left) or a material manipulator (above and right).



Full Discharge