Guidelines for Diisocyanate Storage Tank Systems

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Purpose

The following guidelines have been developed to describe possible equipment options for storage tank systems intended for diisocyanate product service, specifically Monomeric Methylene Diphenyl Diisocyanate (MMDI), Polymeric Methylene Diphenyl Diisocyanate (PMDI) and Toluene Diisocyanate (TDI). Each item on this reference table is more fully described in the subsequent text. This reference table is not meant to be all-inclusive and may not cover all the legal requirements for storage tanks at a particular facility or operation. Consult your supplier for additional information. Consider each item and refer to the accompanying text for discussion. Use of this reference table is not a substitute for the thorough review of the equipment guidelines for diisocyanate storage tanks found in the body of this document.

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	Product		
	MMDI	PMDI	TDI
1. Impervious Spill Containment	▲	▲	▲
2. Material of Construction			
Unlined Carbon Steel	■	▲	▲
Lined Carbon Steel	■	■	■
Stainless Steel	■	■	■
3. Tanks: General			
Above Ground	▲	▲	▲
Safe Access to Top of Tank	●	●	●
Adequate Tank Capacity	▲	▲	▲
4. Pressure/Vacuum Rating			
Known Working Pressure Rating and Vacuum Rating	▲	▲	▲
API or ASME Rated	●	●	●
5. Dry Air or Nitrogen Pad	▲	▲	▲
6. Venting	▲	▲	▲
7. Pressure/Vacuum Protection			
Primary Vacuum Protection	▲	▲	▲
Secondary Vacuum Protection	●	●	●
Primary Pressure Protection	▲	▲	▲
Secondary Pressure Protection	●	●	●
8. Level Indicator	▲	▲	▲
9. Level Alarms			
Low-Alarm	●	●	●
High-Alarm	●	●	●
10. High-Level Switch			
Independent of level indication system	●	●	●
Terminates flow into tank	●	●	●
11. Temperature Control	▲	▲	▲
Temperature Indicator	▲	▲	▲
Low Temperature Alarm	●	●	●
High Temperature Alarm	●	●	●
Insulation	▲	■	■
12. Agitation/Re-circulation			
Tank Agitator	■	■	■
Tank Re-circulation System	●	●	●

	Product		
	MMDI	PMDI	TDI
13. Transfer Pump			
Sealless Type	●	●	●
Pressure gauge on discharge side of pump	▲	▲	▲
Drain valves capped or plugged when not in use	▲	▲	▲
Located Inside Containment	●	●	●
14. Piping			
Carbon Steel	N/A	▲	▲
Stainless Steel	▲	■	■
Heat Tracing	▲	■	■
Insulation	▲	■	■
15. Gasket	▲	▲	▲
16. Filters/Strainers	■	■	■
Drain/Vent Valves With Caps or Plugs	▲	▲	▲
Pressure Gauge on Both Sides of Filter	▲	▲	▲
Located Inside Containment	●	●	●
Temperature Control	▲	■	■
17. Safety Considerations	▲	▲	▲
Shower & Eyewash	▲	▲	▲
Fall Protection	▲	▲	▲

(MMDI) Monomeric Methylene Diphenyl Diisocyanate
(PMDI) Polymeric Methylene Diphenyl Diisocyanate
(TDI) Toluene Diisocyanate

▲ - Equipment typically found on storage tanks that service the identified diisocyanate, and helps provide a basic level of protection against spills, leaks, or injuries. The accompanying text provides additional information.

● - Equipment that also helps provide protection against spills, leaks, or injuries of the identified diisocyanate. The accompanying text provides additional information.

■ - Selection of this equipment depends on the specific product application, there may be several alternatives available. Additional information and guidelines are presented in the accompanying text.

Equipment Guidelines: Descriptions

1. **Impervious Spill Containment**

   Capacity and construction details of the containment area for a storage tank vary according to state and local building codes, but, generally, tanks are installed in areas intended to provide an impervious surface and a defined containment. EPA's distance to toxic endpoint for TDI under the Risk Management Program (RMP) regulations is calculated from the size of the spill surface area (40 CFR Part 68). Reducing the containment surface area may assist in keeping vapors from a worst-case release scenario from going off site. Intermediate containment also may be appropriate where polyols and diisocyanates share a common containment area. Certain containment area designs could possibly meet OSHA's definition of a confined space, so keep in mind whether access into these areas should be restricted. See 29 CFR 1910.146 for additional information on confined space requirements.

2. **Equipment Material Used for Construction**

   Tanks, piping, and associated equipment intended for diisocyanate service are constructed of metals such as carbon steel, stainless or others as approved by the product manufacturer. For quality control reasons, typically stainless steel or lined carbon steel are used for MMDI and modified MMDI. Fiberglass, PVC, polyethylene or other plastics are generally not used as materials of construction for diisocyanate service. The specific product or application involved may necessitate a specific material of construction. See supplier's safety data sheet (SDS) for materials to avoid or contact the supplier with additional questions.

3. **Tanks: General**

   Above ground tanks are used indoors and outdoors. Access to the top of the tank may be required for installing, inspecting, maintaining and calibrating equipment (i.e., level indication, system alarms, and relief devices).

   Tanks intended for diisocyanate service are typically located above ground. Underground storage tank permitting requirements and temperature controls make it largely impractical to consider underground storage (40 CFR Parts 280, 281, 282.50-282.105). Talk to your supplier for additional information on tank location and access.

   Tank capacity should be sufficient to handle amount of materials being delivered. It is important to contact your supplier for typical order size and tank capacity for cargo tank trailers or rail tank cars.

4. **Pressure/Vacuum Rating**

   Knowing a storage tank's maximum allowable working pressure (MAWP) rating will help to properly size relief devices, such as pressure relief devices, vacuum relief devices and to determine the appropriate set point for tank pad pressure. The American Society of Mechanical Engineers (ASME) and the American Petroleum Institute (API) provide pressure-rating certification for storage tanks (API 650, 620 Code, ASTM Section VIII). Tanks built to these ASME or API code will have a specification plate affixed that will include the pressure ratings.

5. **Dry Air or Nitrogen Pad**

   Tanks in diisocyanate service are generally padded with a source of dry, inert gas having a dew point of -40°C/F. Both dry air and nitrogen have been used successfully as inert gas pads. In applications sensitive to the presence of oxygen, nitrogen may be more appropriate than dry air. Pressure regulators, relief devices and a pressure indicator are typical components of a tank padding system. Use of air or inert gas with a higher

dew point (above -40°C/F) could cause formation of solids (polyurea) in the storage tank. Consider a device, with an alarm, for measuring the dew point of the inert gas supply.

6. Venting

Tank overpressure may be prevented during unloading or filling operations by properly designing and installing the tank venting system. For example, if a pump unloading system is employed, it may be possible to return vapor build-up in the receiving tank to the container being unloaded. If a pressure unloading system is used, vapors can be discharged into a suitable treatment system. Further, activated carbon has been used successfully in removing diisocyanate vapors from a vent gas stream. These options, by providing alternatives to venting tanks directly into the working environment, help limit workplace exposures and keep levels below legally permissible limits.

7. Pressure/Vacuum Protection

Relief valves are intended to provide protection from high pressure in diisocyanate storage tanks. Typically, diisocyanate tanks are equipped with two, and sometimes more, means of pressure relief to protect the tank. In most tanks, the primary pressure relief device is a pressure vent or the pressure side of a pressure-vacuum conservation vent. A pressure vent or rupture disk is sometimes used as secondary pressure protection. In order to protect against over-pressurization, the set points for these relief devices are often set higher than the set point for the tank's blanketing and padding system, but lower than the tank's maximum allowable working pressure rating.

To prevent potential implosions, it may be appropriate to equip diisocyanate storage tanks with a means of vacuum protection. Vacuum protection may be accomplished with a vacuum vent, the vacuum side of a pressure-vacuum conservation vent, a rupture disk, a vacuum breaker or any combination of the above.

A scheduled inspection and preventive maintenance program can be effective in helping to prevent failure or malfunction of pressure and vacuum relief devices.

8. Level Indicator

A level indicator provides a means to identify the volume of liquid in a diisocyanate storage tank. Level indication systems that have been used successfully include weigh scales, pressure transmitters, by-pass visual level indicators made of steel, radar, sonar, and ultrasonic devices. Glass and plastic sight tubes may not be suitable because they can become opaque or plugged, leading to an inaccurate level reading or detoriate and break. The result could be a significant spill from a tank overflow or a leak in the tube. A scheduled inspection and preventive maintenance program can be effective in helping to prevent failure or malfunction of tank level indication systems.

9. Level Alarms

Low-level alarms help protect transfer pumps from being run dry, which can damage the pump. High-level alarms can help alert operating personnel before

the tank is overfilled. These alarms may function from the tank's level indication system or can be separate devices installed in the tank sidewalls. A scheduled preventive maintenance and calibration program can be effective in helping to prevent failure or malfunction of tank level alarm systems.

10. High-Level Switch

High-level shut-off switches aid in preventing tank overflow. For pressure unloading systems, this switch would be interlocked to an automatic valve in the unloading piping. For pump unloading systems, the switch would be interlocked to the unloading pump. It is designed so that a critical high-level would activate the switch, closing the automatic valve and/or shut off the unloading pump depending on system design. Depending on the unloading method, simply shutting off a centrifugal pump may not completely stop the flow of product into the tank.

Keeping the switch independent from the tank level indication system can provide a backup system in the event the primary level indication system fails. A scheduled preventive maintenance and calibration program can be effective in helping to prevent failure or malfunction of a high-level shutoff switch.

11. Temperature Control

The freezing point of the specific product involved and the desired processing temperature helps determine the appropriate degree of temperature control for diisocyanate products.

Temperature control measures may include, but are not limited to, temperature controlled rooms, electric tracing systems, external heating panels, external heating coils, insulation, and external heat exchangers on re-circulation loops, or combinations of these items. The most widely used heating mediums include tempered low-pressure steam, water, glycol and oil. System design considerations also include potential for cross contamination of heating medium and product and avoiding localized heating which could result in the creation of a dimer within the material. Use of internal coils (versus external coils) in diisocyanate vessels can present a potential hazard because an adverse chemical reaction could occur if the coils fail.

Outdoor storage tanks that are insulated also can include measures such as cladding to help protect the insulation from weather. However, outdoor carbon steel tanks can be at risk of corrosion due to wet insulation.

Diisocyanate storage tanks connected to an auxiliary heat source are typically equipped with a temperature indicator and a temperature alarm system. For products where tight temperature controls are appropriate, both low and high temperature alarms can be used.

Note: Isocyanate products will slowly begin to decompose at temperatures >160°C (>320°F). At higher temperatures, decomposition will be extremely rapid and a large volume of carbon dioxide gas and other dangerous byproducts can be formed. The proper design of temperature control systems helps prevent possibility of localized overheating.

12. Agitation/Re-circulation

The decision of whether or not to use a tank agitator is usually based on the particular product application. When used, consider whether the agitator's material of construction is consistent with that used for the tank. In addition, consider whether any gasketing materials are compatible with the diisocyanate involved.

Piping that permits the contents of a diisocyanate tank to be re-circulated can aid with temperature control and provide a location for the installation of a heat exchanger and filter. During system design, consider accounting for the amount of heat certain types of pumps may input into a product.

13. Transfer Pump

Both canned motor and magnetic drive, sealless pumps have a long history of service with a variety of diisocyanate products. Either a centrifugal or positive displacement pump may be appropriate, depending on the product involved. Product transfer pumps are typically installed on an impervious surface inside a defined containment area. Pump installations can include a pressure gauge in the pump discharge piping. An isolation valve, installed between the gauge and the piping, can facilitate gauge replacement. Isolation valves and drain or bleed valves, installed on both sides of the pump, can aid in future maintenance activities. Drain or bleed valves are typically placed at a low point in the piping system, but high enough to permit a catch container to be placed under the valves. The materials of construction for all wetted pump surfaces and for the pressure gauge and drain or bleed valves are consistent with that used for the transfer piping.

14. Piping

Material of construction for unloading, re-circulation and transfer piping for diisocyanate service is typically consistent with that required for the bulk tank. Fiberglass, PVC, polyethylene or other plastics typically are not considered appropriate options for construction of diisocyanate piping due to the potential for permeability and embrittlement. Depending on the product involved and the specific geographic location, temperature control, including heat tracing and insulation, may be appropriate for unloading and transfer piping. Outdoor piping that requires insulation can include cladding to help protect the insulation from weather. Unprotected outdoor carbon steel piping is at risk from the potentially corrosive effect of wet insulation and thus merits evaluation of appropriate protection. The type of heat tracing used could include electric, hot water, or a mixture of glycol and water. The type of tracing used will also be a product specific and application-dependent decision.

15. Gasket

Typical gaskets, including non-graphited gaskets impregnated with Polytetrafluoroethylene (PTFE) fluorocarbon or braided PTFE fluorocarbon fiber, are commonly used. Spiral-wound gaskets made of PTFE fluorocarbon have also been used with success. Depending on the application, other materials of construction may be considered. Contact your supplier for additional information.

16. Filters/Strainers

Filters or strainers may be appropriate for many diisocyanate bulk systems, and can be installed in the product unloading piping, in the tank re-circulation piping, or in both places. Bag and cartridge filters or basket strainers have been used successfully in diisocyanate service. Micron or mesh rating for the filter or strainer will vary, depending on the product involved and the specific application. Filter or strainer installations may include isolation valves, drain valves and pressure gauges on both sides of the unit. Isolation and drain valves allow the filter or strainer to be blocked in and bled down for changing, while pressure gauges allow operations personnel to view a pressure drop across the filter or strainer

to determine when the elements need to be replaced. The filter or strainer system is typically installed on an impervious surface inside a defined containment area. The drain valves are placed at a low point in the system, but still high enough to permit a catch container to be placed under the valves. The materials of construction for the filter or strainer housing, drain valves and other wetted parts are consistent with that used for the transfer piping. Isolation valves, installed between the pressure gauges and the piping, can facilitate gauge replacement.

17. Safety Considerations

Safety considerations include but are not limited to, providing a safety shower and eyewash installation in handling areas (including unloading and bulk storage areas). Such measures can help in situations where there is a potential for diisocyanate exposures. If a shower and eyewash are installed, then they should be installed and maintained in accordance with ANSI Z358.1.

Fall protection must be considered when discussing access to the top of the storage tank. Fall protection must be constructed and used in accordance with current OSHA standards, and all elevated work must comply with OSHA's fall protection standards (29 CFR Part 1910).

LEGAL NOTICE

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