Carbon Dioxide Storage:

Choosing Between Urethane- or Vacuum-Insulated Units

A few years ago, refrigerated, urethane-insulated carbon dioxide (CO_2) storage units were used in virtually all applications. In recent years, however, vacuum-insulated equipment has gained in popularity, bringing with it confusion regarding which technology is best suited for which application.

The purpose of this article is to provide readers with enough information on carbon dioxide and carbon dioxide storage equipment so they are able to make informed decisions when it comes time to select CO_2 storage equipment.

Most urethane-insulated units manufactured before the early 1980s had mastic or fiberglass outer jackets. Many of these units remain in use throughout the world today. In the early 80s, however, designers switched to an aluminum outer jacket, a move that met with great success in the industry. Today, aluminum-jacketed, urethane units have a well-deserved track record of durability and service.

One of the more historic problems associated with urethane-insulated units was their susceptibility to moisture that could saturate the insulation over time and then have to be replaced. This problem was particularly troublesome with mastic-jacketed units because moisture has a more debilitating effect on the mastic insulation than it has on fiberglass.

The use of aluminum-jacketing has virtually eliminated this problem. The only time it seems to arise is when the outer metal jacket is punctured and repairs go unattended for an extended period of time. The need to reinsulate these units is almost unheard of today and many of those early models are still in service in "like new" condition.

Both urethane- and vacuum-insulated units have an inner, carbon steel pressure vessel manufactured in compliance with the ASME Code, Section VIII, Division I.

DIFFERENCES IN MAINTENANCE

If a vacuum-insulated unit loses its vacuum, its insulation value is immediately lost. The leak must be located and repaired and a new vacuum must be pulled on the unit. Downtime will vary depending on the extent of the damage and the time required to locate the leak, make the repairs and pull a new vacuum.

In most cases, on-site repairs can be made using a variety of sources in most countries throughout the world

If the exterior of an aluminum-jacketed CO_2 storage unit is damaged, repairs can be made locally with virtually no downtime. However, if repairs to the outer aluminum jacket are not completed as soon as possible, the interior insulation can become saturated and the unit will then have to be reinsulated.

The insulation factor for a vacuum-insulated unit is seven to ten times greater than that of a urethane-insulated unit. Generally, urethane units have Six to Eight inches (150 - 200 mm) of insulation. In most parts of Globe, however, six inches (150 mm) is the norm.

Some companies in US use standard 4 inches of PUF. Studies have been conducted on four- and six-inch-thick urethane-insulated, 30-ton horizontal CO_2 storage units. Actual heat entry and holding times were determined from these tests. The conclusion reached was that units with six inches of insulation out performed those with only four inches of insulation by a margin of 34 percent, based on their individual heat-entry rates.

In some applications, heat-entry rates play an important role in determining which type of vessel to select. For most applications, a constant inside pressure of 250 to 300 psig must be maintained inside the CO_2 unit. When product is withdrawn from the unit, heat also is removed and must be replaced to maintain a proper working pressure.

Head Office: 1404, Chiranjiv Tower, 43, Nehru Place, New Delhi 110019, India
Phones: 0091 (011) 26447075, 26447076 • Fax: 0091 (011) 26426647
E-Mail: info@gifindia.com, gifindia@touchtelindia.net, gifindia@vsnl.com

In the case of vacuum-insulated units, the increased insulation value allows for very little heat entry. Therefore, when CO_2 is withdrawn from this type of unit, a vaporizer is required to maintain the proper operating pressure.

If the pressure inside the unit is allowed to drop below the triple point (60.4 psig, 4.16 bar and –69.9°F [-56.6°C]), the CO_2 will convert to dry ice. If this happens, the unit would have to be removed from service for a prolonged period of time to allow pressure to return to normal operating conditions. You can readily see, for this type of application, the heat-entry rating of urethane-insulated units can be very helpful.

When storage units are located in high ambient temperatures, and little or no product is being withdrawn for prolonged periods of time, a refrigeration unit will be required. In many applications, such a fire protection and batch applications, refrigeration will be required on both urethane- and vacuum-insulated units.

It would be misleading to state that either type of unit will never require a vaporizer or refrigeration system, or that all urethane units require a refrigeration system. The specific application, frequency of usage and amount of product withdrawn will determine the best type of insulation and accessories required.

For applications where vapor or a large amount of liquid CO_2 is withdrawn on a regular basis, a refrigeration system is not required. Urethane systems are manufactured with SA 350 LF2 flanges in manholes and with internal evaporation coils as standard equipment when refrigeration system is required. External refrigeration systems have been developed for those units manufactured without an evaporator coil inside the unit.

In general terms, the capital cost of a urethane-insulated storage unit will be less than a vacuum-insulated storage unit. However, that statement concerns only the cost of the CO_2 storage unit itself. The purchaser should evaluate the total operating cost and life expectancy of the unit under consideration, including a vaporizer and/or refrigeration system, if required, to determine if a urethane- or vacuum-insulated unit is best for their needs.

If you determine a vaporizer and/or a refrigeration system is needed, the operating cost of that equipment also should be calculated into the cost analysis. To develop a good cost analysis, the following information is necessary:

- Capital cost of CO_2 storage unit;
- Capital cost of application equipment;
- Depreciation schedule on storage unit;
- Depreciation schedule on applications equipment;
- Installation cost, including foundation required; and
- Estimate of equipment maintenance schedule and cost.

The maintenance on a vaporizer is minimal. Today's refrigeration systems are environmentally safe and virtually maintenance free. If maintenance ever is required, certified service technicians are available throughout most of the world.

Where space is limited, vertical CO_2 units are more readily accepted. Both PUF & Vacuum types can be offered.

However, when there are no limitations on space, horizontal units are a more economical choice. Foundations for vertical storage units are much more costly than for horizontal storage units.

In addition, standard vertical units are generally only available in sizes up to 50 tons (45 metric tons) capacity. Standard horizontal units are available with capacities ranging up to 120 tons (109 metric tons).

Obviously, there is a place in today's market for both types of units. The best advice to heed when selecting which one is best for you is to let the specific application determine your ultimate decision.

For more information you may contact us at
Ph : 0091-11-26447075 / 26447076/ 51608246

Fax : 0091-11-26426647

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