Design Considerations for Cold and Cryogenic Piping Systems

Cold and cryogenic piping systems present the mechanical engineer with very challenging design considerations in trying to build an efficient functioning pipe insulation system. Cold piping like ammonia refrigeration and cryogenic piping in almost all ambient environments will have a continuous moisture vapor drive into the pipe insulation so the potential for pipe insulation to absorb water and reduce thermal efficiency is always there, along with the potential for pipe corrosion when steel piping is used.

So, in designing a below ambient pipe insulation system, the engineer must assume that even with the best vapor barrier the potential for the insulation to pick up moisture and the potential for pipe corrosion from this moisture exists. That's because in the real world, material applications are never 100% perfect.

Recognizing this, the engineer should select the most effective zero perm vapor barrier available; use a highly efficient moisture resistant insulation and have a corrosion protection layer in the system in the event moisture does penetrate the vapor barrier due to imperfect application of the components.

This system should work equally well on new piping applications and on retrofit applications that are already in service.

The Polyguard Insulation System as shown below is a proven insulation system for cold and cryogenic applications in both new and retrofit applications. It contains RG 2400 Gel, Styrofoam Insulation, Zero Perm or Insulrap Vapor Barrier and Metal Jacketing. This type of system has been the application of choice used for over 20 years on Ammonia Refrigeration pipe and tank for food & beverage service and other cryogenic pipe & tank applications.

RG 2400 Gel: This hydrophobic gel blocks moisture and oxygen from connecting with the anodes and cathodes in metal, just like Epoxy Paint products do. The difference is that RG products do not dry, cure or harden, so they are able to expand and contract with the pipe, tank or metal structure. On a painted surface, moisture can get in eventually and cause

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corrosion, particularly after the paint has cracked. RG products also contain a ph transforming chemical which performs a 3rd level of defense to passivate any moisture so that it can not connect with the anodes and cathodes in the metal structure. In addition, sand blasting is not needed for a great bond, we recommend SP-1 or SP-2 for surface prep, any loose scale should be removed via hand tool. Also, the product can be applied in all temperature conditions since curing is not an issue and the product will easily adhere to the metal structure in sub freezing temperatures. For these reasons this product has mostly replaced epoxy primers and paints for cryogenic applications.

Styrofoam Insulation: Extruded Polystyrene Insulation is the insulation of choice for cold storage and Ammonia Refrigeration applications due to its tightly closed cell structure. It is so resistant to moisture that it is also widely used as floatation billet devices for docking structures. The insulation version has the lowest moisture absorption rate of any closed cell foam in the industry, which means that it will retain its high aged R-Value for a very long time, as moisture cannot easily enter the cell structure. Compared to Urethane Spray Foam, the XPS product cell structure is void free and consistently tight for additional life expectancy, R-Value consistency and moisture resistance. Styrofoam has been in the market for over 50 years and is a superior product in cold pipe and cryogenic tank insulation.

ZeroPerm Vapor Barriers: Polyguard manufactures 2 types of vapor barriers, both of which are rated at 0.00 permeance. This means that if intact, the product will not allow vapor drive to pass through. This will further keep moisture away from the insulation and ultimately protect the pipe from contact with moisture. The 2 types of vapor barriers are Zero Perm film, and Insulrap which is also Zero Perm but has an additional rubberized asphalt layer for further protection against vapor drive. The layer of rubberized asphalt will self seal if the film gets punctured. Both products are good choices for cryogenic applications.

The Polyguard Products system described in this paper has been in use by many of the leading food and beverage producers in North America for almost twenty years. It's a proven system and continues to be the system of choice for most design engineers specializing in cold and cryogenic systems.

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