NRC-2 SUPERINSULATION

Installation

Two conditions are essential for the effective use of NRC-2:

1. Interstitial pressure of less than 10^{-4} torr must be maintained to eliminate gaseous conduction.
2. NRC-2 must be installed in a manner which minimizes solid conduction paths and prevents lateral gradients along multilayers.

To achieve these conditions, and optimize the overall design, the following information should be noted:

NRC-2 should be installed crinkled. Do not try to smooth it. The superinsulation should be applied to give minimum area, near the cold wall rather than the warm wall, and as loosely as possible. When the packing factor drops below 60 layers per inch, the superinsulation should be retained near the inner surface to minimize the area of heat leak.

To obtain optimum insulating performance, careful attention must be paid to every detail of cryogenic engineering design. NRC-2 reduces the heat flux to such an extent that other previously ignored heat leaks (due to supports, fill pipes and leads) can become predominant. Failure to consider this fact may result in the inability to obtain anticipated results.

For practical installation on irregular shapes, a template should be made for cutting the necessary shapes from sheets of NRC-2. Each blanket should be made up of approximately 12 layers. When using electric shears, the multilayers can be cut to conform to the template without welding at the cut edges.

Layers Per Inch

In most cases where there are limits to the thickness in a multilayer application, no significant reduction in heat leak will be achieved by increasing the number of layers beyond 80 per inch. The thinnest application which will provide dimensional stability is about 40 layers per inch. Optimum dimensional stability is usually achieved at 60-80 layers per inch (see Figure 2).

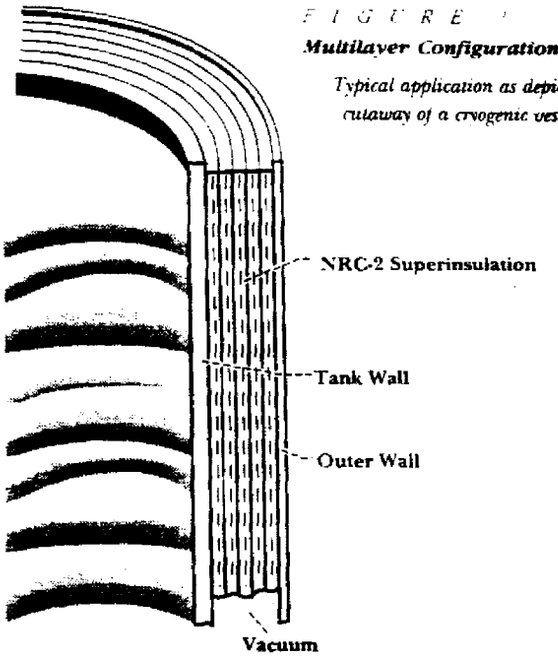

FIGURE 1

Multilayer Configuration

Typical application as depicted in a cutaway of a cryogenic vessel.

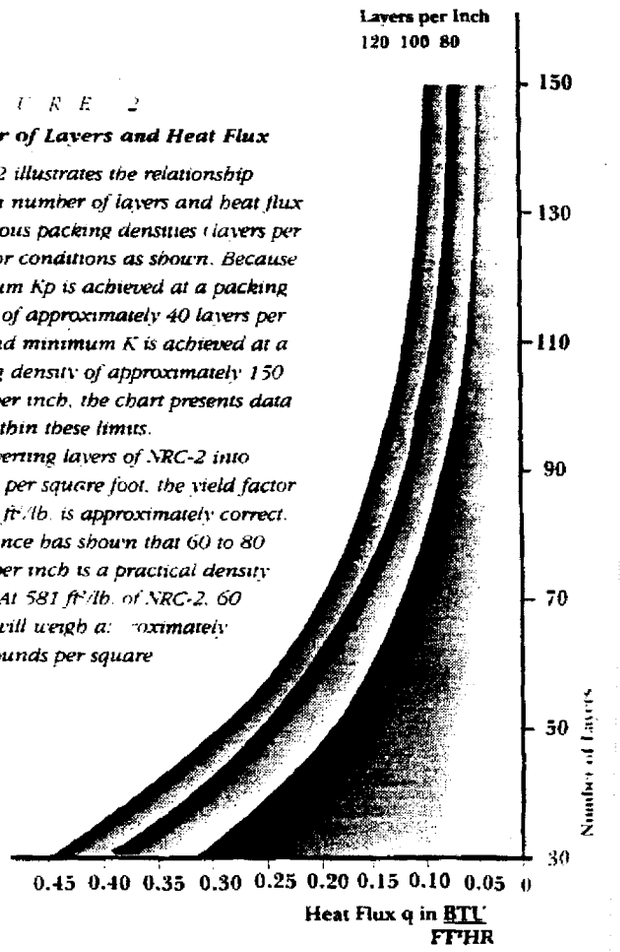

FIGURE 2

Number of Layers and Heat Flux

Figure 2 illustrates the relationship between number of layers and heat flux for various packing densities (layers per inch) for conditions as shown. Because minimum Kp is achieved at a packing density of approximately 40 layers per inch and minimum K is achieved at a packing density of approximately 150 layers per inch, the chart presents data only within these limits.

In converting layers of NRC-2 into pounds per square foot, the yield factor of 581 ft²/lb. is approximately correct. Experience has shown that 60 to 80 layers per inch is a practical density to use. At 581 ft²/lb. of NRC-2, 60 layers will weigh approximately 0.11 pounds per square foot.

Venting

Venting must be provided for minimum evacuation time. The superinsulation must never be sealed in a gas-tight package unless the envelope is designed to rupture during evacuation. NRC-2 is available with self-venting perforations, if desired.

Because spaces between the layers must be maintained at a pressure less than 10^{-4} torr, the edges of the layers should only be sealed together to keep the material in place.

Obtaining High Vacuum

To obtain the necessary high vacuum between layers in a sealed system, the raw material should be stored and used in a dry, dust-free environment. It is recommended that NRC-2 be handled only with lint-free gloves.

In fabricating vessels, attention must be paid to the many requirements of high vacuum engineering including welding techniques. Sealed system evacuation should use trapped diffusion pumping and a suitable getter and/or cryosorbent system. Bakeout temperatures should not exceed 280° F and continuous duty temperature should be limited to 200° F, if the material is to be subject to mechanical stress.

Where taping techniques are needed, such as for guarding cuts and holes, use a suitable heat sealable polyester base tape. Wherever edge tears are a hazard, the edges should be turned over and trimmed. Pressure sensitive tape should only be used for temporary support, and should be removed before subjecting the multilayers to pumpdown.

Isothermal Conditions

Isothermal conditions should be carefully established in each layer over the entire insulated surface. Interleaving techniques should be used to connect adjacent multilayers at discontinuities and penetrations. There should be no optical paths through the insulation at joints. Joints should be offset in successive layers as shown in Figure 3A.

Since the edge of a stack of layers represents a black body in incident radiation, it should not "see" any region of high thermal flux, see Figure 3B.

Tubes, cables and vessel supports require special attention for the efficient application of multilayer NRC-2. A superinsulation layer applied to a penetration should extend only to the point at which the temperature of the penetration is the same as that of the extended layer. This eliminates any lateral temperature gradient in the superinsulation, see Figure 3C.