



SUPERIOR PRODUCTS INTERNATIONAL II, INC.

REFRIGERATED UNITS

The technical requirements for transport refrigeration units are more severe than for many other applications of refrigeration. The equipment has to operate in a wide range of ambient temperatures and under extremely variable weather conditions (sun radiation, rain, etc.). It also has to be able to carry any one of a wide range of cargoes with differing temperature requirements, and it must be robust and reliable in the ever-changing transport environments.

Estimated diesel power requirements (as equivalent fuel use) for road units are from 11 kW for a typical van unit to 23 kW for a trailer unit, giving an overall figure of around 0.05 kWh per tonne km.⁶ This high power requirement is necessary to obtain a fast temperature pull down and fast recovery in distribution with many door openings. This corresponds to equipment with cooling capacity about 4 times the body heat loss cooled at -20°C and 10 times the body heat loss cooled at 0°C at 30°C ambient. Running hours may be between 1800 and 4000 hours per year.

Intermodal container units may require electrical power of around 2 kW for frozen goods and 5 kW for chilled, but this is very dependent on unit design and operating conditions. It is notable that the close temperature control requirements and more rapid air circulation needed for chilled goods result in higher power requirements than for frozen goods, despite the lower temperature differences to be maintained.

Although the degree of temperature control (and thus the degree of security for food safety and quality) in refrigerated transport equipment is excellent, the effects of equipment, packaging and stowage mean that this is achieved at the expense of energy use.

Good thermal insulation is a necessary part of efficient use of refrigeration, and changes in insulation foams, necessary for other environmental reasons, may increase power consumption. Insulation suffers degradation of thermal properties with time, which must be allowed for in energy budgets. For chilled cargoes in particular, new technologies such as Super Therm should be evaluated.

Typically, from the moment fiberglass insulation is placed in retail packaging, it is exposed to air, packaged, shipped, and placed on the shelf for shipment to the end user. The fiberglass insulation will lose 30% of its volume due to hydrolysis from the moisture trapped in the packaging.

It is imperative for the trailer's insulation to perform effectively year after year. Thereby, decreasing operational cost as the cooling unit will run less, consume less fuel, and require less maintenance. Extended productivity and a longer useful life cycle are also obtained as Super Therm® helps maintain the insulation performance as the trailer ages. As a refrigerated trailer ages, its insulation system will degrade because of trailer damage, moisture intrusion, or air loss. Insulation degradation is largely due to the normal aging of the trailer. The cooling unit has to work harder to make up for this loss of thermal efficiency, causing cooling unit run-times and fuel costs to increase. Eventually the insulation will degrade so much that the unit will not have enough cooling capacity to get the job done.

Even well maintained refrigerated trailer liners is permeable, meaning the liners allow gasses to escape and suffer insulation degradation over time. Refrigerated trailers are insulated with polyurethane foam, which is a light weight polyurethane foam insulation with a highly thermally efficient cell gas is the goal of the insulating process. When used in refrigerated trailers, polyurethane foam is injected into the walls, floors and ceiling, etc. A chemical reaction then takes place, during this process, the "insulating" gas in foam or the "blowing agent" expands the foam and is retained in the cell structure of the polyurethane matrix. However, over time, some of the cell gas escapes from the foam and air migrates into the cells. As more of the insulating cell gas escapes and air gets into the cells, the polyurethane foam loses its insulation capacity. This is called thermal degradation and happens to the polyurethane foam insulation in all traditionally lined refrigerated trailers.

Until now, the only way to compensate for the decreasing insulation performance has been to make sure the cooling unit has enough excess capacity to maintain temperatures over the course of time. But a refrigerated trailer coated with Super Therm will dramatically slow down the loss in insulation performance, extending the useful life, and increasing the effectiveness of the trailer. Super Therm helps to keep refrigerated trailer on the road and generating revenue by maintaining excess cooling capacity, decreasing unit maintenance downtime, and expanding its productivity.

The sun can heat a trailers roof surface to over 200°F. Most trailer roof substrates are poor reflectors of heat, absorbing as much as 98% of solar heat (radiation). The roofs become a solar oven; hot enough to cook an egg when the outside temperature is only 90°F. The sun's rays and high temperature transforms the trailer roof into heating panels radiating heat to every surface within the trailer. In refrigerated trailers this means that the cooling units must work harder to keep the perishable contents at their prescribed temperatures, using excess fuel and energy.



Longevity

- ◆ Super Therm® can also increase the longevity of the reefer roof. Ultraviolet (UV) rays from the sun break down many conventional roofing materials.
- ◆ Super Therm® reflects the sun's ultraviolet rays, and slows down roof aging.
- ◆ Super Therm® prevents corrosion, fights against the growth of mold, mildew, fungus, and algae.

Contraction/Expansion

The reefer roof materials also contract and expand daily as they heat up during the day and cool down at night.

- ◆ Super Therm® can lower roof and wall temperatures also reduce the rate of any chemical breakdown.
- ◆ Super Therm® reduces expansion and contraction of the roof, which helps to keep the roof seams from leaking.
- ◆ Super Therm® doesn't experience large daily temperature fluctuations so it undergoes less thermal fatigue.
- ◆ Super Therm® can increase roof and wall system life and significantly decrease maintenance and expenditures.

Insulation

- ◆ Insulation restricts heat conduction across walls, flooring, doors, and the roof of transportation vehicles. The load area is reasonably or even tightly sealed to restrict air leakage.
- ◆ Insulation limits the amount of ambient heat and humidity that enters the vehicle during hot weather and the amount of internal heat (mostly from the product) escaping to the outside, causing product chilling or freezing during freezing weather.
- ◆ Most insulation is foamed-in-place or components of extruded panels that are composed of materials that deteriorate slowly over time (about 5% of the insulating quality per year). Manufacturing improvements have brought about trailers with thinner walls, creating greater internal load space, while maintaining sufficient insulating capability for most conditions of produce transportation.
- ◆ Insulation can be damaged and its thermal barrier value lessened by lift truck damage during loading and unloading operations. Water intrusion that initiates at these damage points greatly reduces the insulation quality and even facilitates temperature transfer.
- ◆ Highway trailers typically do not have ducted sidewalls because this feature, while improving temperature management, adds weight and reduces the available load space. In hot weather, in particular, this may be an important factor in localized product temperature gain if produce is loaded directly against the sidewalls.

