How Insulation Works (or Doesn't)

Cold-Chain Challenges Explained

How the Kangaroo Mailer Works to replace EPS

Our Kangaroo Mailer controls all three methods of heat transfer in a cost-effective and compact shipping solution. High-quality polyurethane foam slows conduction while it cocoons your product and ice packs. The outside surface of the Kangaroo Mailer is much smaller than the boxes it replaces so convective and radiant heat gain is greatly reduced. All the void is squeezed out by the expanding foam, eliminating internal convection that shortens gel pack duration. The Kangaroo Mailer is available with a metallized exterior to improve radiant performance on your customer's doorstep (since the Kangaroo Mailer doesn't go into a box).

Because of all of the design benefits of an expanding mailer over an EPS cooler, the mailer can utilize less material to achieve the same results. This saves money and takes material out of the refuse stream.

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Insulation works by slowing the transfer of heat which can move in three ways: conduction, convection and radiation. Understanding the influence of these three methods allows one to make better and more informed choices.

Convection

Convection occurs when warmer areas of a liquid or gas move to cooler areas in the liquid or gas. Cooler liquid or gas then takes the place of the warmer areas. This results in a continuous circulation pattern. Water boiling in a pan is a good example of these convection currents.

Controlling convection is the most overlooked element in cold-chain shipping. Often taken for granted, closing the lid on an EPS cooler traps a certain amount of air within the container. By reducing the air space in a container you reduce convection and improve performance.

Conduction

Conduction is the transfer of heat between substances that are in contact with each other. The better the insulator, the slower heat will be transferred. Metal, as a good conductor, quickly transfers heat from one side to the other. Foam, as a good insulator, slows the transfer of heat.

Slowing conduction is the primary role of insulation. Most thermal shipping materials (EPS, FPF, denim, rock wool, etc) have comparable performance slowing conduction.

Radiation

Radiation is a method of heat transfer that does not rely upon any contact between the heat source and the heated object as is the case with conduction and convection. Heat is transmitted though empty space by thermal radiation (infrared radiation), a type electromagnetic radiation . No mass is exchanged and no medium is required in the process of radiation. Examples of radiation is the heat from the sun, or heat released from the filament of a light bulb.

Matte black surfaces absorb the most thermal radiation while mirrors absorb the least. If the mirror surface is dusty or in contact with a material with higher emissivity (ability to absorb) such as cardboard, that material will conduct the absorbed heat to the mirror surface, defeating all radiation insulation benefits.

Radiation is the least influential method of heat transfer when it comes from thermal shipping. Even in the most extreme environments, heat gain comes from the convection currents of air around the package conducting heat on to the surface of the package.

Metallized Barrier Film

Several thermal shipping options utilize a shiny metallic surface. These are not foil and are primarily an aesthetic feature that increases the cost of a product with no measurable performance improvement when used inside of a carton. They are harder to recycle than non-metallized plastics.

R-Value Explained

Measuring R-Value of cold-chain insulation systems is like measuring gas mileage while you are rolling down hill. R-value is a measure of a material's resistance to heat transfer. The test method requires a technician to measure the thermal resistance of a 12"x12"x1" specimen placed between a cold plate and a hot plate while measuring the energy transfer required to maintain a certain temperature gradient. This does not take into account air movement,moisture levels, or size of the shipping container. If you shrink the exterior surface of a container, you are reducing the amount of area exposed to conduction, convection, and radiant energy. By shrinking the interior surface you achieve even better performance. Care needs to be taken to seal the container.