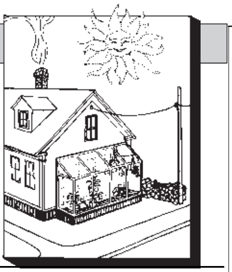

High-Tech Appliance Insulation

by Alex Wilson

Last month in this column I discussed the new restrictions on chlorofluorocarbons (CFCs), and how they might affect the way we insulate our houses and appliances. This month, we'll look at one technology being pursued as an alternative to CFC-blown rigid insulations for appliances: vacuum panels.

Anyone who has enjoyed a hot cup of coffee from a thermos bottle, can appreciate the ability of a vacuum to insulate. By reducing the number of air molecules in the evacuated space, conduction of heat from one molecule to another is greatly reduced. The same principal can be applied to panels used in insulating refrigerators, freezers, and water heaters.

Two approaches to vacuum panel insulation are currently receiving most of the attention: soft-vacuum-powder insulation and hard vacuum. The first of these is closest to commercialization.

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The soft-vacuum powder-fill insulation idea has been around for quite a while, according to Dave McElroy at the Oak Ridge National Laboratory, in Tennessee. The idea is to reduce the spacing between particles by creating a very fine powder, and then drawing a low-pressure vacuum to increase the distance across which heat must conduct from particle to particle. Most researchers use amorphous silica for the powder, because the material is structureless and has a low conductivity in its solid form. Heat loss across the material is greatly reduced.

It seems quite realistic that an R-25-per-inch vacuum panel with long-term stability can be achieved. Researchers in the U.S., France, Germany, Italy, and Japan are all working with this technology, although the exact level of that research is difficult to gauge, according to McElroy.

A French company, L'Airliquid, holds a U.S. patent on a soft-vacuum powder insulation panel, which it developed for insulating liquified natural gas tankers. Oak Ridge National Laboratory tested a prototype of their 2 inch-thick panel for 40 months, during which time its R-value went from 17 to 16.

A Japanese company, Matsushita, had a soft-vacuum powder insulation on the market three years ago, although production has apparently stopped. Oak Ridge measured the R-value of these refrigerator panels at R-18 per inch.

Here in the U.S., General Electric, in Louisville, Kentucky, was issued a patent on vacuum-powder insulation last year. Oak Ridge measured the R-value of the prototype panels at up to R-19 for a 1 inch-thick panel. Other U.S. manufacturers, including Whirlpool and Admiral, have been looking into vacuum panel insulation but are reluctant to talk about their research.

"The technology is pretty much in hand," according to McElroy; "now it's a question of refining and getting the economics right." Ken Downs at General Electric, who developed the vacuum-panel technology, indicated that his research team has developed good laboratory panels, but that nobody has developed an acceptable production process yet.

The other alternative being studied is a hard-vacuum panel. Tom Potter, at the Solar Energy Research Institute in Boulder, Colorado, has been the leading proponent of this technology With hard-vacuum panels, a much Larder high-pressure vacuum is drawn —about the same as a thermos bottle—and it is theoretically possible to produce an inch-thick panel with an R-value of 150-200, according to Potter.

In commercial production, Potter expects that much thinner vacuum panels, about a tenth of an inch thick, would be produced with an R-value of about 15. These panels could be used singly, or stacked with Offset edges, to insulate refrigerators, freezers and water heaters. Under the best of circumstances, however, hard vacuum panel insulation is quite a few ears away.

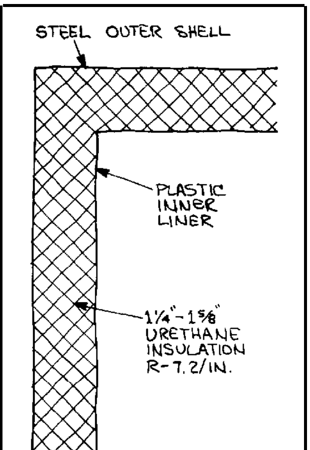

Figure 1

How these vacuum insulation panels might actually be used in refrigerators and freezers is indicated in the illustrations. Figure 1 shows a conventional refrigerator/freezer with rigid urethane insulation (one-and--quarter inches in the refrigerator portion and one-and-five-eighths inches in the freezer portion).

Figure 2 shows an inch of soft-vacuum powder insulation. with the remainder of the wall cavity filled with a non-CFC-blown rigid insulation. Researchers suggest that by maintaining the same wall thickness, appliance manufacturers would not have to spend as much money in retooling for vacuum insulation. Also, the rigid foam will add rigidity to the structure. A 16.7 cubic foot refrigerator/freezer with this configuration would use about 35 percent less energy than a conventional energy-efficient model.

Figure 3 shows a thin outer layer of hard-vacuum insulation, with the remainder of the wall cavity filled with rigid foam insulation (again, enabling manufacturers to avoid some retooling expenses). The foam provides most of the rigidity required for the unit. This option uses about 40 percent less energy than a conventional 16.7 cubic foot unit.

Multiple layers of hard vacuum insulation can be used without rigid foam insulation. Because of the very thin walls, a refrigerator with the same outer dimensions as today's 16.7 cubic foot model would have an interior volume of 22.8 cubic feet. However, the steel used for such a nit may need to be stronger to make up for the eliminated foam insulation in previously discussed designs.

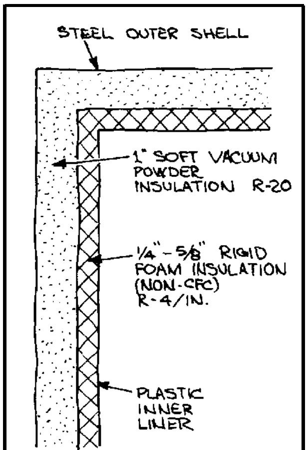

Figure 2

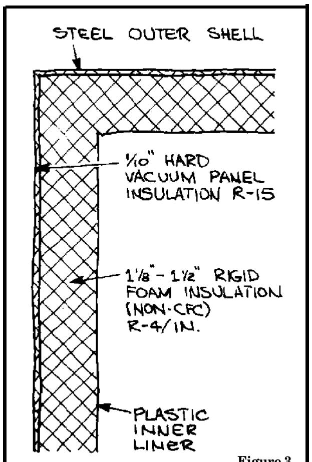

Figure 3

While hard-vacuum panels seem to offer a lot of potential for refrigerators and freezers, they may be even better suited to water-heater tanks. Water heaters are not subjected to the same mechanical stresses as refrigerators (opening and closing doors and moving them around), and the cylindrical shape lends itself well to vacuum insulation.

With all of these appliances, high temperature differences are maintained across the insulated walls, so high levels of insulation can easily be justified. In fact, if we use the "degree-day" approach to look at optimal insulation levels for these appliances, we come up with some rather remarkable figures. A typical freezer operates at about 30,000 degree-days per year, while refrigerator/freezers and water heaters operate at about 20,000. If we can justify R-30 insulation in a house located in a 7,000 degree-day climate, why can't we justify R-40 or R-50 for an appliance in a 20,000 to 30,000 degree-day "climate?"

Vacuum-panel technology makes those levels possible, while maintaining an acceptable wall thickness, and without using insulation produced with CFCs. ■

Alex Wilson is a technical writer based in Brattleboro, Vermont who specializes in energy and building issues.