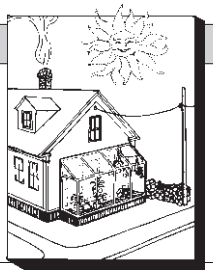
Foam Insulation and the CFC Problem

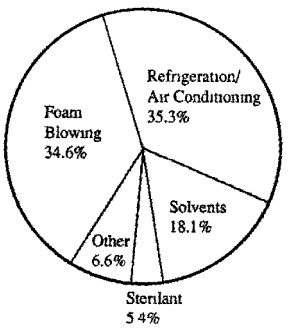


by Alex Wilson

The concern over ozone depletion in the upper atmosphere, and efforts to curtail the use of CFCs (chlorofluorocarbons), is likely to have far-reaching effects on the way houses are built. A recent conference in Washington, D.C., "Substitutes and Alternatives to CFCs and Halons," held January 13-15, brought over 600 people together from widely divergent backgrounds to discuss this issue.

CFCs, known most commonly by their DuPont tradename, "Freon," have been used since the 1920s as refrigerants, aerosol propellants, industrial solvents, sterilization fluids, and foam-blowing agents for both rigid and flexible foams. Halons are a more recent class of chemicals which are used in fire extinguishing.

United States
End-Uses of CFCs



Source*
United States EPA, December 1987

Both CFCs and halons are thought to cause depletion of the earth's protective ozone layer in the stratosphere, 15 to 50 kilometers above the earth's surface. Ozone plays a vital role by absorbing high-energy ultraviolet light. The chlorine and bromine introduced into the stratosphere by CFCs and halons react with the ozone, converting it to O_2, which does not absorb UV light. One chlorine or bromine ion can destroy several thousand ozone molecules. Reductions of ozone levels in the stratosphere, it is theorized, will cause widespread skin cancer, eye damage, immune system damage and other health and environmental problems.

Many man-made compounds contain chlorine and bromine, but most are fairly unstable and break down long before they can reach the stratosphere. CFCs and halons can last for more than 100 years because a their tremendous stability (this is one of the reasons the compounds have been so successful as refrigerants and foam-blowing chemicals). It takes the high energy of UV light to break the chemical bonds, so they aren't degraded until they get into the stratosphere—where the chlorine and bromine ions do their damage.

This problem was first recognized in 1974, and it led to the ban of CFCs as aerosol propellants by the U.S., Canada, and Scandinavian countries in the late seventies. After that, the issue was pretty much forgotten about until British scientists discovered an alarming "hole" in the ozone layer over Antarctica a few years ago. Reductions of as much as 85 percent of the ozone have been observed during the past two years, and evidence clearly indicates that the hole is growing. During the fall of 1987, in fact, the ozone over Antarctica thinned out so much that the scientists working there took measures to protect themselves from the high levels of UV light reaching the ground.

As a result of these findings, twenty-four nations signed a treaty, or protocol, in Montreal last year to freeze and gradually reduce CFC and halon production and use worldwide. The U.S. Senate is due to ratify the protocol early in 1988, and EPA has already proposed regulations for implementing it. The January conference, sponsored by EPA, The Conservation Foundation and Environment Canada, was an effort to bring together the industries that will be affected and share information on substitutes and alternatives.

I have been following this issue for several years with a special interest in how it might affect building technologies and practices. The conference in Washington reinforced my belief that our industry will be forced to undergo considerable changes. But to understand why, it is necessary to back up and describe how and why CFCs are used in rigid insulation materials.

Currently, all rigid-foam insulation materials, except expanded polystyrene (EPS), rigid fiberglass, and a few other less common products, are manufactured with CFCs as the blowing agents. The most common rigid insulation materials in the Northeast—extruded polystyrene, polyurethane, polyisocyanurate, and phenolic foam insulation—all are manufactured with CFC-11 or CFC-12.

In the manufacturing process, liquid CFC is mixed with the chemical components of the foam. The CFC, having a very low boiling point, boils immediately, and expands the foam. The result is a closed-cell rigid insulation material, with CFC gas filling the cells. Because CFCs conduct less heat than air, the insulation materials foamed with CFC have a higher R-value than those relying on trapped air for their insulation (including fiberglass, cellulose, and EPS). High R-value rigid foam has allowed us to build very well-insulated houses with relatively thin walls.

Estimated 1985 CFC-Blown Foam Insulation Market and CFC Use

Industry Segment	Foam Type	Mkt Size (MT)	Percent Market	CFC-11 (MT)	CFC-12 (MT)	CFC-113 (MT)
Insulating Laminates and Boardstock						
Lam Bdstk	PUR	9,140	53.5	12,800	0	0
Lam Bdstk	P S	49,100	28.6	0	2,950	0
Lam Bdstk	PhenoI	10,000	5.9	700	0	700
Bdstk-Bldg Cons	PUR	19,100	11.2	2,700	0	0
Bdstk-Indst Cons	PUR	1,300	0.8	190	0	0
Sub-Total		88,640	100.0	16,390	2,950	700
Poured Insulating Foams						
Bldg Const	PUR	19,100	19.8	2,290	960	0
Indust Const	PUR	3,000	3.1	360	150	0
Refrigeration	PUR	54,400	56.5	6,530	2,720	0
Transportation	PUR	19,800	20.6	2,380	990	0
Sub-Total		96,300	100.0	11,560	4,820	0
Sprayed Insulating Foam						
Bldg Const	PUR	61,200	65.3	7,340	610	0
Indust Const	PUR	22,900	24.4	2,750	230	0
Transportation	PUR	9,700	10.3	1,160	100	0
Sub-Total		93,800	100.0	11,250	940	0
TOTALS		278,740		39,200	8,710	700

MT = Metric Tons
PUR = Polyurethane and Polyisocyanurate
PS = Polystyrene

Source: Radian Corporation (U.S. EPA data), January 1988

So how will these materials be affected? It is possible that no changes will be necessary. If substitutes are found for CFC in other applications, the rigid insulation industry may be allowed to continue using CFCs without restriction. Or, future scientific studies may show that the ozone depletion theories are wrong. But neither of these possibilities seems all that likely. In fact, according to speakers at the conference, it is more likely that even greater restrictions on CFC use will be required to prevent for the ozone depletion.

In terms of alternatives to CFCs, there are a number of prospects for rigid insulation, but none look great. CFC manufacturers have been looking for non-ozone-depleting alternatives since 1974. Two major prospects have been identified to date for replacing CFC-11-HCFC-123 and HCFC 141b. FC-134a shows promise as a substitute for CFC-12.

All three have some drawbacks as foaming agents for rigid foam insulation, however. First of all, they are much more complex to make. The chemical reactions needed are multi-step and result in lower yields than the single-step production of CFC-11 and CFC-12. So production cost will be higher.

While that may not make much difference for a refrigerator manufacturer, who uses relatively little CFC, a doubling or tripling of the CFC cost will have a dramatic effect on rigid insulation manufacturers. Rigid foam is currently about 15 percent CFC by weight, so a big cost increase for the foaming agent will have a big effect on total cost. In fact, it could very easily price high-R-value insulation materials right out of the market.

Furthermore, the thermal conductivity of the proposed alternatives is lower than that of CFC-11 or CFC-12. Rigid foams produced with HCFC-123, HCFC-134a, or HCFC-141b will not insulate as well as the rigid insulation currently on the market. So you will spend more and get less. There are also concerns about flammability of HCFC-141b, compatibility of HCFC-123 with some plastics, and lower material use efficiency with HCFC-123 (it will take more material to produce a given volume of foam).

Based upon all I've heard and read, I believe that most high-R-value rigid insulation materials will be priced out of the construction market within 5 to 10 years. They will be unable to compete with EPS and various batt and cavity-fill insulations. Higher-density EPS board stock will come onto the market to satisfy some of the needs currently satisfied by CFC-blown rigid insulation.

I don't believe that high-R-value insulations will disappear altogether, however. They will still be needed for numerous specialty insulation markets, such as refrigerators, and in applications where fire safety, structural considerations, and other factors justify their much higher cost over EPS.

We can hope that a totally new product will be developed, with all of the advantages of current state-of-the-art rigid foam insulations, but without its drawbacks. After attending this conference, however, I believe such a product—if it could be developed—will have to be something totally new.

Whatever the outcome, the CFC issue is likely to keep a lot of researchers busy, and keep us busy following their new developments. ■

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