OPINION

# Environmentally responsible fluorocarbon products*

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*Hydrochlorofluorocarbons and hydrofluorocarbons are needed to achieve a rapid chlorofluorocarbon phaseout. These alternatives meet the safety, efficiency, cost, environmental and performance criteria required to convert existing systems originally designed for CFCs as well as in new systems.*

THE focus of this note is the family of fluorocarbon products that are commercially available today and their relationship to global warming. As we transition from chlorofluorocarbons, two issues will drive the technology and products we choose: ozone depletion and global warming.

There is now a global action plan to protect the ozone layer and minimize greenhouse gas emissions. The Montreal Protocol is truly a historic agreement developed with the cooperation of governments, scientists, industry and environmental groups. The Protocol calls for a complete phaseout of CFC production in industrialized nations by the end of this year. Newly industrialized nations may cease CFC production by the year 2006. In any case, the phaseout will require nearly every industry to convert from CFCs to environmentally acceptable alternative products and technologies.

With this in mind, we should ask ourselves whether we are doing the right kind of things. Is the Montreal Protocol working? The scientific evidence is credible and the Protocol is helping us find alternatives which will not deplete the ozone layer.

As we move forward, newly industrialized nations will have similar challenges. With the CFC production phaseout for such nations approaching within the next decade or so, there is much that can be learned and adapted from the experience base that exists today. Equally important is the positive role that all nations can play in considering and suggesting better solutions. One such solution is the use of environmentally responsible fluorocarbon technologies that are readily available.

Fluorochemicals were used globally in every aspect of our daily lives. We need refrigerants to keep our food cold and preserve the freshness of our vegetables and meats. We use aerosol propellants in personal care and industrial sprays as well as in pharmaceutical products. Foam blowing agents provide a foundation for building insulation and food packaging. Fire extinguishing agents aid us in suppressing or extinguishing fires, and solvents are used in the cleaning of critical electronic, optical and medical devices. All of these products traditionally used fluorocarbons. I use the term 'fluorocarbons' in a generic sense in that they all contain fluorine. They have significant social and economic benefits.

Alternative products to CFCs include hydrofluorocarbons, or HFCs, and hydrochlorofluorocarbons, or HCFCs, and other speciality non-CFC chemicals which provide for timely, cost-effective, and environmentally responsible solutions. Unlike fully halogenated CFCs, HFCs contain no chlorine and, therefore have zero ozone-depletion potential. HCFCs contain some chlorine but have only two to ten per cent of the ozone depletion potential of CFCs. We are aware of the advantage a majority of the HCFC and HFC alternative products have with regard to atmospheric lifetime. On average, it is less than 14 years. Thus there is a much lower ozone destruction potential from these products than from CFCs, which have lifetimes averaging about 100 years.

HCFCs and HFCs offer viable options for achieving a rapid phaseout from CFCs. They meet safety, environmental and performance criteria and work in existing systems originally designed for CFCs or with minor equipment modifications. They have been studied extensively with the above objectives in mind.

Although alternative fluorocarbon technologies provide a good balance of social, economic, and environmental benefits, they have also come under attack as contributors to global warming. The fluorocarbon industry shares concerns about possible impact of global warming and its potential social and economic effects. We know that the emissions of greenhouse gases are a result of both natural processes and human activities. For example, carbon dioxide is emitted by animals and plants during respiration, and other natural activity. Additional contributors to carbon dioxide emission include the burning of biomass and fossil fuels as well as other industrial activity. The major anthropogenic greenhouse gases are carbon dioxide, CFCs, methane and nitrous oxide.

There has been considerable research and discussion related to the effect of CFC alternatives on global warming. Obviously this effect has to be considered in the context of global warming from all sources as it relates to sustainable development.

In this regard, the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS) and the US Department of Energy co-funded two studies using a systems approach to determine the overall contribution of CFC alternatives to global warming. These studies assessed the direct contribution of greenhouse gases used to make or operate the systems, and the indirect contribution of carbon dioxide emissions resulting from the energy required to run the systems over their normal life. Both should be considered when determining the total global warming impact of the system. The sum of the direct and indirect emissions of greenhouse gases for the technologies considered is referred to as 'total equivalent warming impact' or TEWI. The calculated TEWI is sensitive to assumptions of the system lifetime,

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emission losses, and the integration time horizon chosen to calculate the global warming potential values as well as the source and consumption of energy.

Based on this systems approach, the *main conclusions of these studies pub*lished in September 1995 include the following:

The use of non-fluorocarbon and not-in-kind technologies may expand in already established niche markets, and other NIK technologies may find new market applications. But it appears unlikely that conventional HFC technologies can be displaced to any large degree in the foreseeable future.

Energy efficiency is a powerful tool to mitigate future potential climate change. In most applications, HFCs are the most efficient and safest available technology.

In many applications, not-in-kind technologies will need to compete with the demonstrated continuing improvements in efficiency, emissions control, and product reclamation of conventional refrigeration, air conditioning, insulating, and cleaning/drying technologies.

As it pertains to global warming from the use of refrigerators and freezers, Figure 1 which uses data from AFEAS shows the calculated and normalized radiative forcing associated with CFC-based equipment and those based on HFCs and HCFCs. A comparison of the upper portions of the two graphs shows the overall improvement which arises from the use of alternatives such as HFCs and HCFCs. Also included in these charts is the contribution due to the carbon dioxide from the energy use associated with the household refrigerator.

In the lower graph is shown a sharp spike, the release of the blowing agent used in the insulation of the refrigerator. This is assuming that the refrigerator is crushed after its normal useful life. The very narrow region above this spike is from the refrigerant itself. The area under the curves represents the global warming effect from time-zero to a designated number of years. Both charts show that the carbon dioxide resulting from the energy use of the refrigerator itself will contribute to global warming even 500 years later.

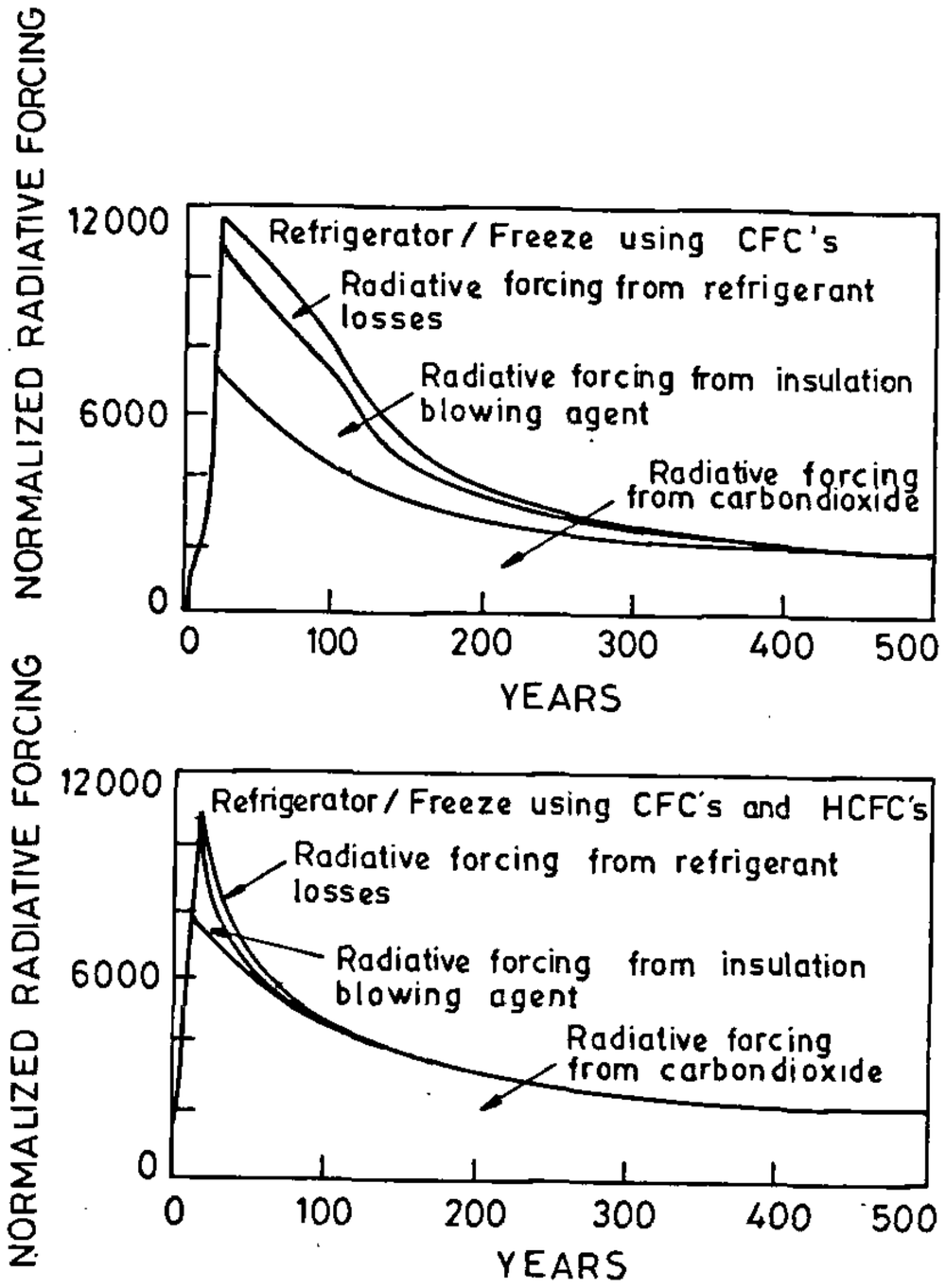


**Figure 1.** Contributions to global warming from refrigerator/freezers.

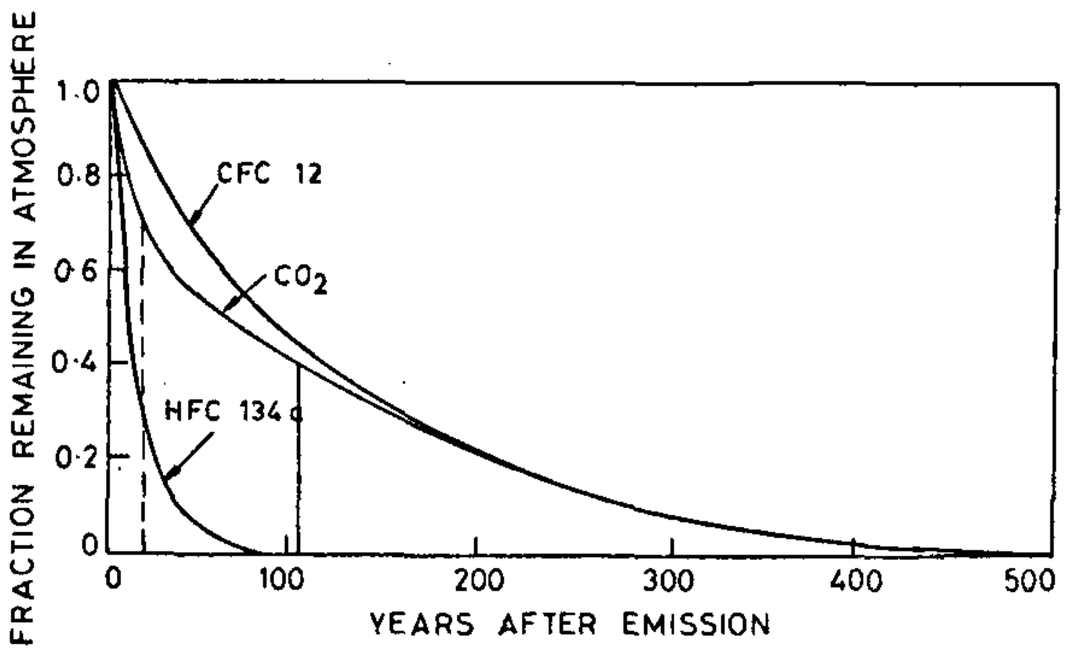


**Figure 2.** Purge rates for some global warming gases.

To evaluate contributions to global warming, there also needs to be agreement on the appropriate time span over which the global warming potentials should be calculated. Assessments of the global warming potential of several compounds are available for time horizons of 20, 100 or 500 years. I referred to the long-lasting effect of carbon dioxide earlier. The need for agreements on acceptable time spans is due to the differing purge rates of greenhouse gases

from the atmosphere. For example, Figure 2 shows that if the integrated time horizon is set for 100 years, all the contributions of HFC-134a are covered but a substantial part of the effect of carbon dioxide is not. If it is set for 20 years, which is about the average lifetime of refrigerators, about 72% of the potential effect of the refrigerant is counted. However, for the same integrated time horizon, less than 10% of the effect of carbon dioxide is accounted for. The values which have been used in the calculations for construction of this and the preceding graphs have been taken from a 1994 report on 'Radiative forcing of climate change' published by the Intergovernmental Panel on Climate Change.

There are many opportunities to convert from CFCs to more benign materials. The biggest opportunity in India may be in the refrigerated food transport industry which can build on the experience base of milk transportation which is done so well. Although most vegetables and fruits are eaten fresh, there can be a significant reduction in waste through refrigeration and refrigerated transport. This is not something that is new. I see more and more cars with air conditioners either as original equipment or as a retrofit option. As our automotive industry grows further, new cars might use a non-CFC as refrigerant. It makes economic sense to design and build new equipment now that will use alternatives to CFCs rather than to redesign later when CFCs can no longer be produced.

Internationally, the collective efforts of government, industry, environmental groups and scientists have contributed to saving the ozone layer and minimizing global warming emissions. As a result, there is good news about the ozone layer. Review of the science shows that the ozone layer will likely return to an acceptable level about 250 years faster than previously predicted because of this transition out of ozone-depleting compounds.

The international community also is coming together to address global warming and climate change issues. The November 27, 1995 issue of *Chemical and Engineering News* has an article on this subject. 'On the basis of a variety of evidence a consensus is emerging among researchers that human beings, primarily through their burning of fossil fuels are already perturbing the Earth's climate – defined as weather averaged across years and large regions', according to this article. It also states that, 'this consensus and the evidence that supports it are documented in the United Nations Intergovernmental Panel on Climate Change's latest report to be released next month.'

At the end of the Asia Pacific Leaders Summit on Climate Change in Manila, a 'Manila Declaration' was issued reinforcing how critical the Asia Pacific region is in the international community's efforts to address issues related to climate change.

I would like to reproduce some of the text of the declaration because I believe it symbolizes the challenges, opportunities and commitment that India and other nations in Asia have in this regard.

> 'We, the participants of the Asia Pacific Leaders' Conference on Climate Change, composed of representatives from 33 countries... affirm our commitment to promote the objectives of the Framework Convention on Climate Change, notably: formulate, implement, publish and regularly update national, and where appropriate regional programs containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptations to climate change.'

In moving toward a regional climate change strategy, the declaration states that 'sustainable development' must be the guiding principle of all development strategies.

What does 'sustainable development' mean in this context? I believe it means implementing strategies that are in the best interest of every nation, socially, economically, as well as environmentally.

Ozone depletion and global warming are environmental challenges for all nations of the world. There are sub-sets within these challenges that might be more important to a particular nation. In this context, India's leadership role as one of the largest newly industrialized nations is critical.

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