Andy Pearson

Itchy Foes?

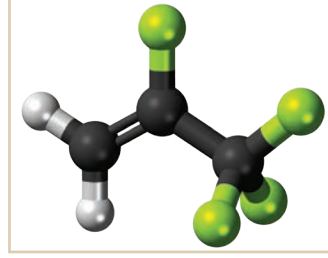
BY ANDY PEARSON, PH.D., C.ENG., MEMBER ASHRAE

Last month's column looked at good things and bad things; now we turn our attention to a family of refrigerants that transcends that discussion and causes deeply divided opinions to emerge on many fronts—the fluorinated alkenes, more commonly known as HFOs.

Even the adopted name of this family has generated polarized reactions. Opponents have dismissed it as "a marketing stunt." These chemicals contain hydrogen, fluorine and carbon so they are obviously HFCs, aka f-gases, which are currently the subject of restrictive legislation around the world. Furthermore, the "O" in the name is potentially misleading since they don't contain oxygen.

Proponents point out calmly and often that "O" stands for "olefin" (pronounced oalyfin), a term currently used by the International Union of Pure and Applied Chemistry to describe any molecule that contains a carbon-to-carbon "double bond." Molecules with these types of bonds are called "unsaturated" because, like a half-damp sponge, it is possible for them to absorb more elements by adding them to either end of one of the double bonds, turning it into a single bond.

Is it a bird, is it a plane…?



However, the adoption of the new family name has historical precedent. All synthetic refrigerants were simply known as "halocarbons" until it became necessary in the 1980s to discriminate between those containing only chlorine, fluorine and carbon, those also containing hydrogen, and those without any chlorine. Unfortunately, the new name, HFO, is not perfect. What about unsaturated fluorocarbon compounds that don't contain hydrogen? What about those, like ethylene and propylene that only contain hydrogen and carbon—are they hydroolefins or just olefins? And furthermore, to hyphenate or not to hyphenate?

This unusual family of molecules is not new. They have been familiar to chemists for decades (under the name fluoroalkenes). The addition of the double bond into the mix makes the compounds generally more reactive than their fluoroalkane (that is, saturated) equivalents. This means that they do not last as long in the atmosphere which, in last month's terms is "a good thing," but that they are flammable, clearly "a bad thing." Just how flammable is a subject of great and detailed debate. The most commonly proposed substances occupy a grey area between the completely inert and the highly combustible.

In fairness, it must be said that traditional refrigerants containing hydrogen, such as R-22 and R-134a also occupy this grey area. They happen to lie on one side of the flammability fence and the HFOs lie on the other side. The exact location of the borderline is a question of opinion and much debate. It is not a clear-cut scientific fact but depends on factors such as pressure and temperature and even leads to such philosophical questions as "what is a flame?" and "what is a spark?" A lot of additional work, including fresh insights and new understanding, is required to enable us to determine how to deal with the reactivity of HFOs in the myriad applications of the refrigeration and heat pump world.

The world of refrigerants became more complicated when we decided that in addition to having gases that were nonflammable and nontoxic we also wanted them to have no effect on the ozone layer and not cause global warming. At the same time systems are to be "cost-effective" (usually a synonym for "as cheap as possible") but also must use minimal energy. Now we are contemplating the addition of further constraints—for example "no persistent effect on the local environment" or "no toxic products of combustion." It is clear none of the proposed working fluids for refrigerating and heat pump systems satisfy all of these criteria, and the prospect of finding something that satisfies them all is nonexistent.

The answer to this riddle, therefore, lies in the realms of the economists, legislation-writers and accountants, not the chemists and engineers. We need a method of assessing relative merits of different options, taking all relevant factors into account. As cheap as possible is a good measure, but the key question is "what is possible?" or, to be more exact, "what is permissible?" ■

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