An Overview of Specialty Fluorochemicals

Fluorine has a number of chemical properties that make it particularly desirable for a wide variety of different industrial, commercial, and even medical applications. In particular, it is the most electronegative and the most highly reactive of all the elements, and readily forms compounds with all elements except for the three lightest noble gases. One particularly useful property of fluorine is that it forms strong and stable covalent bonds with carbon.

Due to these important and highly useful chemical properties, specialty fluorochemicals have numerous applications in a range of industries. The addition of fluorine or fluorine substituents improves the desirable qualities of an amazingly wide variety of compounds including pharmaceuticals, plastics, elastomers, and surfactants.

One of the most well-known uses of fluorine is the addition of fluoride to drinking water and toothpastes, to strengthen tooth enamel and help prevent tooth decay. There are many more highly specific uses of fluorine and specialty fluorochemicals, most of which are concentrated in the industrial, agricultural, and pharmaceutical industries.

Types and Uses of Specialty Fluorochemicals

Agricultural Uses: The addition of fluorine to many agricultural herbicides, pesticides, and fungicides improves the potency and therefore reduces the required application rate of these substances.

Photoresists: These polymers are used in semiconductor lithography. The addition of fluorine or fluorinated substituents to photoresists improves desirable chemical and physical properties.

Surfactants: Fluorine is a key component of surfactants and related compounds such as stain repellants.

Dyes: Adding fluorine or fluorinated substituents to many dyes improves their chemical and light resistance, and also their fixation yield.

Liquid Crystals: Adding fluorine to liquid crystal for use in display devices improves desirable chemical and physical properties such as the viscosity and miscibility of the liquid.

Plastics and Elastomers: With the addition of fluorine, these substances become more chemically and thermally stable. Due to these desirable properties fluoroplastics and fluoroeslastomers are used in a variety of ways, including in wiring insulation, gaskets and seals, hoses, and laboratory equipment.

Ion-Exchange Membranes: The use of fluorinated polymers allows ion-exchange membranes to be used in harsh environments, as the addition of fluorine improves the chemical and thermal stability of the membranes.

Custom-made Fluorochemicals: One particularly advantageous aspect of fluorine is that it can be added to a wide variety of chemical substances to increase stability, potency, and other desirable qualities. This means it is often possible to create custom-made specialty fluorochemicals.

A Closer Look at Fluorocarbons

Fluorocarbons are a particular type of fluorochemicals in which fluorine atoms are covalently bonded to carbon atoms in varying numbers and configurations. These covalent bonds are strong and stable, and this has been a major reason for the widespread of use fluorocarbons for a variety of applications. Fluorocarbons have been used as lubricants, propellants, refrigerants, solvents, and in water and stain-repellent products.

Concern over the slow environmental degradation of fluorocarbons has led to reduced usage of many of these substances. Some, such as carbon tetrachloride, were once available for public use, but are now much more tightly regulated. Most fluorocarbon solvents now have a much more limited range of industrial uses.

Some fluorocarbons (such as Freon) have a particularly bad reputation, however, due to their use as refrigerants and propellants. These have commonly contained chlorine in addition to fluorine. While the strong fluorine-carbon bonds make these substances highly resistant to environmental degradation, the addition of chlorine makes them highly reactive and destructive to the earth’s ozone layer. For this reason, the use of chlorofluorocarbons has been largely discontinued.

Despite environmental concerns, some fluorocarbons (such as fluoroplastics and fluoroeslastomers) are still in common use. One example is Teflon, which is a very common component of non-stick cookware.

The Use of Fluorine in Pharmaceuticals

One increasingly widespread application of specialty fluorochemicals is in the pharmaceutical industry, in which the ability of fluorine to improve the existing properties of other chemicals makes it enormously useful.

Simply by adding fluorine, the pharmacological properties of a drug can be improved in potency quite significantly, allowing for the use of lower doses to achieve the same effect as was previously gained.

Aside from this highly desirable property, another important advantage of adding fluorine to pharmaceuticals is that the shape of the resulting fluorochemical is largely unchanged. This is particularly important because the bioactivity of many drugs is highly dependent on the shape of the chemical compound.

One drawback, however, is the fact that the addition of fluorine improves the stability of pharmaceuticals. While this is an enormous advantage for most other specialty fluorochemical applications, in the pharmaceutical industry this is not always the case, because in some cases, improving the stability of a drug can reduce its metabolic degradation.

Currently, up to 50% of all modern pharmaceuticals contain fluorine. These include anesthetics, antidepressants, antifungals and antibiotics, antacids, cholesterol lowering agents, steroids and other anti-inflammatory agents, and certain types of anticancer chemotherapeutic drugs.

About the Author

Stephanie Larkin is a freelance writer who writes about issues and topics pertaining to the use of chemicals such as Fluorochemicals