Fluorine

Product Stewardship Summary

Air Products is a leading global producer of elemental fluorine, fluorine mixtures and fluorine compounds. For the electronics industry, Air Products has the ability to offer high-volume manufacturing of fluorine as a cleaning gas for their chamber etching equipment. Fluorine is also used to manufacture fluorochemicals for the pharmaceutical, herbicide, and nuclear power industries. Fluorine mixtures allow plastic manufacturers to modify the adhesion and wettability properties of plastic surfaces for the automotive and petroleum industries.

Chemical Identity

- Chemical Formula: F₂

Uses and Benefits

For thin film photovoltaic and LCD manufacturers, Air Products has developed an on-site chamber cleaning gas supply option for fluorine. In this application, fluorine is converted to fluorine radicals, which have the ability to clean materials deposited on chamber surfaces.

A gas mixture of 20% fluorine in nitrogen is marketed under the Airopak® trade name. Our patented Airopak process uses fluorine mixtures in the blow molding process for plastic containers to create a barrier on the interior surface that minimizes permeation. These containers are used to package gasoline and other fuels, solvents, pesticides, automotive and household cleaning products. New automotive applications utilize Airopak mixtures to modify the surface of plastic films in order to increase adhesion of paints. In the electronics industry, Airopak is used to etch highly accurate microscopic patterns critical for semiconductor manufacturing.
Physical and Chemical Properties
At room temperature and atmospheric pressure, fluorine is a pale yellow gas that is heavier than air and has a sharp, pungent odor. Fluorine is the most reactive element, combining readily with most organic and inorganic materials. As a strong oxidizer, fluorine changes fire chemistry such that the combustion process is accelerated and combustible material will burn more vigorously. Some materials that are noncombustible in air will burn in the presence of fluorine. When diluted in mixtures, the fluorine reactivity is reduced. A gas mixture consisting of 20% fluorine in nitrogen is commonly used.
Fluorine reacts slowly with water to form hydrofluoric acid.

Health Effects
Fluorine is highly toxic and must be handled with caution. Inhalation at even low concentrations irritates the respiratory tract; at high concentrations, fluorine inhalation may result in severe lung congestion.
On contact with moisture, the hydrofluoric acid formed can produce severe burns. These severe chemical burns may not be immediately painful or visible. These injuries require specialized medical treatment. For more information, refer to Air Products’ Safetygram, Medical Treatment Protocol For Hydrofluoric Acid Burns.

Environmental Effects
Fluorine can be manufactured, used and disposed of safely. Industries commonly use a scrubber or absorber to capture fluorine emissions.

Exposure Potential and Risk Management Measures
Industrial Use
We ship fluorine mixtures in high-pressure compressed gas cylinders, tube trailers or bulk modules, depending on the quantity required by the customer.
It is important to have good ventilation when working with fluorine and to keep it in a closed system. According to the U.S. Occupational Safety and Health Administration (OSHA), fluorine in workplace air should not exceed 0.1 part per million, averaged over an eight-hour work shift.
Workers should use sturdy leather gloves, safety glasses and safety shoes when handling cylinders. When connecting, disconnecting or opening cylinders, workers should wear loose-fitting leather gloves, a face shield, safety glasses, and a long-sleeved shirt or jacket.
Fluorine is a powerful oxidizing element, so equipment material selection is important. Materials that form a good fluoride coating will be protected from further reaction. Special cleaning and treatment procedures are required for systems using fluorine. Any equipment that uses this product must first be thoroughly cleaned and dried. The equipment should then be treated with increasing concentrations and/or pressures of fluorine as a final cleaning step. This treatment process will allow the fluorine to react with and eliminate any impurities without ignition of equipment and will impart a protective metal fluoride surface layer.

Consumer Use
We do not sell fluorine or fluorine mixtures to consumers, and no consumer uses are known.
**Regulatory Information**

Several regulations govern the manufacture, sale, transportation and use of fluorine. These laws vary by country and geographic region. You can find general regulatory information in the Material Safety Data Sheet.

**Sources for Additional Information**

- Air Products and Chemicals, Inc. MSDS
- Safetygram: Handling, Use and Storage of Compressed Gas Cylinders
- Safetygram: 20% Fluorine/Nitrogen Mixture
- Safetygram: Medical Treatment Protocol For Hydrofluoric Acid Burns
- Compressed Gas Association

**Conclusion**

Fluorine is a highly reactive chemical used in a variety of industries. Workers can handle it safely with minimal environmental effects when they follow industry and company guidelines.
Contact Information

**Emergency Response System**
- Tel 1-800-523-9374 (Continental U.S. and Puerto Rico)
- Tel 1-610-481-7711 (other locations)
- 24 hours a day, 7 days a week
- For assistance involving Air Products and Chemicals, Inc. gases and equipment

**Technical Information Center**
- Tel 1-800-752-1597 (U.S.)
- Tel 1-610-481-8565 (other locations)
- Fax 1-610-481-8690
- E-mail gasinfo@airproducts.com
- Monday–Friday, 8:00 a.m.–5:00 p.m. EST

We developed this Product Stewardship Summary to give you a general overview of the chemical. This Summary is not meant to provide emergency response or medical treatment information. You can find in-depth safety and health information on the Material Safety Data Sheet for the product.