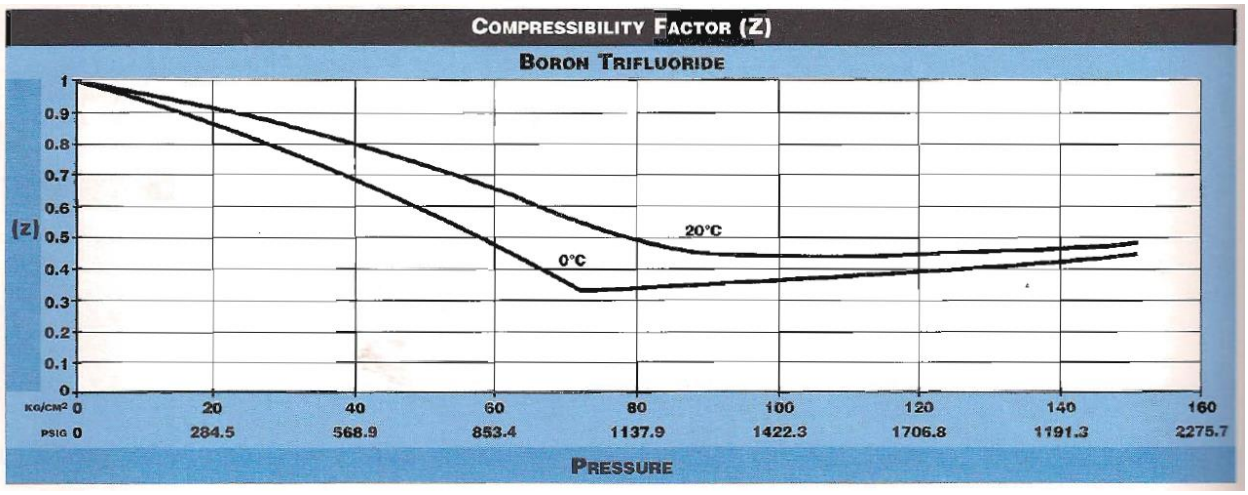
Chemically Speaking LLC

Boron Trifluoride

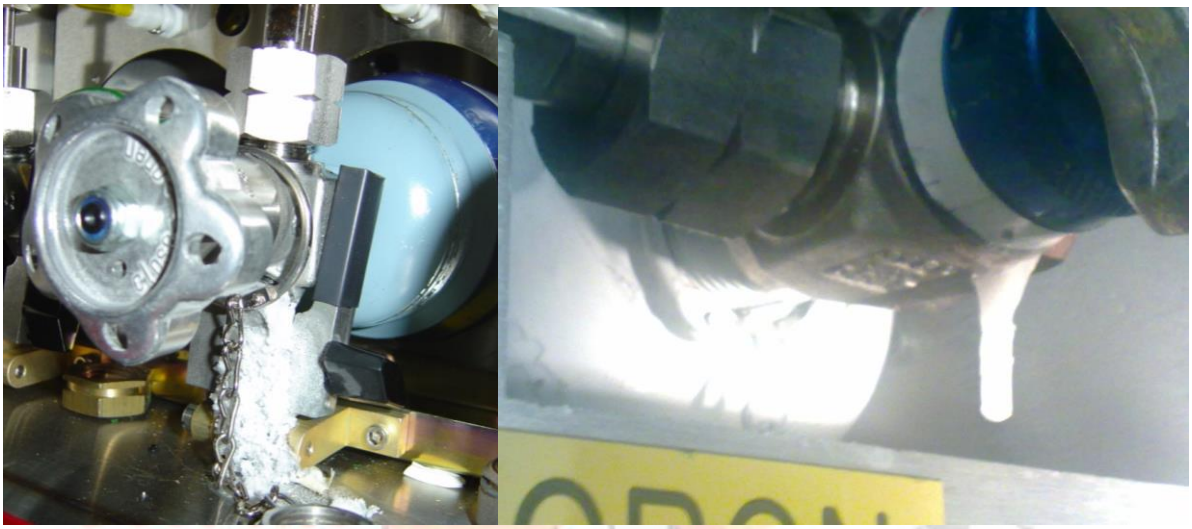
- Boron Trifluoride is a compressed toxic & corrosive gas that is colorless but reacts immediately with moisture in the air to form dense white fumes
- BF_3
- CAS# 7637-07-2
- UN# 1008
- Molecular Weight: 67.8
- Cylinder Pressure @ 70°F (21°C), 60 lbs, 44 l, 1800 psig
- Gas Density of 0.192 lb/ft^3, 3.08 gm/l @ 70°F (21°C)
- PEL of 1 ppm, LC_{50} 806 ppm, IDLH of 25 ppm
- Shipping Labels: Toxic Gas
- Boiling Point, 1 atm. -149°F (-100°C)
- Freezing Point, 1 atm. -199°F (-128°C)
- Critical Temperature 10°F (-12°C)
- Boron Trifluoride has a vapor density heavier than air (70°F). (21°C) - 2.32
- Gas Specific Volume @ 70°F (21°C) - 5.6 ft^3/lb (350 cc/gm)
- Autoignition - Not Flammable
- Flammability (LFL -UFL) - Not Flammable
- Thermal Stability - Very stable
- Water Solubility - Boron Trifluoride is highly soluble forming the hydrates HBF_4 and H_3BO_3 which are highly acidic, 3.22 gms/gm H_2O at 0°C 1 atm
- Odor - Acidic, irritating
- Latent Heat of Vaporization @ boiling point - 122.6 BTU/lb (285 kJ/kg)

Since it has a critical temperature of 10°F (-12°C), it normally behaves as an compressed gas and is filled to 1,450psig.
Like silane, BF_3 has significant compressibility based on temperature and pressure



BF_3 and/or the acids formed on contact with water vapor will be strong irritants to mucous membranes, including the eyes, nose, throat, and lower respiratory tract. Overexposures will produce tearing of eyes, coughing, and throat irritation. Severe overexposures could lead to pulmonary edema and chemical pneumonitis (lung inflammation).

BF_3 reacts with water in the air to form BF_3 hydrates and, with an excess of water, Fluoroboric Acid. These compounds are fairly stable and are corrosive. Under extreme conditions (e.g., pH<2 and temperature >90°C), hydroxyfluoroborates and Hydrofluoric Acid (HF) may be formed



A small leak will react to form a white gel which will drip down the side of the valve/cylinder

Emergency Response

A leak will create a dense white cloud of acidic mist

Difficult to see.

Sets off smoke detectors

Severe acid burns if only wearing work uniform

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The Jan 2013 BF_3 incident in Taiwan was due to a local company copying the design of the 5502 ERCV but the door did not have any flange safety nuts. In addition, the gas supplier ER team did not secure cylinder. As a result, the cylinder slid back and forward as it was being driven 40 km to their site causing the cylinder cap to spin off. This allowed the cylinder valve to be impacted so many times until it badly damaged and leaking heavily. It fully pressurized the ERCV with BF_3 to a pressure of 600 psig. Since the copycat ERCV had no flange safety nut, this pressure was not detected when they tried to open the ERCV. The sudden release of pressure ripped off the door propelling it over 100 ft.

BF_3 Cylinder Containment, Taiwan Jan 2013

It was fortunate that no one was injured in this event.

BF_3 Incidents

A leak creates a dense white cloud that is difficult to see through.

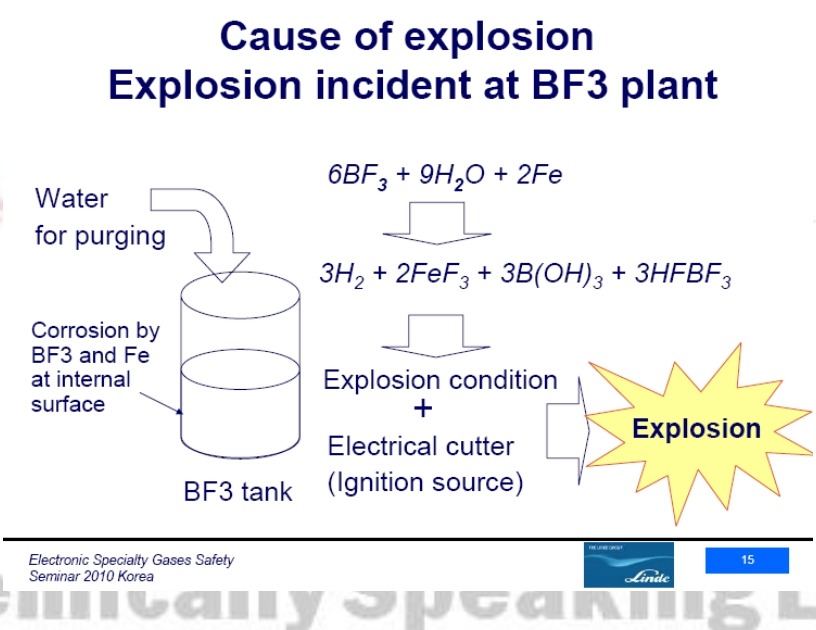
The typical mineral acid gas sensors will not detect a leak. Smoke detectors detect it before the gas sensors.

Unusual Incidents

In June of 2002 a Pressure Relief Device started to leak at a gas supplier warehouse in China. The cloud was quite dense and the employees having no ER Equipment wrapped a plastic bag around the cylinder top. This melted in 10 minutes. They immediately threw it into a cistern where it leaked for almost a year. They added some sodium hydroxide to the water. In April 2003 they used some hooks to grab the cylinder cap

at a BF_3 manufacturer

Four workers doing maintenance died when a tank used to store boron trifluoride blew up on Dec. 24, 2009, at a plant in Osaka, Japan.



According to police and other sources, the five employees were removing sludge from the tank at the time that had been created while the vessel was being cleaned with water. Four employees were on top of the tank, the surviving employee was cutting a hole in the tank with an electric saw. Police believe that sparks from the sawing may have caused the explosion.

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References:

1. Jones, W. R., Incorrect Assumption of Boron Trifluoride Hydrolyzation to Hydrogen Fluoride and the Effect on Existing Monitoring Techniques, SSA Journal Volume 12 Number 1 - Spring 1998 pp. 19 – 23
2. Goyal, H. K., Barky, J. B., Evaluation of Gas Monitoring Technologies for Detection of Boron Trifluoride Leak in A Semiconductor Fab Environment, SSA Journal Vol. 14 Winter 2000, 36-40

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