

# What to Understand About Chemistry to Make the Best Materials Choices

Strong oxidizers can damage metal, causing pitting or rust and creating possible safety concerns.

By **Mark Freeman**

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**I**n chemistry, a strong oxidizer is a substance (like chromic acid) that can cause other substances (like seals and gaskets) to lose electrons. So, an oxidizer is a chemical species that undergoes a reaction that removes one or more electrons from another atom. This causes a change in mass. Metals will turn into their respective heavier oxides, and the carbon in graphite will oxidize into carbon dioxide—which, although molecularly heavier, is a gas at room temperature.

This happens in pumps, valves, pipelines or any other equipment that have seals and gaskets carrying a strong oxidizer. It will cause pitting or rust and, depending on your choice of seal material, may require shorter service intervals.

Ultimately, you may have to look for a more suitable material that can handle strong oxidizers.

More importantly, an oxidizing agent can cause or contribute to the combustion of another material.

The U.S. Department of Transportation defines oxidizing agents specifically. DOT's Division 5.1(a)1 means that a material may enhance combustion or quickly raise pressure causing a rapid chemical reaction. A fire may start or, even worse, create or facilitate an explosion.

There have been instances of fires or explosions in mining, chemical process and even fertilizer factories where strong oxidizers were used.

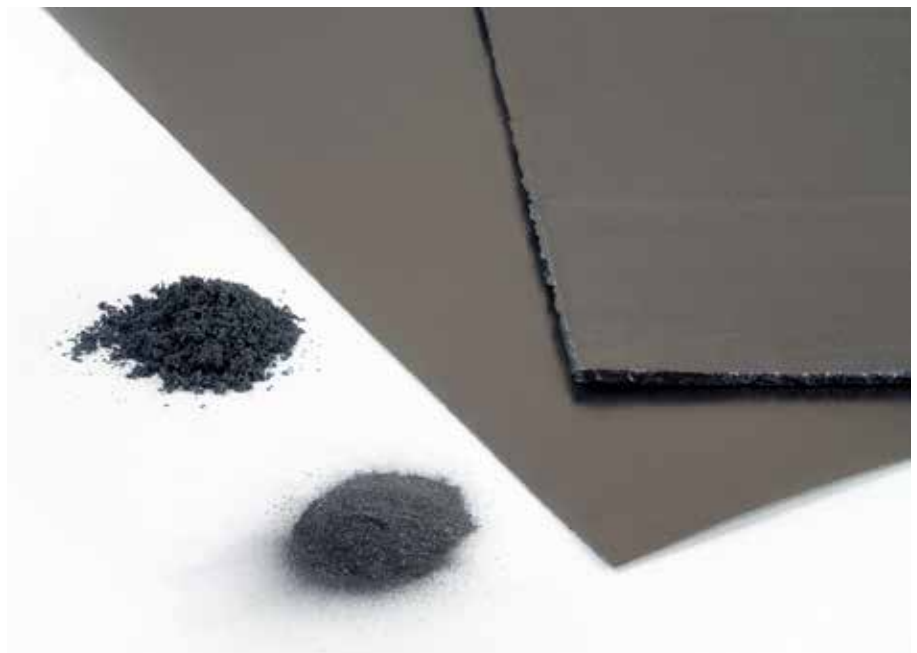


Image 1. Powder resin graphite (Courtesy of author)



Image 2. Thermabraid braided gasket packing

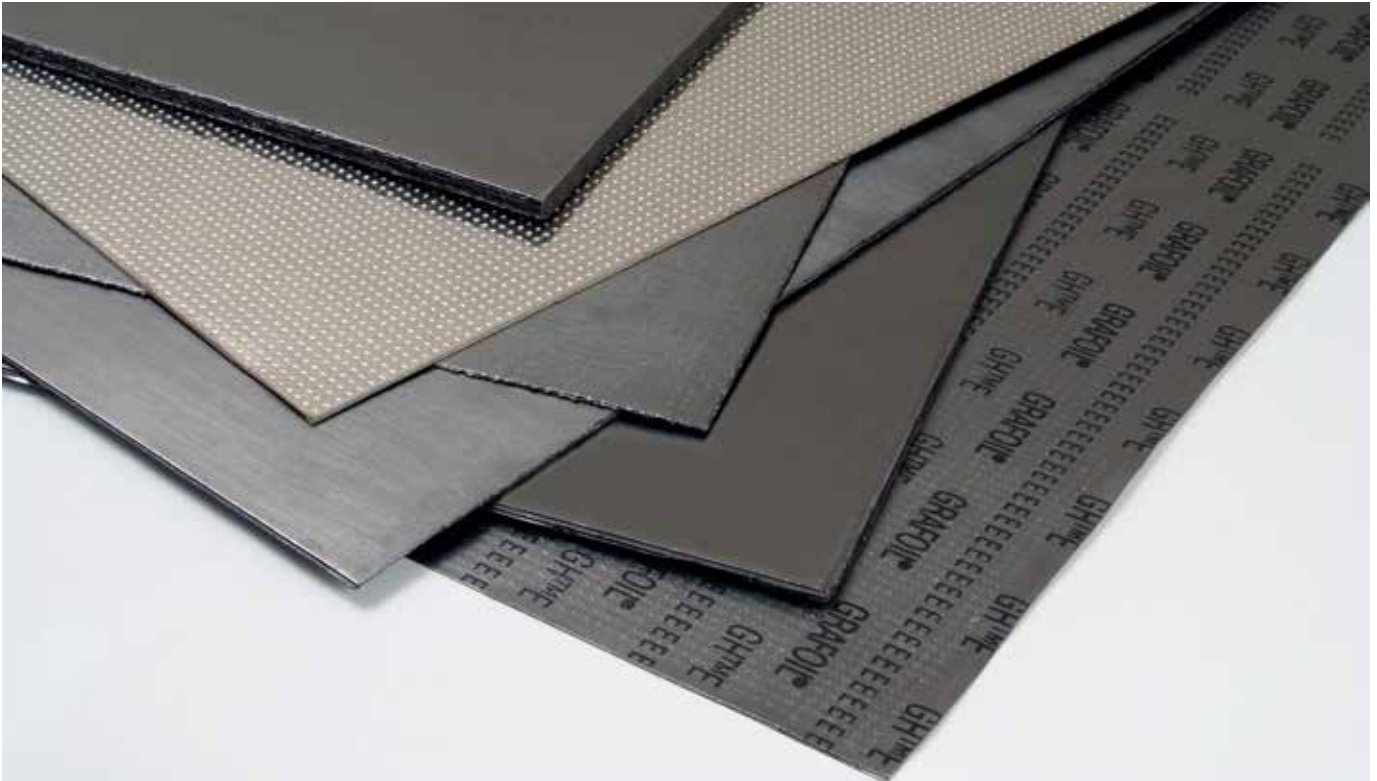


Image 3. Laminated graphite

**The U.S. Department of Transportation defines oxidizing agents as materials that may enhance combustion or quickly raise pressure causing a rapid chemical reaction. A fire may start or, even worse, create or facilitate an explosion.**

The following example shows how an ammonium nitrate explosion can affect not only the plant but also the surrounding area.

**Deadly Force**

A West Texas fertilizer company storage and distribution facility caught fire on April 17, 2013. As firefighters attempted to extinguish the blaze, the plant exploded with the force of 10 tons of TNT, killing 15 people and injuring 200. It destroyed 60 nearby homes and left a 93-foot-wide crater where the plant once stood.

All said, it is important to choose the right sealing material for strong

oxidizers. There are multiple products on the market for the chemical processing, oil and gas, mining and aerospace industries.

A fluoropolymer, such as polytetrafluoroethylene (PTFE), can handle most strong oxidizers, as long as the temperature is below 260 C (500 F). This is also true with a modified PTFE because they are chemically inert and stable.

Strong oxidizers will weaken most other material to various degrees. Much of a material's capability to withstand a strong oxidizer depends on the used concentration, the service temperature and the service pressure. Therefore,

consult with the sealing material manufacturer to ensure compatibility.

**How Graphite Handles Strong Oxidizing Environments**

Graphite starts as natural mineral flake and is mined in various parts of the world. The flakes form a layered structure of completely crystalline graphite, which is essentially elemental carbon. In this form, it is used for products like powdered lubricant and lead in pencils. It has excellent lubricity in this form.

Expanded graphite is produced with the use of strong oxidizing agents such as sulfuric and nitric acids. The acids weaken the bonds between the graphite

layers, the flakes are then rinsed, dried and exposed to high heat.

The heat causes the layers to separate and expand dramatically to form expanded worm-like macro structures. The structures can then be recompressed into flexible graphite forms.

Flexible graphite is a soft material that is resistant to many strong chemicals and high heat. It has a low coefficient of friction and is proven to be advantageous over braided carbon or graphite fiber packings mainly as it is a better conductor of heat—a plus on moving shafts.

Flexible graphite is also naturally lubricious, conformable and resilient. It has good corrosion resistance and is compressible, allowing it to conform to most mating surfaces or valve cavities.

The chemical compatibility of flexible graphite can be enhanced with a blocking agent like PTFE. However, flexible graphite's temperature limit will be restricted by PTFE's limit of 260 C (500 F). If high temperature is an issue, this configuration will not work.

Flexible graphite, in combination with PTFE, is an extremely effective material in sealing fugitive emissions or volatile organic compounds (VOCs). VOCs have been targeted by several government agencies as a source of air pollution. Although, flexible graphite alone has a long way to go in stopping all fugitive emissions, it is a trusted sealing material for valves, flanges and stems in the chemical process, power generation, and oil and gas industries.

**Flexible Graphite Pitfalls**

Flexible graphite may be susceptible to chemical attack in the presence of strong oxidizing fluids, including air at extremely high temperatures. These include liquids such as 20 percent concentration of nitric acid or a 98 percent concentration sulfuric acid, the same chemicals that are used to break down mined graphite into expanded graphite flake.

Some flexible graphite compositions include oxidation inhibitors or are physically structured to extend temperature capability when exposed to these extra strong oxidizers.

The class of organic chemicals that should not be used are those that are highly oxidizing like nitrates, persulfates, perbenzoates and peroxides. Unacceptable compatibility

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Image 4. Thermacord flexible graphite packing yarn

for inorganic chemicals includes molten sodium, potassium hydroxide and chlorine dioxide.

However, many of the chemicals depend on the concentration, and some engineering groups can create an inhibitor that is right for a specific oxidizer. For instance, a 704 stainless steel cladding provides the user with protection against strong oxidizers while still providing the benefits of flexible graphite.

When in doubt, do a test loop using a pump to pressurize the strong oxidizer exposing it to flexible graphite. The pressure, temperature and concentration of the oxidizer must be exact as used in service, as to provide some idea of how the material will react to a given chemical.

It is easier to list the chemicals that are not compatible with flexible graphite

(about 50) than those that are (more than 600 tested). A list of incompatible materials are listed on the next page. ■

### Next Month: Flushing Arrangements



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**STRONG OXIDIZERS FOR FLEXIBLE GRAPHITE**

Aqua Regia	Chromium	Nitromuriatic Acid	Potassium Chlorate
Bromine (dry)	Chromium Trioxide*	Norge Niter	Potassium Chromate
Calcium Chlorate	Dichloropropionic Acid*	Norwegian Saltpeter	Potassium Dichromate
Calcium Hypochlorite*	Dichromates	Oleum (Fuming Sulfuric Acid)	Potassium Nitrate
Calcium Nitrate	Hydrogen Dioxide	Oxygen*(above +600 F)	Sodium Chlorite*(over 4%)
Chlorazotic Acid	Hydrogen Peroxide	Ozone	Sodium Hypochlorite*
Chlorine Dioxide*	Lime Nitrate	Perchloric Acid	Sodium Peroxide
Chlorine Trifluoride	Lime Saltpeter	Permanganate Solutions	Sulfuric Acid
Chloric Acid	Molten Alkaline	Persulfates	Sulfur Trioxide*
Chloroazotic Acid	Nitrates	Perbenzoates	
Chloronitrous Acid	Nitric Acid*	Perborates	
Chromates	Nitric Oxide	Peroxide Potassium Bichromate	
Chromic Acid	Nitrocalcite		
Chromic Anhydride	Nitrohydrochloric Acid		

*\*Flexible graphite may be acceptable in specific temperature or concentration ranges.*

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