

Material Guidelines for Gaseous Oxygen Service

All organic and inorganic materials will react with gaseous or liquid oxygen at certain pressures and temperatures. The reaction that occurs can cause a fire or an explosion. Because of these inherent dangers, process system design and control valve material selection are extremely important.

Oxygen service has many inherent hazards and requires careful and knowledgeable design of the process system. The information and guidelines presented here are intended to help the user; however, other factors such as service conditions and process system design must be considered to properly select materials that will handle this gas in a safe manner.

Many of the materials commonly used in control valves have ignition temperatures above the normal flowing temperature of gaseous oxygen. Ignition of these materials by normal flowing temperatures is generally not the danger. The danger is in the ignition of these materials by abnormal, localized high temperatures. Listed below are some of the common causes of localized high temperature. This list has been compiled from the best information available, but does not necessarily contain all the hazardous conditions that might be encountered in oxygen service applications.

Common Sources of Localized High Temperature

Flow Velocity

All valve materials should be suitable for oxygen service, and material selection should meet the

velocity criteria, such as set by the Compressed Gas Association Pamphlet G-4.4 (copies can be obtained from Compressed Gas Association, Inc., 500 Fifth Avenue, New York, NY 10036). In general, if the velocity through the port of the valve can exceed 61 meters per second (200 feet per second), only copper-base alloy material should be used for valve body and trim parts in contact with the flow stream.

Foreign Particle Impingement

A foreign particle, such as weld spatter, that is being carried in the flow stream and that strikes the valve trim or the valve body wall might have its kinetic energy transformed into sufficient heat to raise the impinging particle or the material it strikes to its respective ignition temperature.

Ignition by Already-Burning Material

An organic valve disk, for example, that has already been ignited by foreign particle impingement will release sufficient heat to ignite surrounding metallic materials, thus initiating a serious fire.

Vibration

A part that is caused to vibrate, usually by the flowing velocity, might generate enough heat from internal friction to raise its temperature to its ignition point.

Adiabatic or Rapid Compression of Gas

Opening a valve to pressure the downstream system will result in the compression of the gas in the downstream system. If this is done rapidly, it can result in abnormally high gas temperatures, which might ignite material in the valve and piping system.

Static Electricity Discharge

The flow of gas across the trim of a ball, butterfly, or eccentric disk valve might generate a static charge on

the trim. Because these valves inherently do not have a good grounding path from the trim to the valve body or from the valve body to the pipeline, use proper provisions and care for their grounding. Failure to do this might allow a discharge spark between the trim and valve body or between the valve body and adjacent piping, igniting the surrounding material.

Conclusion

This list shows that many of the hazards arise from the velocity of the flowing gas. For this reason, it is imperative that the system be designed such that flowing velocities will be low.

Organic Materials

Organic materials have ignition temperatures below those of metals. Use of organic materials in contact with oxygen should be avoided, particularly when the material is directly in the flow stream. When an organic material must be used for parts such as valve seats, diaphragms, or packing, it is preferable to select a material with the highest ignition temperature, the lowest specific heat, and the necessary mechanical properties.

Lubricants and sealing compounds should be used only if they are suitable for oxygen service and then used sparingly. Ordinary petroleum lubricants are not satisfactory and are particularly hazardous because of their high heat of combustion and high rate of reaction.

The approximate ignition temperatures in 138 bar (2000 psig) oxygen for a few organic materials are shown in table 1.

Table 1. Typical Ignition Temperatures

MATERIAL	TYPICAL IGNITION TEMPERATURE IN 138 BAR (2000 PSIG) OXYGEN	
	°C	°F
PTFE and PCTFE	468	875
70% Bronze-filled PTFE	468	875
Fluoroelastomer	316	600
Nylon	210	410
Polyethylene	182	360
Chloroprene and Nitrile	149	300

Metals

The selection of metals should be based on their resistance to ignition and rate of reaction. Following is a comparison of these two properties for some commonly used valve materials.

Resistance to Ignition in Oxygen

Materials are listed in order from hardest to ignite to easiest to ignite.

- Copper, copper alloys, and nickel-copper alloys -- most resistant
- Stainless steel (300 series)
- Carbon steel
- Aluminum -- least resistant

Rate of Reaction

Materials are listed in order from slowest rate of combustion to most rapid rate of combustion.

- Copper, copper alloys, and nickel-copper alloys -- do not normally propagate combustion
- Carbon steel
- Stainless steel (300 series)
- Aluminum -- burns very rapidly

Note that stainless steel, once ignited, burns more rapidly than carbon steel. Nevertheless, the austenitic grades (300 series) of stainless steel are considered to be much better than carbon steel because of their high resistance to ignition.

Suggested Guidelines

Consider the following guidelines when selecting process equipment for gaseous oxygen service. These guidelines are for customer use in selecting appropriate equipment for oxygen service, and neither Emerson, Emerson Automation Solutions, nor any of their affiliated entities assumes responsibility for material selection.

1. All regulators and control valves should be degreased and processed for oxygen service in accordance with current Emerson or customer specifications. Suitable lubricants, anti-seizing compounds, gaskets, and packing are included in Fisher™ Specification FGS 8A11, Cleaning, Processing, and Handling Equipment for Oxygen Service.
2. All metals in contact with oxygen in the main flow stream should be of appropriate materials suitable for the given oxygen service.

In general, diaphragm casings, diaphragm plates, springs, and other parts not in the main flow stream may be of ordinary materials such as carbon steel, stainless steel, or cast iron. It is suggested, however, that all valve body and trim parts in contact with the flow stream be made of copper, copper alloy, or nickel-copper alloys.

3. All diaphragms in contact with oxygen gas should be made of fluoroelastomer.

4. All O-rings in contact with oxygen gas should be made of fluoroelastomer or a similar fluorocarbon elastomer.
5. Organic materials should be avoided for use in valve seats or other parts exposed to the flow stream.
6. Filters should be placed upstream of all valves and regulators. Only non-ferrous, inorganic filter elements should be used. Filters must have regular maintenance and cleaning.
7. To minimize the number of parts in contact with oxygen, oxygen should not be used as supply pressure to a pneumatic instrument or an actuator.
8. Plated parts should not be used in the main flow stream because of their potential contributions to foreign particle impingement.

Note

Some users of oxygen valves and regulators have established their own standards and specifications for construction materials. The customer's instructions in those instances will be followed. Emerson disclaims responsibility or liability if materials other than copper-based alloys or nickel-copper alloys are in contact with the flow stream.

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