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POSITION PAPER

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USE OF TAPERED AND PARALLEL (STRAIGHT) THREADS IN ALUMINUM ALLOY CYLINDERS

Question

What is the recommended valve thread type, tapered or parallel, for aluminum alloy cylinders used in oxygen service?

Answer

Each valve thread type has its own advantages. When there are no regulatory requirements that specify the valve thread type, the choice of valve thread type is up to the individual or organization (packager) doing the valve installation.

Background

The compressed gas industry in many parts of the world successfully has used both tapered and parallel threaded valves in aluminum alloy cylinders in oxygen service.

In Australia, aluminum alloy cylinders have been manufactured successfully for approximately 30 years using the cold extrusion process also with tapered threads in oxygen service.

In Europe, aluminum alloy cylinders have been manufactured successfully for more than 50 years using the hot extrusion manufacturing method. This process permits the use of tapered thread designs, especially with the use of shrunk-on neck rings, which provide additional reinforcement to the cylinder neck.

In North America, aluminum alloy cylinders also have been successfully manufactured for more than 30 years using a cold extrusion process with hot necking to produce straight thread designs.

Valves installed properly, whether with parallel or tapered inlet thread design, have proven to be reliable.

Comparisons of tapered and parallel threads

Table 1 lists the characteristics of each thread design as they relate to various aspects of the compressed gas industry.

Table 1—Thread design comparisons for high pressure aluminum alloy cylinders

Aspect	Parallel	Tapered
History	Stresses in the neck/threaded region are less, which is an important design consideration if the cylinder alloy is susceptible to stress cracking (e.g., sustained load cracking).	Stresses in the neck/threaded region are greater due to use of mechanical torque on threads to achieve a leak-tight cylinder/valve connection. This is an important design consideration if the cylinder alloy is susceptible to stress cracking (e.g., sustained load cracking). NOTE—Historically, tapered threads have been the preferred thread design worldwide for toxic, flammable,

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Aspect	Parallel	Tapered
		and corrosive gases.
Variation within design	Parallel thread profiles and sizes differ throughout the world. Differences are: – diameter; – pitch; and – thread form (profile).	Tapered thread profiles and sizes differ throughout the world. Differences are: – diameter; – pitch; – thread form (profile); – taper angle; and – thread form normal to the cone surface or parallel to the cone axis.
Production variation	It is much easier to achieve machining within gauge limits. It is required that the sealing O-ring contact area on either the valve or the cylinder be free of irregularities that can be the source of an improper seal. It is required that the top surface (face) of the cylinder be held to tight tolerance.	It is more difficult to manufacture for dimensional control. Thread chatter is more relevant. Dimensions on opposite ends of tolerance limits of the valves and cylinders can be the source of a difficult installation. Minimizing thread ovalness is important for this design.
Installation	Some special skill is needed to manually install parallel valves. There are O-ring/flange installation concerns including defective O-rings and damaging of the O-ring during installation (see O-ring). Torque (versus number of turns) is the primary method of ensuring proper installation. An overtorqued valve can cause hidden damage to the valve flange. Mismatches of straight into tapered designs are known (see CGA SB-19, *Potential Valve Thread and Cylinder Thread Mismatch*) [1].	Some special skill is needed to manually install tapered valves. Skills for the application of lubricants such as tape are needed (see Lubricants). An overtorqued valve causes excessive distortion of the thread form and development of a pitch error. Mismatches of tapered into straight designs are known [1].
Seal	The seal is created by O-ring compression.	The seal is created by a combination of thread sealant and metal deformation.
O-ring	Material compatibility, size, lack of flaws, and hardness are critical to a proper seal. It is required that a suitably specified O-ring be chosen for the gas service (see Leak).	No O-rings are needed (see Leak).
Lubricants	No lubricant is needed. Not using a lubricant can be an advantage where a lubricant can be reactive with the O-ring or gas service. If a lubricant is used, it is required that it not interfere with the short- or long-term performance of the O-ring. It is required that lubricants not be used on threads for oxidizing gas service.	Lubricants (commonly tape or paste) are often used. Improper manual taping can cause gathering of tape. When used, it is required that the choice of tape be compatible with the valve and cylinder materials as well as the gas service. It is required that only suitably specified tape be chosen. NOTE—Not all lubricants are the same (even all polytetrafluoroethylene tapes are not the same and suitable for all applications).

Aspect	Parallel	Tapered
Leak	Release of contained materials can occur (e.g., vibrating loose) from improperly manufactured/assembled parts or an improper installation. Aging of the O-ring can lead to leaks.	Release of contained materials can occur from improperly manufactured/assembled parts or an improper installation. Overtorquing of a valve to cure a leak causes higher neck stresses and might not stop the leak.
Valve removal and multiple installations	Multiple proper installations are possible without thread distortion to the valve or the cylinder. Re-installing a used valve into the same cylinder from which it came is not necessary. If previously overtorqued, a used parallel threaded valve can cause damage to the thread in a different cylinder. It is required that the threads and O-ring be evaluated for continued use when the valve is removed. It is common practice to install a new O-ring each time the valve is reinstalled. For proper visual inspection, it is required that the threads be cleaned if lubricants were used. Valve removal should follow the guidelines outlined in CGA P-38, *Guidelines for Devalving Cylinders* [2].	Thread deformation that occurs on proper installations limits the number of re-installations in which the valve and cylinder can be used. When a valve is removed from a cylinder, the valve may be re-installed into the same cylinder or replaced with a new valve. If previously overtorqued, a used tapered threaded valve might have a pitch error that can cause damage to the thread in a different cylinder. Since the tapered thread valves are installed using lubricants, it is required that the threads be cleaned for proper visual inspection. Valve removal should follow the guidelines outlined in CGA P-38 [2].
Mistaken valve removal under pressure	If a valve is mistakenly removed while a cylinder is under pressure, parallel threads might permit the operator to hear a release of gas before the valve is ejected.	If a valve is mistakenly removed while a cylinder is under pressure, tapered threads are less likely to permit the operator to hear a release of gas before the valve is ejected.
DANGER*: Mistaken valve removal under pressure is a dangerous practice and shall not be performed. In all cases, it shall be determined that there is no pressure in the cylinder before devalving is attempted. See CGA P-38* [2].		
Particulates	It is required that old lubricant or O-ring residue be removed.	At the time of the valve removal, pieces of tape can fall from the valve into the cylinder.

Conclusions

Throughout the years, data and experience have been gathered which are the foundation of the information provided in Table 1; however, experience and data gathering are ongoing, and Table 1 reflects what is known at the time of publication.

The choice of inlet thread design should be based on a combination of considerations. In the absence of regulatory requirements, packagers normally have to decide on the types of controls used to safely and accurately manage valve installation and usage within their operation and at their customers' operations.

Guidelines for valve installation should be based on recommendations from valve manufacturers, cylinder manufacturers, and gas packagers. Regardless of the valve thread design a packager chooses for an application and gas service, valves shall be properly installed.

It is recommended that the installation of valves for high pressure aluminum alloy cylinders follow valve installation guidelines in either CGA V-11, *General Guidelines for the Installation of Valves into High Pressure Aluminum Alloy Cylinders*, or ISO 13341, *Transportable gas cylinders—Fitting of valves to gas cylinders* [3, 4].

Current practices and requirements

In North America, Europe, and Australia, the use of tapered thread inlet designs in aluminum alloy cylinders is authorized and preferred for inert, flammable, corrosive, and toxic gases. However, in North America when oxygen is packaged in aluminum alloy cylinders, the cylinders are mandated to have a parallel thread design.

In other parts of the world, including Europe, national authorities have preferred the use of tapered thread inlet designs in aluminum alloy cylinders packaged with oxygen and other oxidizing gases such as nitrous oxide.

On June 12, 2006, the Pipeline and Hazardous Materials Safety Administration issued the final rule on HM-220E, *Hazardous Materials: Requirements for UN Cylinders* [5]. The voluntary compliance date is June 12, 2006, and the effective date is September 11, 2006. In this final rule, DOT is allowing the openings on aluminum alloy UN cylinders in oxygen service to be configured with straight or tapered thread. See 49 CFR Part 171.11 [6]. Also see 49 CFR Parts 178.71(o)(11), 173.301b(c), 178.71(d)(2) and 173.301(a)(10) for thread identification and marking requirements.

References

Unless otherwise specified, the latest edition shall apply.

[1] CGA SB-19, *Potential Valve Thread and Cylinder Thread Mismatch*, Compressed Gas Association, 4221 Walney Rd., 5th Floor, Chantilly, VA 20151. www.cganet.com

[2] CGA P-38, *Guidelines for Devalving Cylinders*, Compressed Gas Association, 4221 Walney Rd., 5th Floor, Chantilly, VA 20151. www.cganet.com

[3] CGA V-11, *General Guidelines for the Installation of Valves into High Pressure Aluminum Alloy Cylinders*, Compressed Gas Association, 4221 Walney Rd., 5th Floor, Chantilly, VA 20151. www.cganet.com

[4] ISO 13341, *Transportable gas cylinders—Fitting of valves to gas cylinders*, Compressed Gas Association, 4221 Walney Rd., 5th Floor, Chantilly, VA 20151. www.cganet.com

[5] *Federal Register,* Vol. 71, No. 112, Monday, June 12, 2006, Rules and Regulations, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. www.gpoaccess.gov

[6] *Code of Federal Regulations*, Title 49 (Transportation), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. www.gpoaccess.gov

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