AIGA

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 (straight), for aluminum alloy cylinders?

Answer

Each valve thread type has its own advantages. If 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

For decades throughout the world, aluminum alloy cylinders have been successfully manufactured using the cold extrusion or hot extrusion process to produce both tapered and parallel (straight) thread designs. However, aluminum alloy cylinders manufactured from 6351 or 6082 alloys can exhibit sustained load cracking (SLC) in the shoulder and the neck of the cylinder. The use of shrunk-on neck rings provides additional reinforcement to the cylinder neck and can reduce the chance for neck crack growth.

Aluminum alloys cylinders are no longer permitted to be manufactured from 6351 or 6082 alloys. Today, 6061 and certain 7000 series alloys are the most commonly used aluminum alloys as cylinders manufactured from these aluminum alloys do not develop SLC.

Cylinders manufactured from 6351 or 6082 aluminum alloys may still be in service and have additional regulatory limitations and/or requirements. In the United States, see Title 49 of the U.S. *Code of Federal Regulations* (49 CFR) Parts 173 and 180 [1]. In Canada, see CSA B339-18, *Cylinders, spheres, and tubes for the transportation of dangerous goods*, Clause 24.2.10 [2].

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

Comparisons of tapered and parallel (straight) 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 (Straight)	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 (for example, SLC).	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 (for example, SLC). NOTE—Tapered threads have been the preferred thread design worldwide for toxic, flammable, and corrosive gases.

Aspect	Parallel (Straight)	Tapered
Variation within design	Parallel (straight) 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 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 valves and cylinders can be the source of a difficult installation. Minimizing thread <u>ovality</u> is important for this design.
Installation	<u>Parallel (straight) valves shall be installed by trained operators following established procedures.</u> 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 <u>CGA V-19, *Marking Requirements to Mitigate Potential Cylinder and Cylinder Valve Thread Mismatches*</u>) [3].	<u>Tapered valves shall be installed by trained operators following established procedures.</u> 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. <u>Overtorquing can also cause galling or shearing of the threads.</u> Mismatches of tapered into straight designs are known [3].
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). <u>Caution shall be used when selecting polymeric or elastomeric components such as O-rings in oxygen service. Nonmetallic materials such as polymers and elastomers can leach plasticizers that could react with oxygen. Polymers and elastomers vary greatly in chemical composition and curing processes and, as such, should be evaluated for use in their specific application.</u>	No O-rings are needed (see Leak).

Aspect	Parallel (Straight)	Tapered
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 shall not interfere with the short- or long-term performance of the O-ring. Lubricants shall not be used on threads for oxidizing gas service.	Lubricants (tape or paste) are often used. Improper manual taping can cause gathering of tape. When used, the choice of tape or paste shall be compatible with valve and cylinder materials as well as the gas service and shall be applied in accordance with manufacturer's instructions and/or company standard operating procedures. Only suitably specified tape or paste shall be chosen. NOTE—Not all lubricants are the same (even all polytetrafluoroethylene (PTFE) tapes are not the same and not suitable for all applications).
Particulates	Old lubricant and O-ring residue and metal chips/particulates shall be removed.	At the time of the valve removal, pieces of tape or metal particulates from the thread can fall into the cylinder.
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 (straight) threaded valve can cause damage to the thread in a different cylinder. Threads and the O-ring shall 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, the threads shall be cleaned if lubricants were used. Valve removal should follow the guidelines outlined in CGA P-38, *Guideline for Devalving Cylinders* [4].	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 tapered thread valves are installed using lubricants, it is required that these threads be cleaned for proper visual inspection. Valve removal should follow the guidelines outlined in CGA P-38 [4].
Valve removal under pressure	If a valve is 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 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.
WARNING: *Valve removal under pressure is a dangerous practice, which can result in death or serious injury, 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* [4].		

Conclusions

Over many years, data and experience have been gathered that 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 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 CGA V-11, *Guideline for the Installation of Valves into High Pressure Aluminum Alloy Cylinders* or ISO 13341, *Transportable gas cylinders—Fitting of valves to gas cylinders* [5, 6].

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 DOT/TC specification aluminum alloy cylinders, the cylinders are mandated to have a parallel (straight) thread design. DOT and TC allow openings on aluminum alloy UN pressure receptacles in oxygen service to be configured with straight or tapered threads. In the United States, 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 [6]. In Canada, see CSA B340-18, *Selection And use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2,* Clause 4.6.1.2; CSA B341-18, *UN pressure receptacles and multiple-element gas containers for the transport of dangerous goods*, Clause 7; and CSA B342-18, *Selection and use of UN pressure receptacles, multiple-element gas containers, and other pressure receptacles for the transport of dangerous goods, Class 2*, Clause 5.2.5.3 s) [7, 8, 9].

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.

References

Unless otherwise specified, the latest edition shall apply.

[1] *Code of Federal Regulations*, Title 49 (Transportation), Parts 100-180, U.S. Government Printing Office. www.gpo.gov

[2] CSA B339-18, *Cylinders, spheres, and tubes for the transportation of dangerous goods,* Canadian Standards Association. www.csagroup.org

[3] CGA V-19, *Marking Requirements to Mitigate Potential Cylinder and Cylinder Valve Thread Mismatches*, Compressed Gas Association, Inc. www.cganet.com

[4] CGA P-38, *Guideline for Devalving Cylinders*, Compressed Gas Association, Inc. www.cganet.com

[5] CGA V-11, *Guideline for the Installation of Valves into High Pressure Aluminum Alloy Cylinders*, Compressed Gas Association, Inc. www.cganet.com

[6] ISO 13341, *Transportable gas cylinders—Fitting of valves to gas cylinders*, American National Standards Institute. www.ansi.org

[7] CSA B340-18, *Selection And use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2,* Canadian Standards Association. www.csagroup.org

[8] CSA B341-18, *UN pressure receptacles and multiple-element gas containers for the transport of dangerous goods*, Canadian Standards Association. www.csagroup.org

[9] CSA B342-18, *Selection and use of UN pressure receptacles, multiple-element gas containers, and other pressure receptacles for the transport of dangerous goods, Class 2,* Canadian Standards Association. www.csagroup.org

PREFACE

As part of a program of harmonization of industry standards, the Asia Industrial Gases Association (AIGA) has published AIGA PP 03, "*Use of Tapered and Parallel (Straight) Threads in Aluminum Alloy Cylinders"*, jointly produced by members of the International Harmonisation Council and originally published by the Compressed Gases Association (CGA), PS-24, "*Use of Tapered and Parallel (Straight) Threads in Aluminum Alloy Cylinders"*.

This publication is intended as an international harmonized publication for the worldwide use and application by all members of Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), EIGA, and Japan Industrial and Medical Gases Association (JIMGA). Each association's technical content is identical, except for regional regulatory requirements and minor changes in formatting and spelling.

NOTE—Technical changes from the previous edition are underlined.

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