AIGA 2007 Meeting

PACKAGED GASES SAFETY









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Safe cylinder package design

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What do we mean by a Cylinder Package?

Gas cylinderCylinder valveValve protection

Bundle





What do we mean by "Safe"?

The Four Essentials:

- Resistant to mechanical loads
- Retains pressure
- Is compatible with the gas and leak detection materials
- Resists corrosion

Always remember local conditions of use!









Local conditions of transportation and use may be rather different than you think.







THE LINDE GROUP













How do we assure these essentials?



 Good, careful, and thorough design
Adherence to Internationally recognised standards such as ISO, EN, CGA, EIGA and AIGA





Let's deal with them one by one





Mechanical loading :

Cylinder valves

- High impact strength
 - Typically high quality ductile brass with traceable composition and mechanical properties.
 - Not too big a gas passage through the inlet connection from the cylinder.
- Valve protection to ISO 11117
 - Guards
 - Caps





Mechanical loading :

Cylinders

- Proper heat treatment to avoid brittle fracture
 - Ensure mechanical properties are right
- Sufficient wall thickness
 - Not simply enough to contain the pressure safely
 - For low pressure cylinders it is theoretically possible to use a high strength alloy that would result in a very thin cylinder wall thickness unable to resist denting in everyday service.
- Do not over torque cylinder valves
 - You could damage the cylinder neck and weaken the valve





Retains pressure :

Leak tight joint between valve and cylinder

Follow ISO 13341 taking particular care about taping.

Valves

- Endurance tested to ISO 10297
 - Tougher requirements for gases such as helium and hydrogen
 - Beware of performance in cold conditions because the sealing elastomers become too hard.







Retains pressure

Cylinders selected to be able to withstand the developed pressure safely:

- Developed (or elevated) pressure of the gas or gas mixture at 65 degC never to be more than cylinder test pressure.
- Where appropriate, pressure relief devices such as bursting discs chosen to function at 80-100% of cylinder test pressure.







Compatibility with the gas

Cylinders

- For most applications either steel or aluminium cylinders can be used
- There are exceptions and they are very important indeed e.g. cannot use chlorine in aluminium cylinders.
- Use guidance from ISO 11114 Part 1





Compatibility with the gas

For cylinder valves

- Valve body materials are normally brass or stainless steel
- Beware of using any copper alloy valves with ammonia and some with acetylene
- The main compatibility issues relate to the "soft" parts such as the valve spindle seat and O rings used in the gland sealing system.
 - Oxygen
 - Carbon dioxide
- But do not forget lubricants: oxygen, food gases
- Refer to ISO 11114 part 2.





Residual pressure valve







Compatibility with leak detection methods

We have also to consider the leak detection method:

- Use of detergent-based fluids that bubble if a gas leak is present.
 - Some contain ammonia which is not compatible with brass cylinder valves
 - Refer to IGC 78/06 Leak detection fluids used with gas cylinder packages







Corrosion

This is the main cause of failure of gas cylinders

- It is very important to keep cylinders dry inside
- The latest high strength steel cylinders will corrode easily and because of their small wall thickness rupture is possible in a short time once moisture is present.
- Aluminium cylinders can be corroded by acidic liquids such as cola syrups and cleaning fluids







Corrosion

- Residual pressure valves offer good protection for such cylinder problems (see ISO 15996).
 - They prevent back-flow into the cylinder from customer processes
 - They hold back a little gas to prevent atmospheric air entering if the customer leaves the main valve open.
 - BUT, to be sure they are working they need a functional check at <u>every</u> refill.







Corrosion

- External protection of cylinders is very important, especially in the tropical, humid climates and marine environment (where applicable) of AIGA members
- Many paint coating systems are available
- Cylinders tend to suffer impact damage to the coating during transportation so the coating system needs to be easy to repair
- Welded cylinders benefit from generous zinc coating under the paint top-coat.







Stress Corrosion Cracking (SCC)

- This is a problem in our industry that is suffered by gas cylinder packages.
- Gases such as hydrogen and carbon monoxide can cause failures of steel cylinders due to hydrogen embrittlement or SCC respectively.
- Choice of cylinder metal and alloy is vital to assure safety.
 - Steel cylinders with limited strength and high ductility better resist hydrogen embrittlement
 - Aluminium alloy cylinders provide the best safeguard against SCC from carbon monoxide. If steel must be used, the moisture levels in the cylinder need to be very closely controlled indeed.







Stress Corrosion Cracking (SCC)

- Similarly, highly stressed components such as bursting discs can fail due to this mechanism e.g. nickel discs mistakenly used in hydrogen cylinders
- Cylinder valves are often the victims of attack by SCC.
- Ammonia-bearing liquids will cause valves to simply snap off from cylinders at the neck!
- Thin components in valves made from copper alloy material that is not stress relieved after machining and where the stress is tensile are very vulnerable to attack.
- When reviewing valve designs take care to look out for such problem areas.







Valve Protection

There are three differing ways to deal with this issue:

Strong valve, no protection

- To meet the requirements of ISO 10297 Annex A
- Valve cap, protection in transport but not in use
- Valve guard
 - The performance requirements of caps and guards are set down in ISO 11117.







Valve protection







Valve Protection

Many cylinders in Asian countries do without valve protection. In these circumstances the valve needs to be able to resist breakage if cylinders fall over.

ISO 10297 requires valves without protection to resist a side impact test of 3.6 times the all-up weight of the cylinder but expressed as Joules. Therefore a 100 kg cylinder needs to have a valve tested to 360 Joules. Australian Standard 2473 is similar.

In such package designs the area of failure is at the interface between valve and cylinder.







Impact testing

- Here is a valve that has been side impact tested to meet ISO 10297 or AS 2473 requirements
- This means it may be used unguarded on cylinder packages up to a specified maximum weight







Valve Protection Caps

- Alternatively cylinder valves can be protected in transport by a cylinder cap.
- These are normally of a ductile metal such as steel or malleable iron.
- It is very important to use a cylinder valve design which is compatible with such a cap or the valve may be accidentally opened when removing the cylinder cap.







Valve Protection Guards

- The third and increasingly popular choice is to use a valve guard.
- These protect the valve during both transport and in use by the customer
- They need to be firmly attached to the cylinder and designed to give easy access for both customer and filling plant connection
- They are often made from steel, malleable iron or plastics. The plastics chosen need to have sufficient rigidity at high ambient temperatures as well as resisting brittle failures in colder climates.







Valve guards come in lots of shapes and sizes

Shroud bolted to cylinder



"Rabbit Ears" bolted to cylinder







Guard height is important!





ISO 11117 requires at least 1 mm between the top of the valve and the top of the guard





Bundles

- The safe design requirements of packages such as bundles require further topics to be addressed by the designer:
 - Provision for lifting and moving
 - Resistance to dropping
 - Gas manifold design
 - Cylinder retention and resistance to twisting
 - Corrosion of the frame and cylinders







Bundle drop testing to EN 13769





The manifold must not leak after the bundle has undergone drop testing





The importance of testing

It is vital to check out the safe design of all gas packages (cylinders and bundles) thoroughly before launching them into the market.

Many test procedures are standardised
ISO 10297 for cylinder valves
ISO 11117 for valve guards
ISO 9809-1,2 for cylinders
EN 13769 for bundles

But practical field testing is very important too.





The importance of testing

- Designers often may not realise what Customers actually do to gas cylinders and bundles!
- Do not let your customers be the ones to discover a safety problem.







Thank you!









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