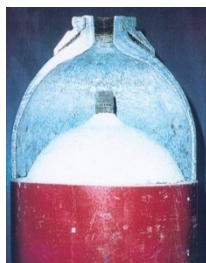


ACETYLENE GAS SAFETY SEMINAR 2009



239
1001



Asia Industrial Gases
Association



Council of Labor Affairs
Executive Yuan



Taiwan High Pressure
Gas Industrial Association

SAHTECH 財團法人
安全衛生技術中心

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Specific Precautions for Acetylene Cylinders

Andy Webb

European Industrial Gases Association



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Why is Acetylene Different to Other Industrial Gases?

Acetylene can decompose
in the absence of oxygen or air



$$\Delta H = -227 \text{ kJ/mol}$$

$$= -8733 \text{ kJ/kg } (\approx 1.9 \text{ TNT-equivalents})$$

Storing Acetylene in Gas Cylinders

- Storage of acetylene in cylinders requires special precautions in order to prevent explosive decomposition of the acetylene within the cylinder
- There are standards for acetylene cylinders and valves which require specific tests to ensure the cylinders and valves are safe

How is Acetylene Stored in Cylinders?

- The cylinder is completely filled with a porous material which may be either:
 - a monolithic block consisting of calcium silicate hydrate with a porosity of about 90 %
- Or
 - a granular or charcoal material
- The porous material absorbs a solvent (usually acetone) so that the solvent is evenly distributed in the cylinder

How is Acetylene Stored in Cylinders?

- Acetylene is dissolved in the solvent – “Dissolved Acetylene” or “DA”
 - Note Special Applications Solvent Free Acetylene UN 3374
- The porous material not only holds the solvent but must be able to stop an acetylene decomposition
- As well the cylinder valve needs to be able to resist decomposition in the cylinder

Inside of Acetylene Cylinders



Monolithic



Non Monolithic

Acetylene Cylinder by Weight

Modern monolithic porous material typically has a “porosity” of 92%. Or in other words only about 8% is “solid”:
Typical 50 litre C_2H_2 cylinder will weigh about 65 kg of which:

Solvent: 20 kg

Shell: 30 Kg

Mass :5kg

Acetylene 10 kg

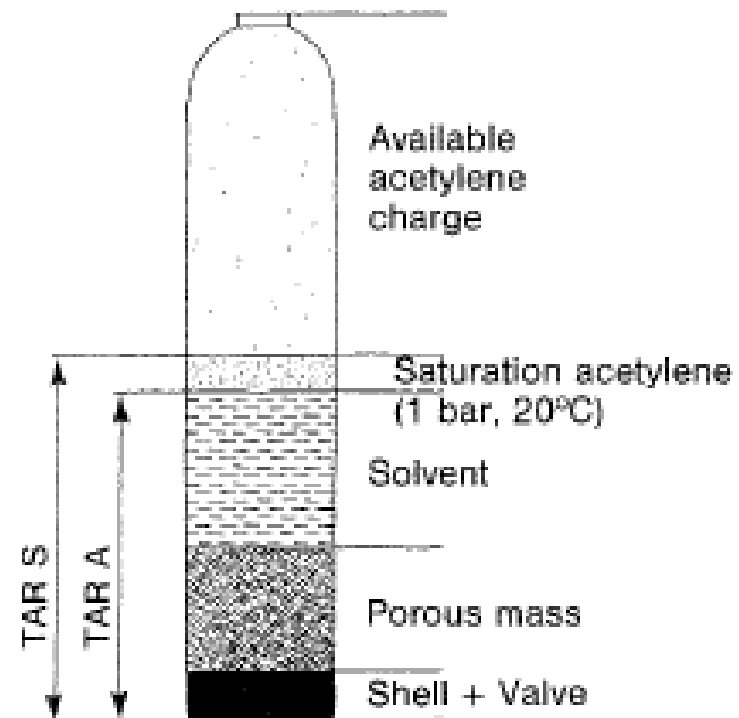


Fig.17 Definitions of TAR S and TAR A. Weight distribution of an acetylene cylinder.

Approval Tests for Acetylene Cylinders

- Acetylene Cylinders must be made to the applicable standards for the country of use
- Taiwan CNS 2724 Refillable Welded Steel Cylinder for Dissolved Acetylene
- Where there are no National Standards consider using ISO 3807 Cylinders for acetylene basic requirements

Example of Approval Tests for New Designs of Acetylene Cylinders

- Testing of the cylinder shell
 - Standards for welded (or seamless cylinders)
- Additional testing of the acetylene cylinder after it is filled with porous material
 - Elevated temperature test to ensure that no hydraulic pressure will be generated
 - Backfire test to ensure that the porous material is able to stop an acetylene decomposition in the cylinder

Cross Section of Acetylene Cylinder after Passing the Backfire Test



- Cylinder is
 - overfilled (+5%)
 - heated (35 ° C)
- Start of acetylene decomposition
 - by melting a metal wire in the ignition tube

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Cylinders After a Backfire on a Filling Plant



Failure of Acetylene Cylinders

- A decomposition in an acetylene cylinder might be started by a backfire or a fire or intense heat
- If the porous material does not stop the decomposition, the cylinder will burst
- Failure of an acetylene cylinder can result from any free volume in the porous material e.g. caused by
 - too large a gap
 - cracks, (large with movement)
 - loose porous material
- Such cavities might act as a location where the acetylene decomposition is not stopped and constantly supplied with acetylene

Approval of the Porous Material

- The approval shall define requirements for safe usage
- Requirements for safe usage include information regarding
 - Size and type of cylinder shells
 - e.g. seamless or welded cylinders
joggle or butt welds
 - Density and porosity of the porous material
 - Core hole filters
 - Maximum permissible top clearance
 - Permissible solvent content
 - Maximum permissible acetylene content

Quality Control for the Porous Material

- The porous material, particularly monolithic material is very sensitive to changes in the production process
 - Its integrity must be ensured by an effective production quality assurance that includes:
 - Raw materials
 - Specifications and inwards inspection
 - Control of porous material to be filled in the cylinders
 - Control of autoclaving process
 - Temperature and time
 - Gap measurement
 - Porosity determination

Porous Material

- Different types of porous materials have different requirements for safe usage
- These may be different in different countries even for one single type of porous material

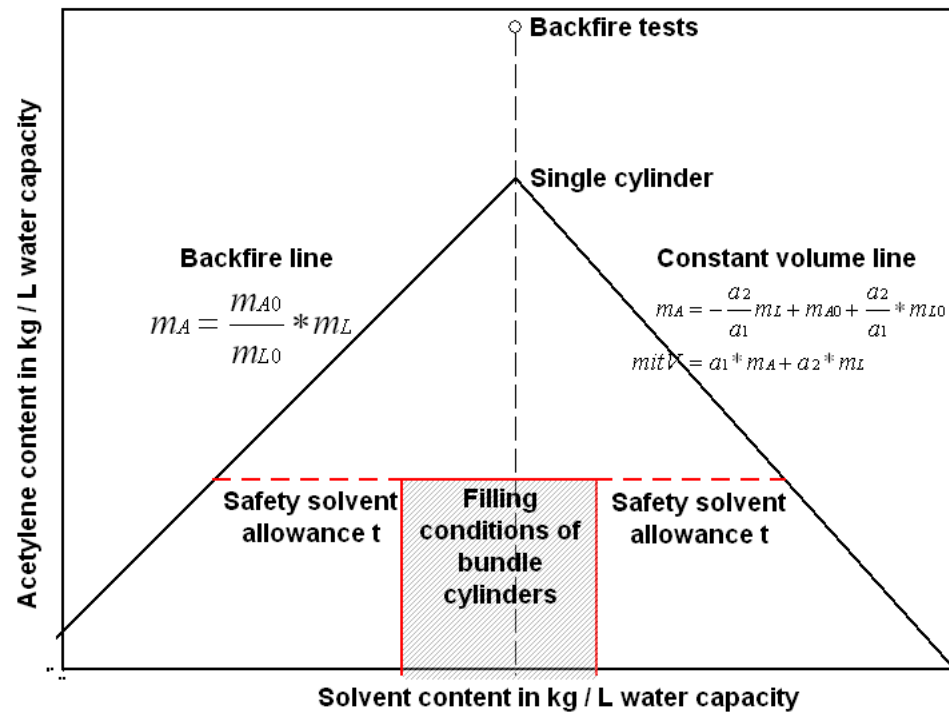
Acetylene Filled in Bundles

Acetylene cylinders may be filled in bundles

- Specific precautions required if filled as a complete unit
- Construction requirements and flash back arrestors
- Acetylene content reduced and filling cycles reduced between solvent checks
- See European Standards:
EN 1800 & EN 12755



Determination of Filling Conditions of Acetylene Cylinders and Bundles



Fusible Plugs

- Major difference between Europe and many other parts of the World – Fusible Plugs
- Europe does not use them, many other parts of the world do use them
- Technical arguments both for and against their use. No harmonised view yet
- Follow the requirements of the regulations of the country of use

Acetylene Cylinder Valves

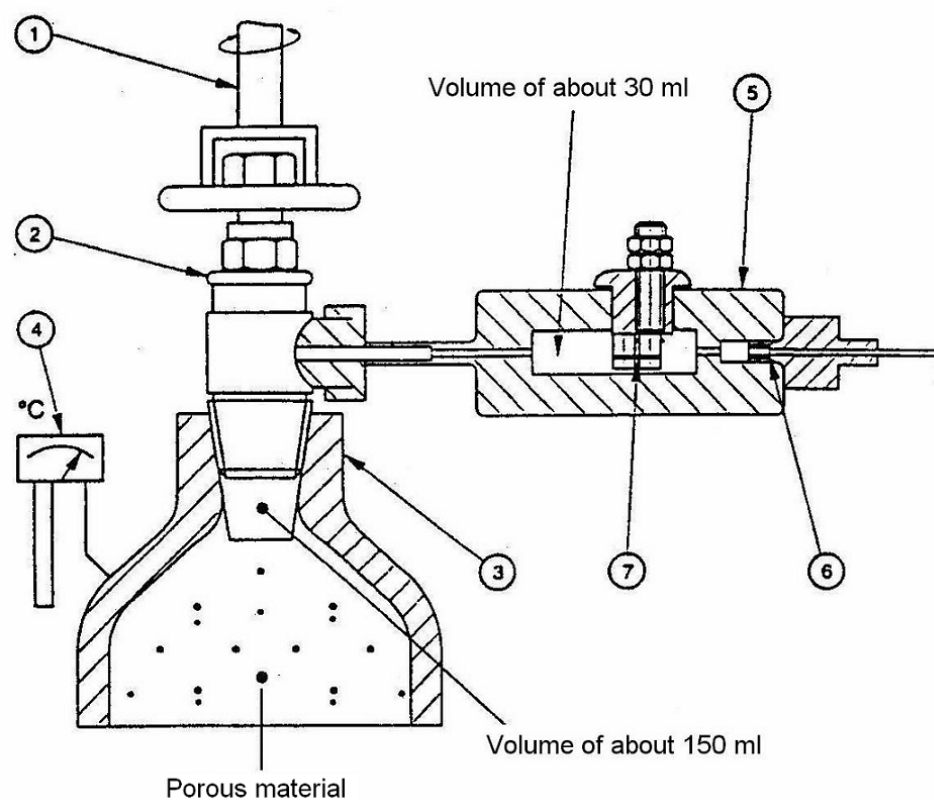
- Cylinder valve is very important – it is the customer interface and keeps the gas in the cylinder!
- Should conform to a standard,
 - Examples CNS 4152, ISO 10297
- Tests for the valve and additional test because it is an acetylene valve
- Material requirements for acetylene cylinder valves, copper content below 65 %,silver content below 50 %

Type Tests of Cylinder Valves

- Testing of cylinder valves can include, depending on the standard:
 - Hydraulic pressure test
 - Tightness tests (different pressures/temperatures)
 - Endurance test
 - Excessive torque test
 - Flame impingement test
 - Impact test (if no valve protection is used)
 - Additional tests for acetylene cylinder valves

Acetylene Flashback Test

- According to ISO 10297 -



1 Remotely operated closing device

2 Test sample valve

3 Acetylene cylinder

4 Temperature indicator

5 Igniter tube

6 Bursting disc

7 Constantan wire

Acetylene Cylinders and Valves - Summary

- An acetylene cylinder that meets all the requirements of the design standard and has been made to the standard will give many years of reliable service
- Acetylene valves are important, not only do they keep the gas in the cylinder, it is the item the customer uses the most!

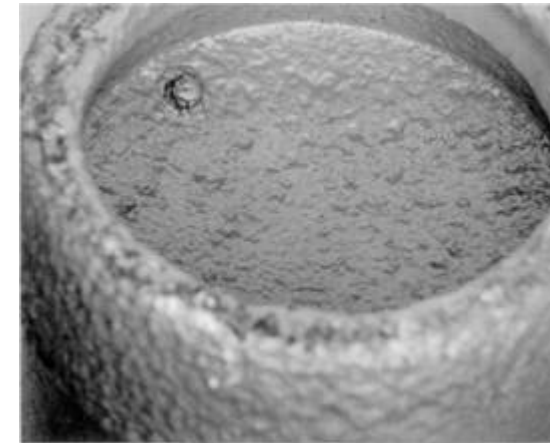
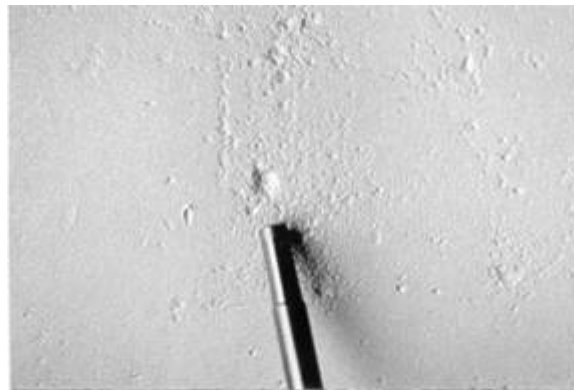
Periodic Inspection and Requalification of Acetylene Cylinders

- Acetylene Cylinders require to undergo a periodic examination to ensure that they are “fit” for continued use
- Intervals between inspections vary according to regulations, (e.g. between three to ten years)
- Examples of standards to follow:
 - ISO 10462 Gas cylinders -- Transportable Cylinders for Dissolved Acetylene -- Periodic Inspection and Maintenance
 - CGA C-13 Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders

Periodic Examination of Acetylene Cylinders

- Two components to the Periodic Examination
 - Cylinder shell, (the outside) and the cylinder valve
 - Porous material (the inside)
- Cylinder Shells
 - Most cylinder shells are welded, though seamless are used
 - Need to look for damage such as dents and corrosion
- Porous Material
 - Either “granular” (charcoal) non monolithic or
 - Monolithic material

Cylinder Shell Examination

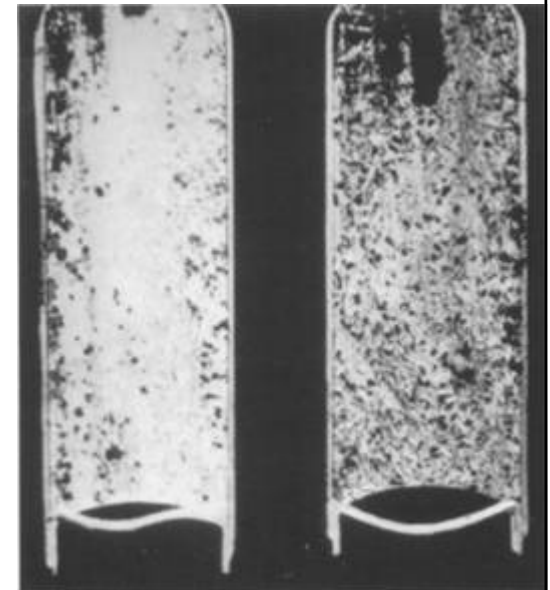
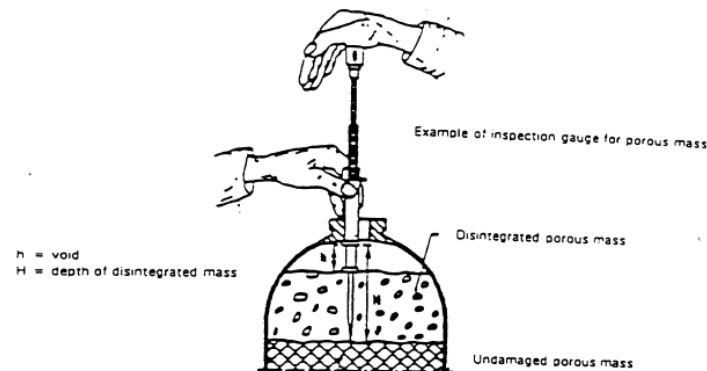


Examples from CGA C-13

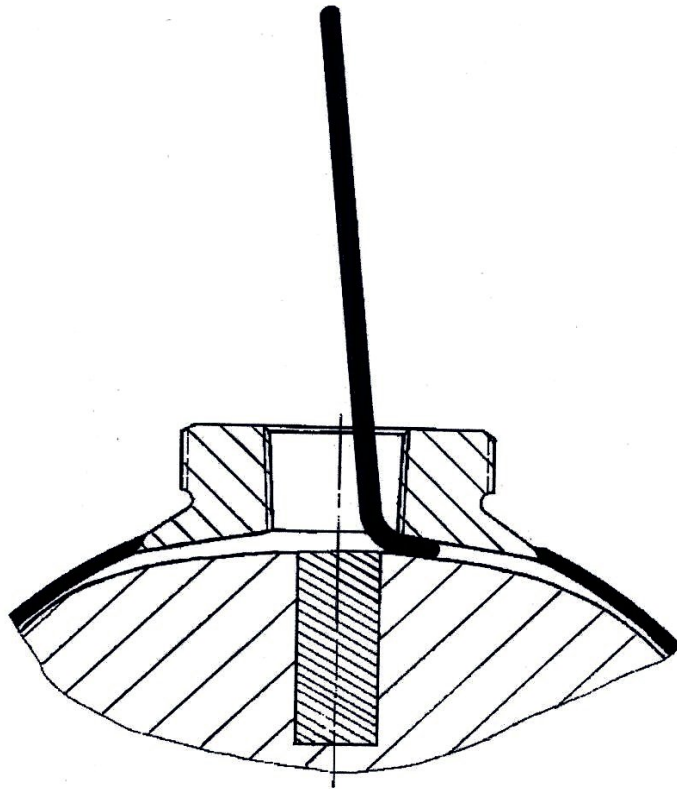
Examination of the Porous Material

- Examination technique depends upon the type of Porous Material
- Granular
 - Compaction
 - Cavities
- Monolithic
 - Cracks
 - Crumbling
 - Cavities

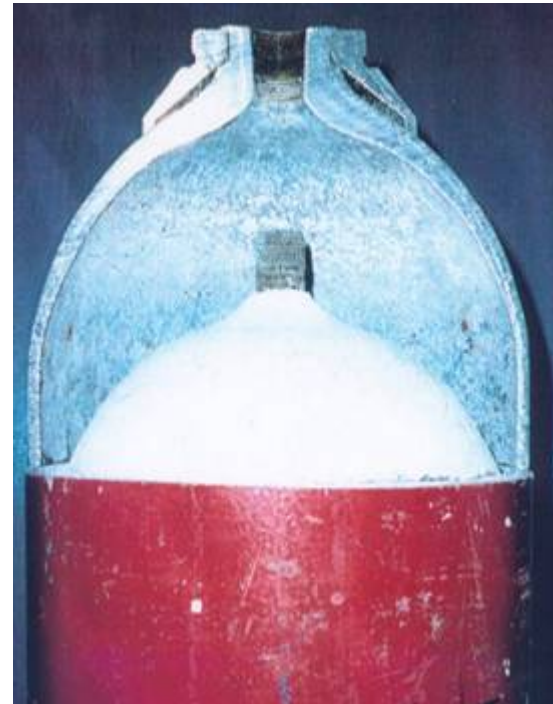
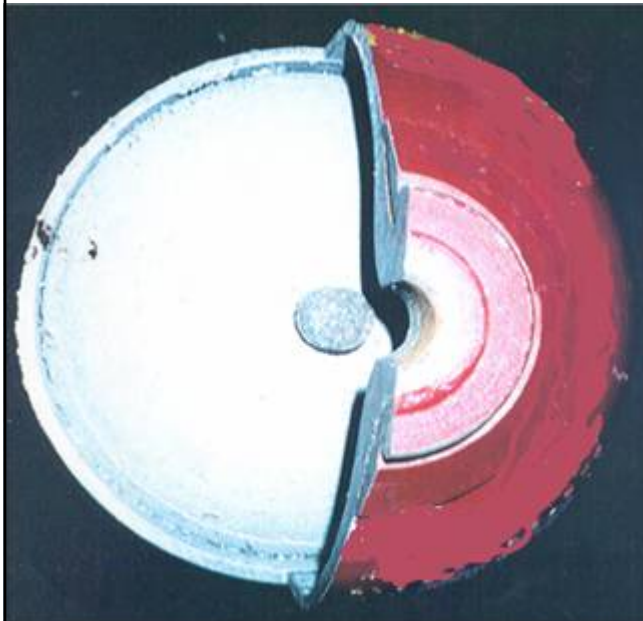
For granular non-monolithic masses only.



Example of Top Clearance



Examples of Porous Material Defects



Periodic Inspection Summary

- Some important points to note:
 - Cylinder Inspection should only be carried out in areas specifically designated and designed for inspection
 - Personnel shall be trained in all aspects of inspection
 - Written procedures
 - Recovery and venting of acetylene prior to valve removal
 - Limit number of cylinders with the valve removed
 - Repair of the porous material according to the manufacturer's recommendations and standard
 - **Don't forget the valve!**
 - See EIGA Doc 79, Cylinder Retest Stations

THANK YOU