Compressed Gas Cylinder Safety

Gas Cylinder Parts

1. Cylinder Valve
   a. Valve Handwheel
   b. Valve Outlet Connection
   c. Pressure Relief Device
2. Valve Outlet Cap
3. Cylinder Collar
4. DOT Specification
5. Serial Number
6. Manufacturer’s Symbol
7. Test Date
8. Cylinder Cap

Presented By

Chris Bogdanoff, Reva Golden, Tony McCrimmon
Brewers Association Safety Subcommittee
The Compressed Gas Cylinder Safety document was sent with Webex invitation. It will be referenced throughout this Power Hour.
Agenda

• Background
• General Safety
• OSHA and Regulatory Compliance
• Storage, Use, Handling/Transport
• Hazard Assessment
• Lessons Learned
• Summary
In the Brewery Setting

• Many of us have more than one cylinder in our facilities
  • Oxygen for wort
  • Carbon Dioxide for production and serving
  • Nitrogen
  • Compressed Air
  • Propane for forklifts and patio heaters
  • “Empty” Kegs
Other Pressure Hazards

- Gas lines and fittings
- Air compressors
- Nitrogen generators
- Gas mixers
- Tanks and barrels
- Dewar vessels and bulk gas storage
- Keg washer
- Refrigeration systems
- Boiler and steam lines
- Natural gas lines
- Hydraulics
Safety Goals

• Compressed gas cylinder and pressure vessel safety is designed to:
  • Reduce injuries from improper use, handling and storage
  • Protect the integrity of cylinders, valves, tanks, vessels
  • Prevent pressure energy releases
  • Prevent release of hazardous chemicals
# How Big is this Hazard?

## 2012-2017: 28 OSHA reportable injuries

<table>
<thead>
<tr>
<th>Common Accidents</th>
<th>Result:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper handling</td>
<td>Low back, musculoskeletal</td>
</tr>
<tr>
<td>Dropping cylinders</td>
<td>Smashed hands, or feet</td>
</tr>
<tr>
<td>Fingers get caught on cart</td>
<td>Finger amputation</td>
</tr>
<tr>
<td>Improper refilling procedure</td>
<td>Asphyxiation, or injury</td>
</tr>
</tbody>
</table>
Common, Bad Scenario

- Explosion of cylinder
  - Improper Storage
    - Bumped over
  - Improper Storage
    - Close to corrosives and that heat impacts integrity

Image source: https://goo.gl/images/5tVNXj
Common, Bad Scenario

• Improper handling
  • Dropped off of forklifts
  • Failure to use carts

• Improper maintenance
  • Neglect 5 year hydrostatic test
  • Valve seat or seal leaks

Image source: https://goo.gl/images/J7mXFZ
The Good News!

- Managing compressed gas cylinder safety is easy
  - Proper training
  - Proper techniques
  - Proper tools and equipment
OSHA Compliance - What do I need to know?

- Valve
- Siphon Tube
- CO₂ Under Pressure
- Liquid CO₂
Regulations

• OSHA Compressed Gases (General Requirements)
  – 29 CFR 1910.101(a)

• OSHA General Duty Clause and Letters of Interpretation

• Labeling and communication requirements
Regulations

OSHA defers standards to other national consensus experts

• When cited in OSHA a deferment standard may serve as enforceable regulation
• Compressed Gas Association (CGA) pamphlets
  – Safe Use, Storage, and Handling
    • Recommend to reference most current revision (**hard to find for free**)
    • CGA’s P-1-2008 Safe Handling of Compressed Gases in Containers
    • CGA’s C-6 2013 Visual Inspection of Compressed Gas Cylinders
## Regulations

**NFPA 55**

<table>
<thead>
<tr>
<th>Material</th>
<th>Unsprinklered Areas</th>
<th>Sprinklered Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Gas Cabinet, Gas Room, or Exhausted Enclosure</td>
<td>No Gas Cabinet, Gas Room, or Exhausted Enclosure</td>
</tr>
<tr>
<td>Cryogenic Fluid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxidizing</td>
<td>45 gal (170 L)</td>
<td>90 gal (340 L)</td>
</tr>
<tr>
<td>Inert</td>
<td>No Limit</td>
<td>No Limit</td>
</tr>
<tr>
<td>Flammable Gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td>150 lb (68 kg)</td>
<td>300 lb (136 kg)</td>
</tr>
<tr>
<td>Nonliquefied</td>
<td>1000 ft³ (28 m³)</td>
<td>2000 ft³ (56 m³)</td>
</tr>
<tr>
<td></td>
<td>2000 ft³ (56 m³)</td>
<td>4000 ft³ (112 m³)</td>
</tr>
</tbody>
</table>
Transportation of cylinders in motor vehicles is also regulated

- Department of Transportation (DOT)
  - 49 CFR 171-179
- Certain quantities of compressed gases may require DOT paperwork, labeling, and transporter certification training
- All quantities must have proper containment and be properly secured
Labeling

- Compressed gases are chemicals too
- Ensure all cylinders have
  - OSHA Primary Label (What’s in there?!)  
  - Fill status (Empty or full?)  
  - DOT labeling is also required for transport  
  - NFPA 704 diamonds for bulk storage areas
Compressed Gas Cylinder Safety

The BA released a one-page Summary of safe work practices

Please follow along with the reference
Storage

Upright and Secure

• If bumped, will it fall over?
  – **Recommended Options:**
    • Chained to the wall; Cargo Straps;
      – At least ¾ of the way up
      – Rated Wall Anchoring
    • Tank cabinets or corral slots
  – **Bad Ideas:**
    • Zip ties, Random rope, Spare string, U-clamps
Storage

Capped

• If the cylinder falls over, will the valve be protected?
  • Remove regulators
  • Thread cylinder cap hand-tight
• Eliminates leaking valve o-rings and seals on regulator
Storage

- Griftan and “fail safe” cylinder caps
  - Does not protect regulator
  - Not OSHA accepted
  - NOT recommended, except if used on “special truck”


Storage

Segregated

- Store empty and full containers separately
- Separate incompatible chemical classes
  - Separate oxidizers and flammables by
    - 20 feet
    - 5 foot high, 30 min fire wall
- In appropriate quantities
  - NFPA limits indoor propane storage to 150 lbs
Storage

Identifiable

• Chemical ID (What’s in there?!)
• Fill Status (Is it empty or full?)

Out of the way

• Keep clear of exit paths and safety equipment
• Store away from high traffic areas
  • Pedestrian, forklift, or other vehicle
• Away from corrosive environments or temperature extremes
• Isolate from electrical contact and circuits
New Storage Technology

- QuickFit disconnect system from Micro Matic
- Eliminates exposed gauges to stop impact damage
- Uses a special cylinder fitting
- Technology being adapted in Europe

http://www.micro-matic.com/products/quickfit
Use

• Safe use is similar to safe storage
  – Upright, secured
• Must demonstrate that cylinder is “really in use”
  • Integral to process or equipment
  • Needle drop when valve is opened
Use

• CO₂ Monitors:
  • Consider installing CO2 monitors and good ventilation in areas where the gas is used:
    • Cellar
    • Brewhouse
    • Walk-in cooler
    • Storage area
Transport / Handling

- **PPE**: closed toe shoe; preferably safety-toe boot
  - Safety glasses
  - Gloves are appropriate to improve grip

- **Capped**: Transport is when you are most likely to knock the tank over!
  - Cap protects the valve

- **Strapped**: Tank locked in securely to transport dolly or vehicle
Transport / Handling

- **Transport Cart or Dolly**
  - Use rated transport device to move tanks from one location to another

- **Small distances:**
  - Tilt tank slightly and turn in small, controlled steps into working position

- **Bad Ideas:**
  - Rolling, Dragging, Sliding, Picking up/Carrying, and/or Cradling on forklift forks
Transport / Handling

• **Transport by Forklift:**
  • Only done with rated pallet adaptor specifically designed for transporting gas cylinders

• **Transport with Motor Vehicle:**
  • Only by persons with a DOT certification, unless exempt quantities
  • **Remember**—Small quantities of vented gas can be harmful or dangerous in your vehicle
Maintenance & Inspection
Maintenance & Inspection

• Pre-use
  – Examine the cylinder or vessel
    • Hydrostatic test etching
    • Look for signs of damage, weakness, or deterioration
• Leak testing and Pressure checking
  – Look, listen and feel
  – Hoses and connection joints
  – Spray with soapy solution
Refilling

• Must have a properly designed system
  • By manufacturer or certified engineer
• Must have a written safe operating procedure
  • Checklist and pre-fill inspection process
  • Maintenance procedures
• Refilling must only be done by properly trained personnel
  • Documented
  • Recurring refresher training
Dewars and Bulk Storage

From: https://www.betbev.com/bulk-co2/
How do these containers differ?

- Essentially they are the same, but because they are larger, the hazards are potentially larger.
- Take the same precautions as with any compressed gas cylinder.
- Be aware of hazards.
Kegs

• Of Course! Empty kegs are pressurized with CO₂
  • Kegs often pressurized higher than usual
  • What happens to the keg while in circulation
  • Inspect keg for damage
  • Kegs that can be comprised should be separated for maintenance
• Only trained personnel work on keg spears
• Take a training course (Not YouTube!)
Paperwork and Documentation

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Paperwork and Documentation

• Written Program
  • Usually included in Hazard Communication program
    • Chemical Inventory and SDS
    • Use, handling, and storage guidelines

• Process procedures
  • Safe operation (SOPs), Maintenance, Refilling
  • Hazard Assessment

• Training
  • Word of mouth may not be defensible
  • If you didn’t document it, you didn’t do it

• DOT exemption
Inventory

It’s not just for safety

• A good inventory can help with QC and process integrity
  – Have you ever run out of oxygen during knockout?
  – Have you ever run out of CO₂ in the middle of a bottling run?

• A good inventory can help save money with rental and demurrage fees
  • Knowing exactly which tanks are coming in and when you returned them to vendor
Hazard Assessment

• Which processes will involve compressed gases?
  – Brewing, cellaring, packaging, QC lab
  – Warehousing, taproom, offsite festivals

• How can misuse of cylinders cause damage to people or processes?

• What steps are you taking to control the hazards?
  – Proper storage, securement and transport tools
  – Safety rated stands and fail safe regulators
  – Double redundancy
    • Secondary regulators, pressure relief and isolation valves
  – Training on proper techniques
Other Hazard Considerations

• Stored energy
  • Release of energy can injure in many ways
    • Many brewing tasks involve stored pressure
    • Secure and remove clamps and fittings properly
    • Know what is behind your line before you disconnect it

• Fire/explosion
  • Flammable gas leaks

• Respiratory/air quality
  • Ventilation and monitoring
What Could Go Wrong?

How Gauges Fail

- Overpressure
- Vibration
- Chemical Incompatibility
- Clogging
- Tampering/Modification
- Misapplication/Mishandling
- Steam
Real Life Examples

• Filling smaller tanks with CO$_2$ causing employee to pass out
Real Life Examples

• Spear had been tampered with while keg was out on distribution; while setting up on keg washer, the spear came out and bumped employee in chest
Real Life Examples

- Moving on cart on uneven flooring caused tank to tip and employees hand to get caught resulting in amputation

Image source: https://goo.gl/images/3xhEzt
Real Life Examples

• Keg washer uses CO₂ unregulated off the bulk tank
  • Braided vinyl hose that T'ed off from the bulk tank
  • Hose was more than 12 years old
• Hose burst and released into a small, unventilated room
Real Life Examples

• Tasting Room manager was changing propane tanks for patio heaters.
• Manager was storing tanks upside-down
Additional Pressure Hazards

- Gas lines and fittings
- Air compressors
- Nitrogen generators
- Gas mixers
- Tanks and barrels
- Dewar vessels and bulk gas storage

- Keg washer
- Refrigeration systems
- Boiler and steam lines
- Natural gas lines
- Hydraulics
In Summary

• Compressed gas cylinders may have significant safety risk
• Relatively easy to manage
• Get equipped for safe storage, use, and handling
• Ensure properly inventoried and labeled
• Provide training to your staff.
  • Enforce the rules!
On-line Brewery Safety Training
Questions & Answers