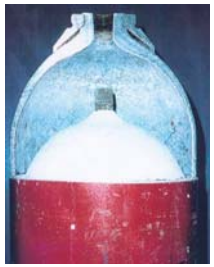
ACETYLENE GAS SAFETY SEMINAR 2009



AIGA
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
Safety & Health Technology Center

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ACETYLENE COMPRESSION & FILLING

Presented by

Vijay Kumar (Linde Gas Asia)

ACETYLENE COMPRESSION & FILLING

Characteristics of acetylene gas is unique

Behavior of acetylene gas is quite different from any other flammable gas.

Very unstable at high pressures.

Gets ignited with very low energy source, without any air/oxygen.

At high pressure the flame can very quickly transform from deflagration to detonation stage.

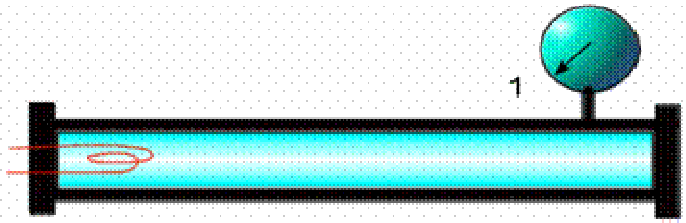
ACETYLENE COMPRESSION & FILLING

Deflagration

Flame travels at sub-sonic speed

Final pressure: 10-11 times initial pressure.

Medium pressures : 0.07-1 bar

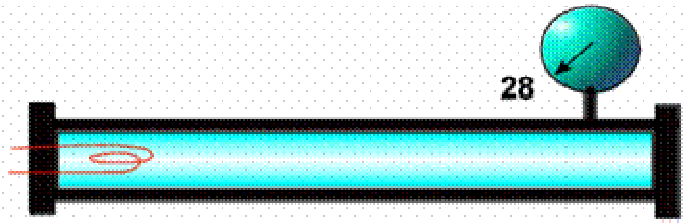


Detonation

Flame travels at super-sonic speed

Final pressure: about 35 to 50 times initial pressure.

High pressures : 1-28 bar



ACETYLENE COMPRESSION & FILLING

Because of the instability and ability to decompose at very low ignition energy.

Compression and filling systems are considered to be very critical areas in terms of safety.

ACETYLENE COMPRESSION & FILLING

Contents

1) **Compression system.**

2) **High pressure piping system.**

3) **Filling process.**

COMPRESSORS (1)

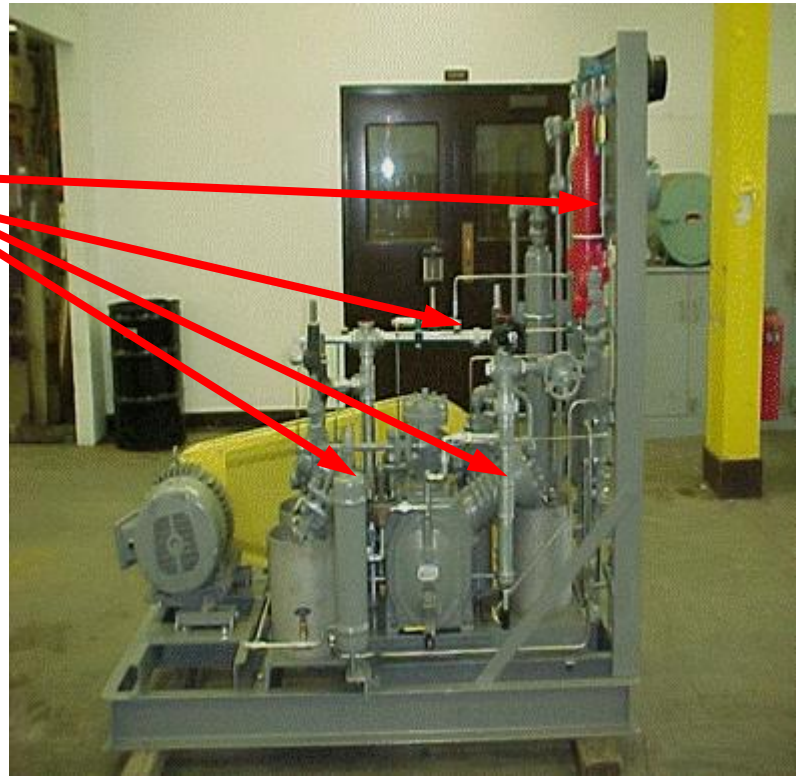
DESIGN CONSIDERATIONS

- Designed for acetylene service.
- Reduce the possibility of decomposition.
  - Proper temperature controls.
  - Operate pressures within specified limits.
- Reliability, safety and easy maintenance.

COMPRESSORS (2)

DESIGN FEATURES

- **All components designed for high pressure acetylene service.**



COMPRESSORS (3)

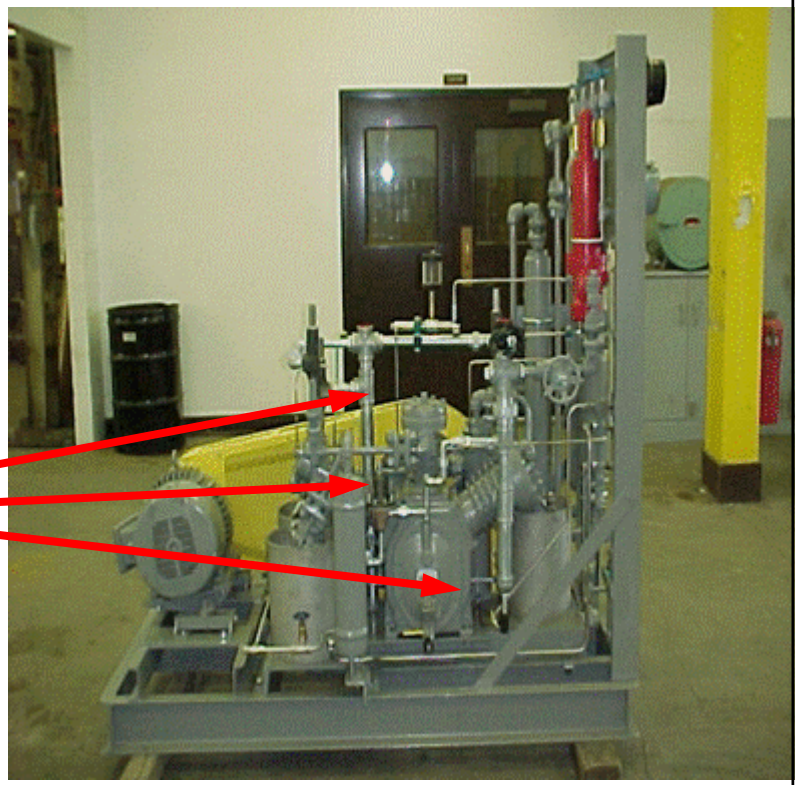
DESIGN FEATURES

- All components designed for high pressure acetylene service.
- **Lower speeds to avoid friction temperatures.**

COMPRESSORS (4)

DESIGN FEATURES

- All components designed for high pressure acetylene service.
- Lower speeds to avoid friction temperatures.
- **Multi stages, to keep compression temperatures in limits.**



COMPRESSORS (5)

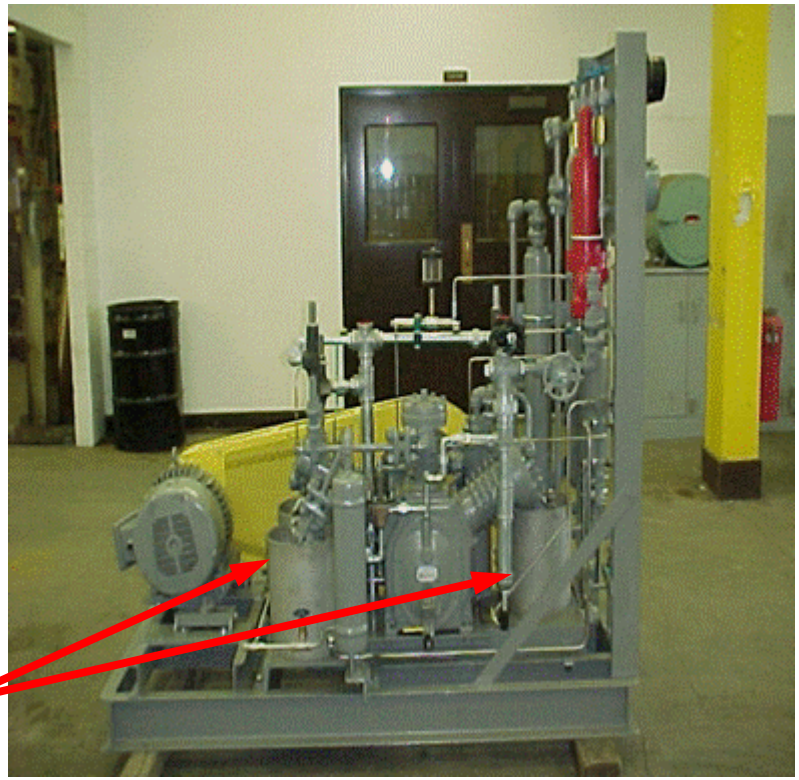
DESIGN FEATURES

- All components designed for high pressure acetylene service.
- Lower speeds to avoid friction temperatures.
- Multi stages, to keep compression temperatures in limits.
- **Water cooled or air cooled.**

COMPRESSORS (6)

DESIGN FEATURES

- All components designed for high pressure acetylene service.
- Lower speeds to avoid friction temperatures.
- Multi stages, to keep compression temperatures in limits.
- Water cooled or air cooled.
- **Inter-stage heat exchangers.**



COMPRESSORS (7)

DESIGN FEATURES

- All components designed for high pressure acetylene service.
- Lower speeds to avoid friction temperatures.
- Multi stages, to keep compression temperatures in limits.
- Water cooled or air cooled.
- Inter-stage heat exchangers.
- **Maximum discharge pressure 28 bars.**

COMPRESSORS (8)

DESIGN FEATURES

- **Proper purge fittings.**

COMPRESSORS (9)

DESIGN FEATURES

- Proper purge fittings.
- **Avoid pressures less than atmospheric pressures.**

COMPRESSORS (10)

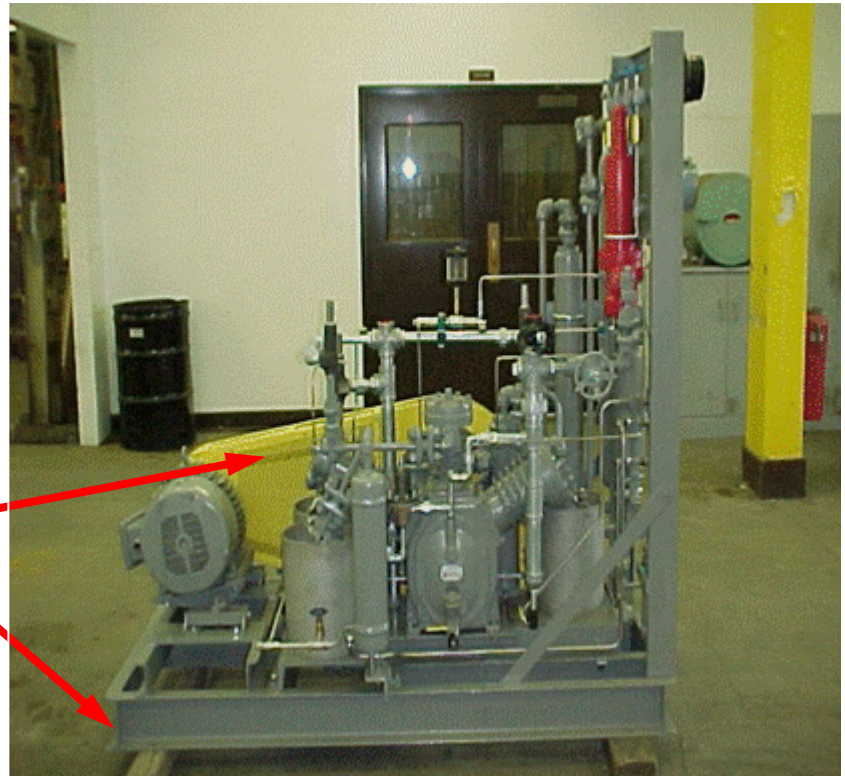
DESIGN FEATURES

- Proper purge fittings.
- Avoid pressures less than atmospheric pressures.
- **No re-cycle system.**

COMPRESSORS (11)

DESIGN FEATURES

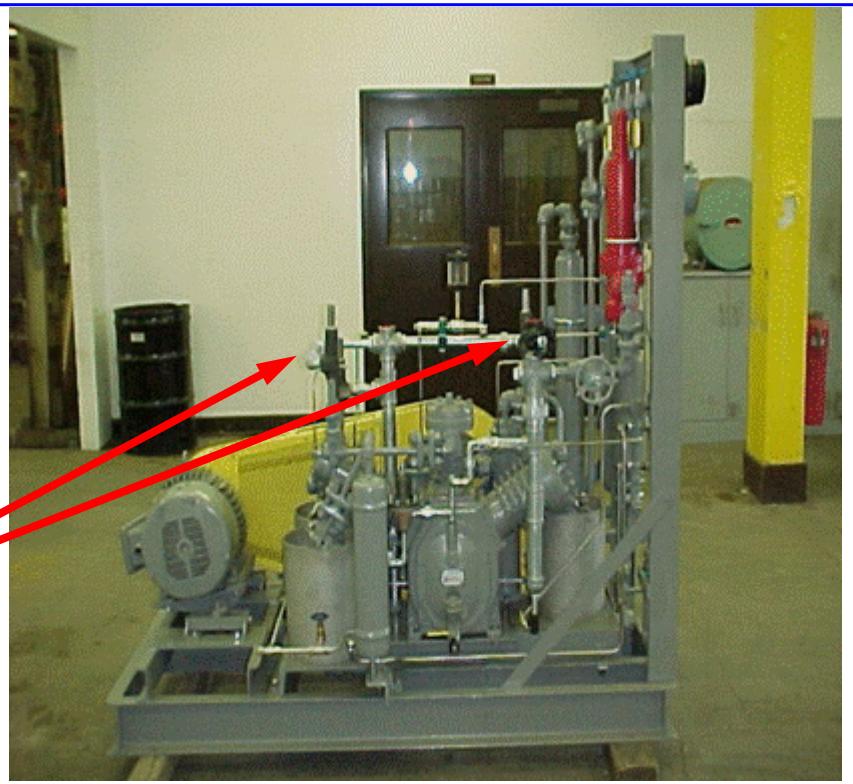
- Proper purge fittings.
- Avoid pressures less than atmospheric pressures.
- No re-cycle system.
- **Belts anti-static material and proper grounding.**



COMPRESSORS (12)

DESIGN FEATURES

- Proper purge fittings.
- Avoid pressures less than atmospheric pressures.
- No re-cycle system.
- Belts anti-static material and proper grounding.
- **Relief valves at the discharge of each stage and crankcase.**



COMPRESSOR (13)

DESIGN FEATURES

Reliability & safety

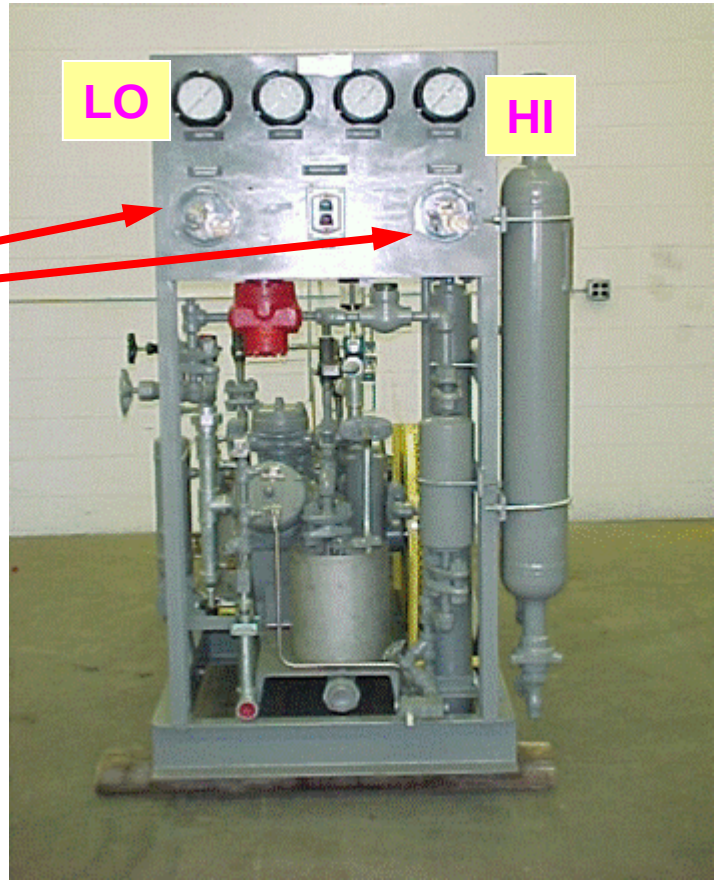
- Corrosion protection - Sacrificial rods.
- Discharge from safety valves shall be piped without restriction to a safe location.
- All drains piped to safe location.

COMPRESSORS (14)

OPERATIONS

Critical operational controls

- **High (discharge) and low (suction) pressure cutout switches.**

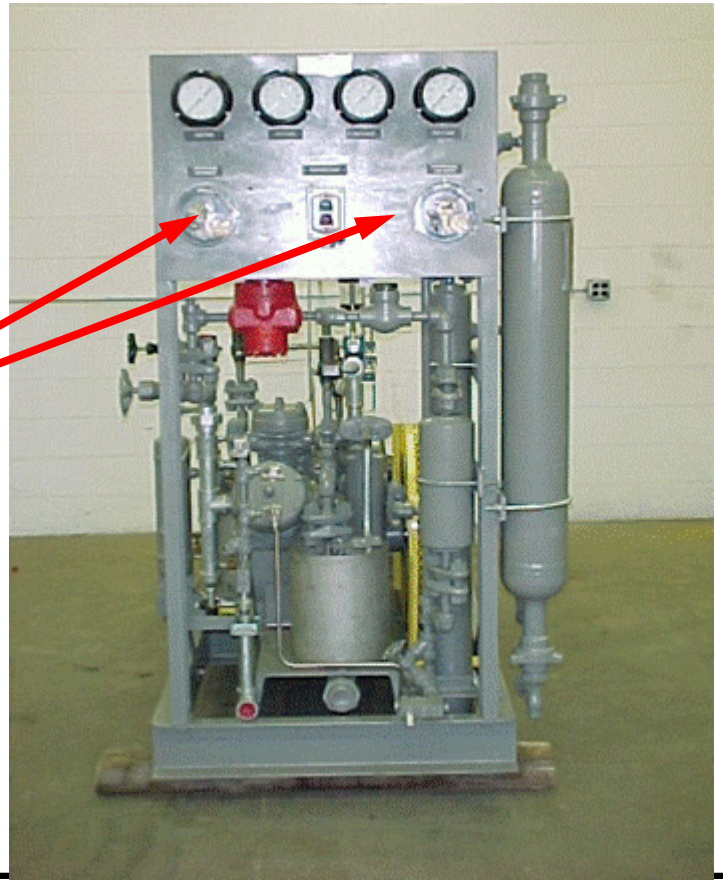


COMPRESSORS (15)

OPERATIONS

Critical operational controls

- High (discharge) and low (suction) pressure cutout switches.
- **Daily check of operation of these switches function.**

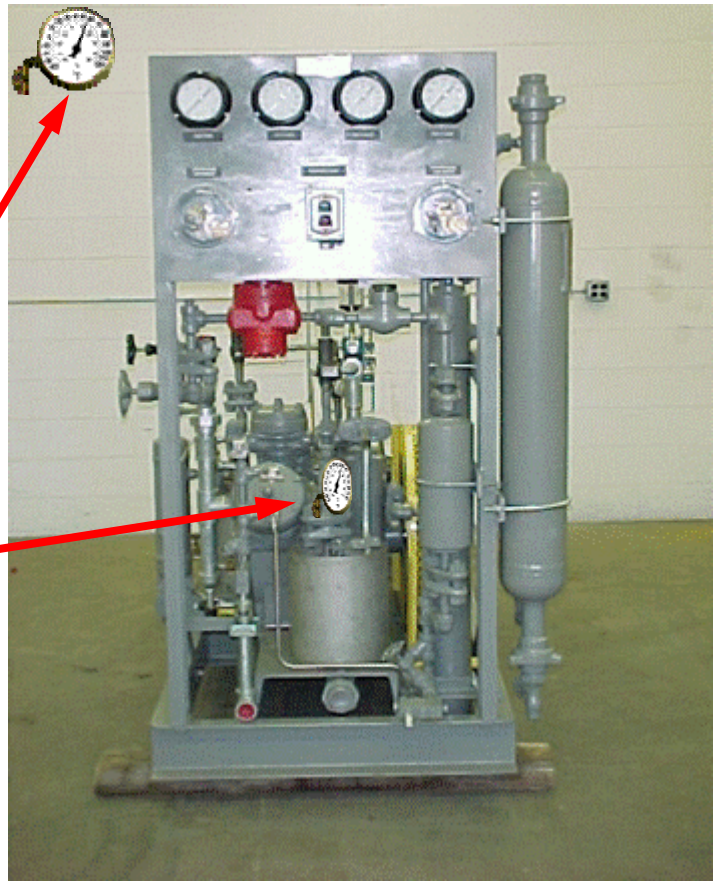


COMPRESSORS (16)

OPERATIONS

Critical operational controls

- High (discharge) and low (suction) pressure cutout switches.
- Daily check of operation of these switches function.
- **Room & cooling water temperature monitoring.**

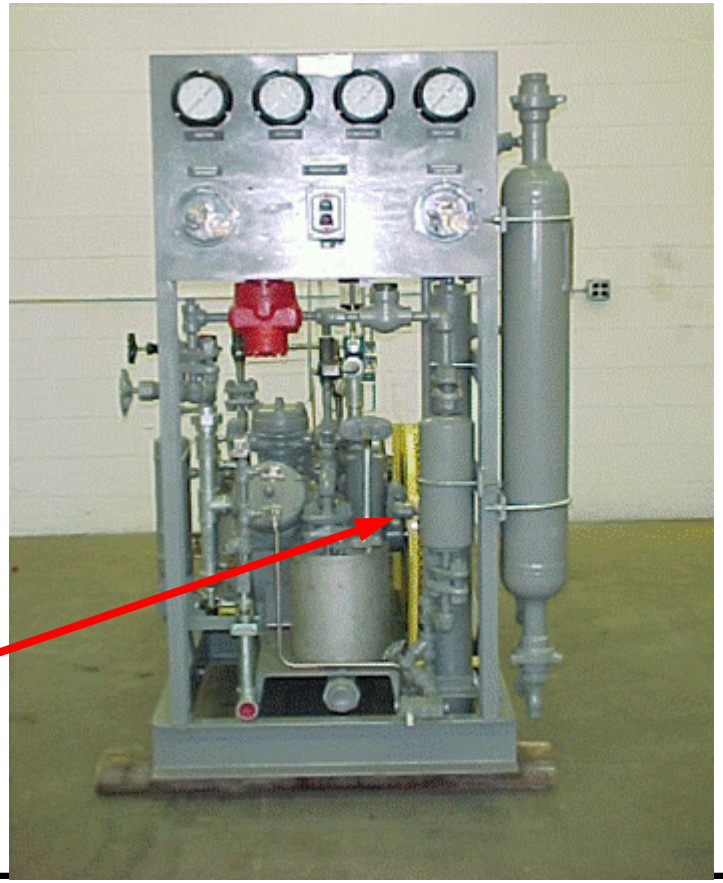


COMPRESSORS (17)

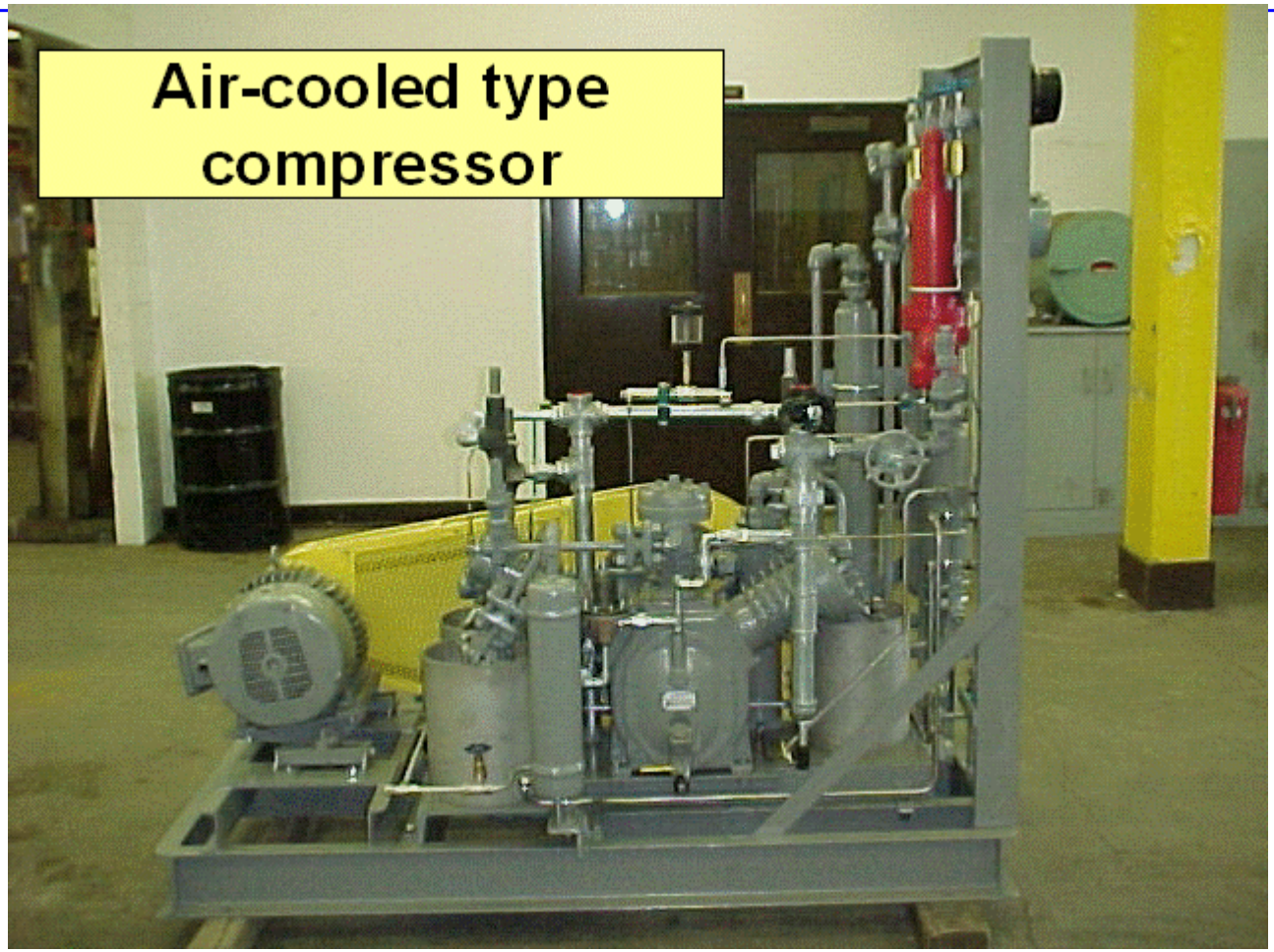
OPERATIONS

Critical operational controls

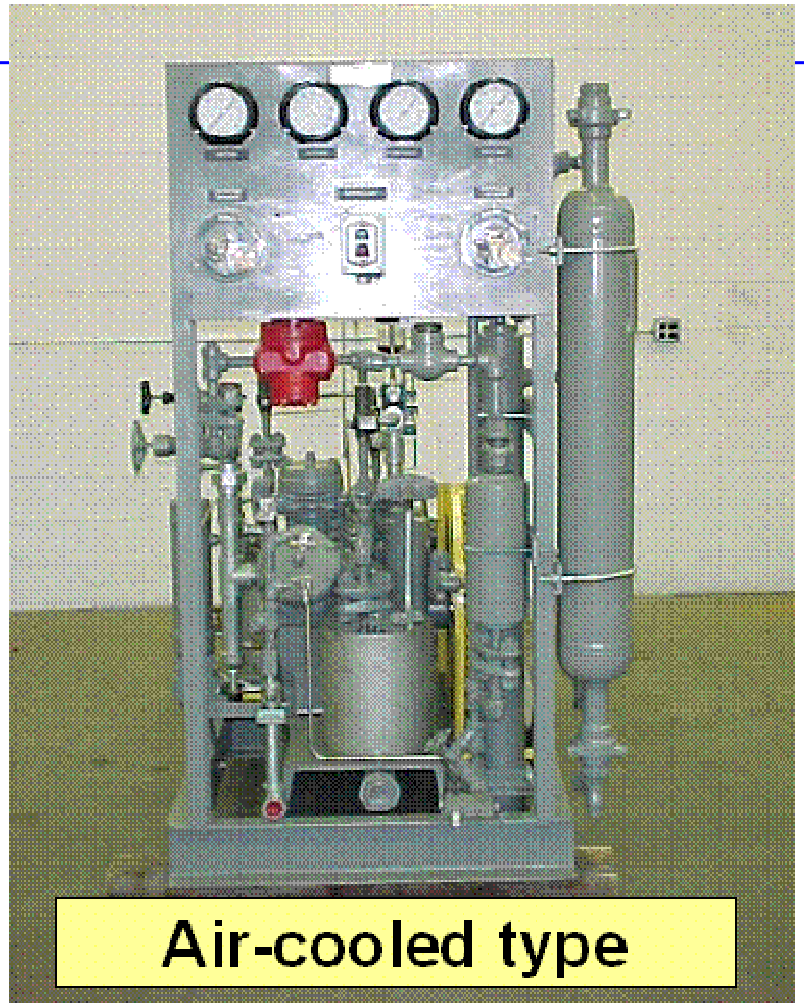
- High (discharge) and low (suction) pressure cutout switches.
- Daily check of operation of these switches function.
- Room & cooling water temperature monitoring.
- **Discharge temperature gauge monitoring.**

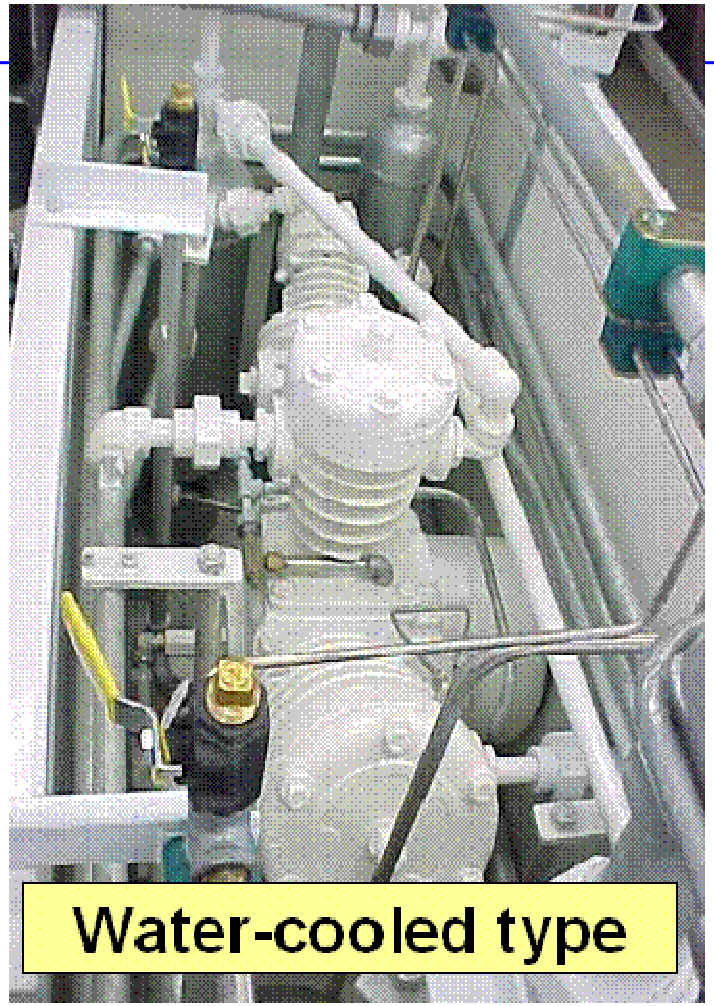


COMPRESSORS (18)

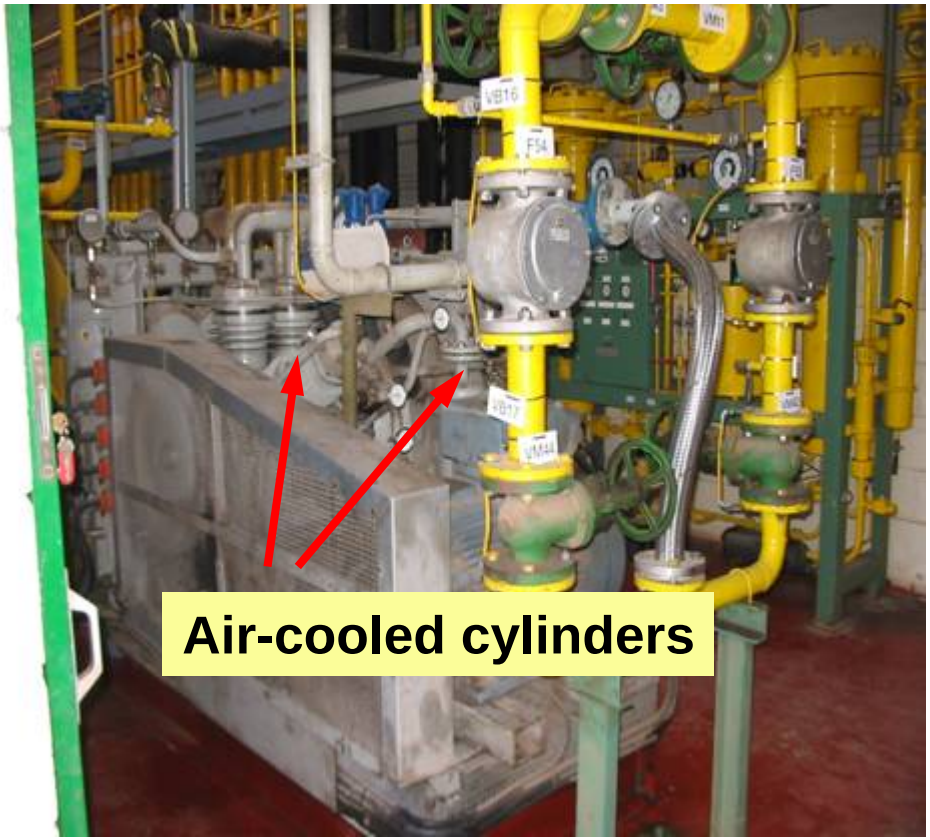


COMPRESSORS (19)

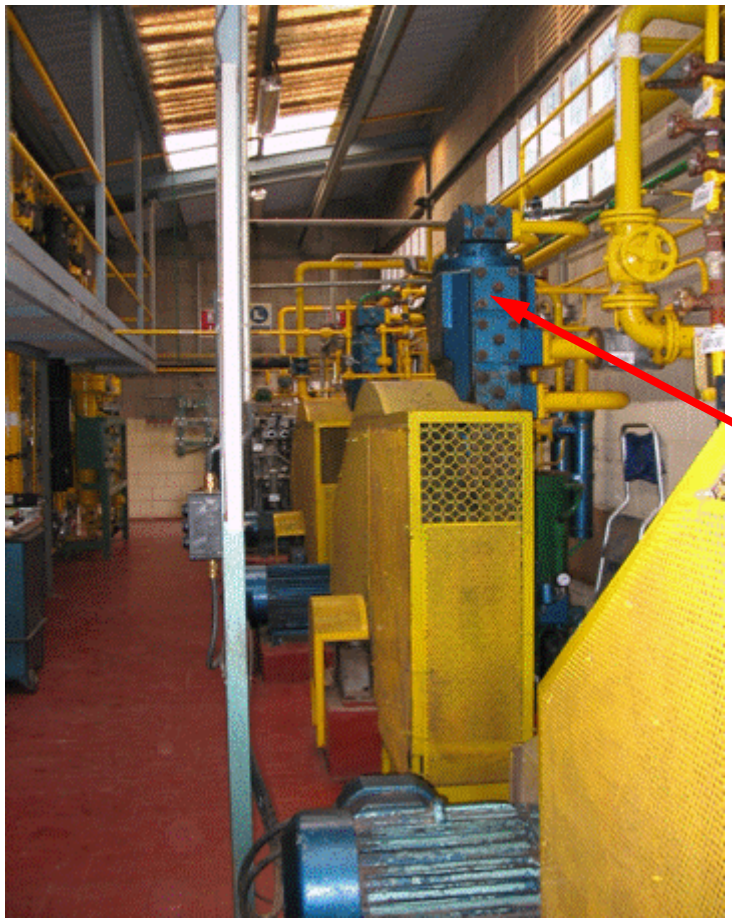




COMPRESSORS (20)



COMPRESSORS (21)



Vertical 3-stage Compressor

HIGH PRESSURE PIPING SYSTEM (1)

DESIGN CONSIDERATIONS

Limit the propagation and contain acetylene flash/detonation pressures

- Flash arrestors to isolate filling manifolds from compressor discharge.
- Types of flash arrestors:
  - **Fusible material**
  - **Heat absorbent bed material**
- Contain detonation pressure: about 35-50 times the initial pressure.
- Piping yield strength greater than detonation pressure.

HIGH PRESSURE PIPING SYSTEM (2)
DESIGN CONSIDERATIONS

HIGH PRESSURE PIPING SYSTEM (3)

OPERATIONAL CONSIDERATIONS

Eliminate sources of ignition

- Limit the flow of gas to 210 m^3/hr in a ¾” Sch80 pipe.
- Positive ground on all lines.
  - Static electricity.
  - Proper continuity. Use of flexitalic gaskets in flanges.
- Clean piping internal surfaces frequently.
- Oiling piping. Use line oilers.
- Leaks free. Leak test systems at 315 bar.

HIGH PRESSURE PIPING SYSTEM (4)

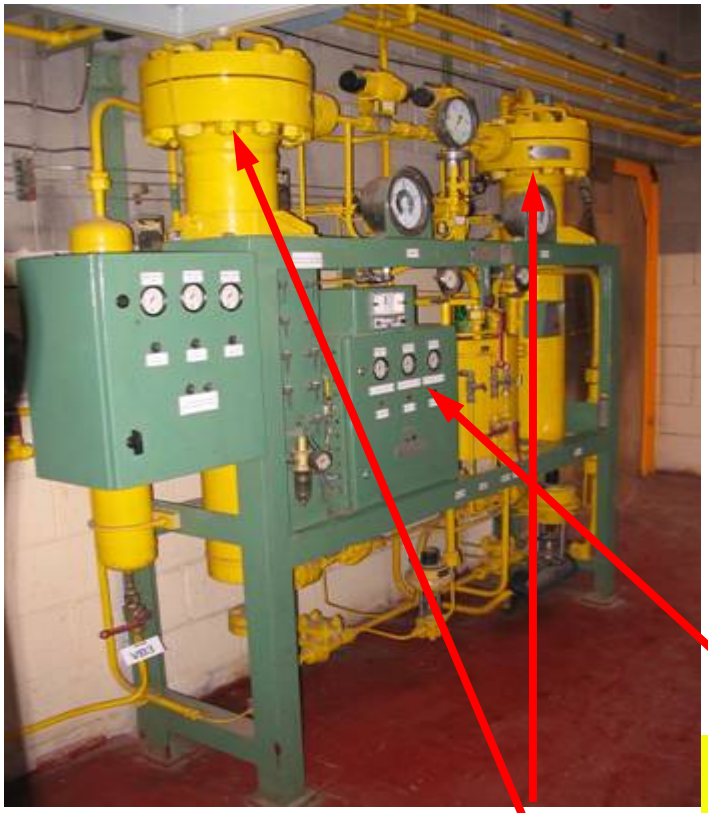
OPERATIONAL CONSIDERATIONS

High pressure driers

- Remove moisture to lower levels.
- Different types of drying agents.
- Operating at 14 bar (minimum) pressure the efficiency is about 98-99%. Therefore, back pressure regulators are provided downstream of driers.

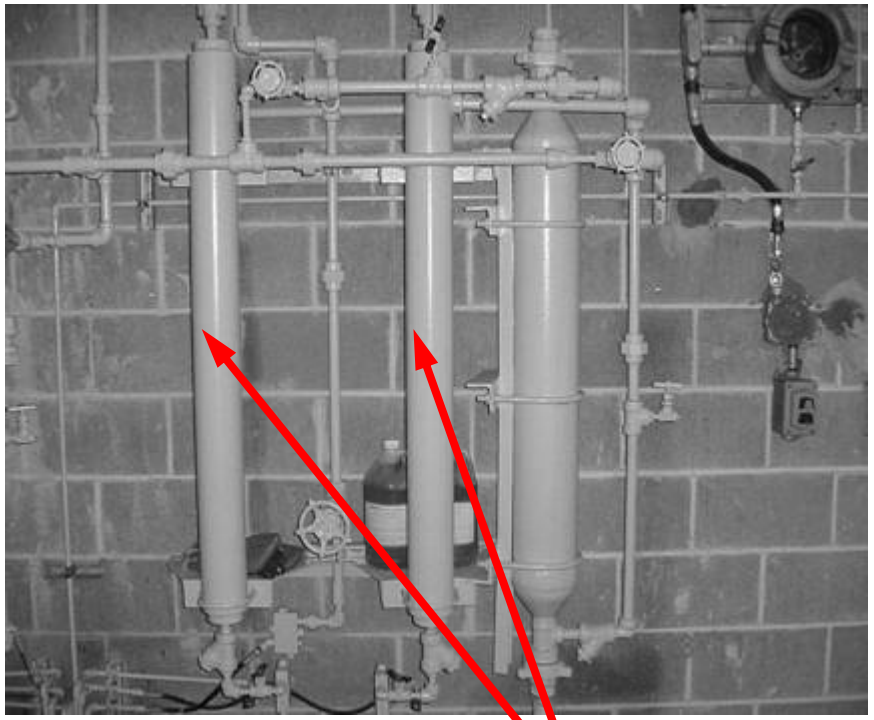
HIGH PRESSURE PIPING SYSTEM (5)

TYPES OF HIGH PRESSURE DRIERS



Molsieve drier vessel

Automatic regeneration controls



Calcium chloride drier

CYLINDER FILLING (1)

Elements of cylinder filling process

- **Ensure the correct quantity of product is filled in the cylinders.**
- **Protect the cylinder from internal contamination.**
- **Pre-fill Inspection – Important step.**
- **Proper method of replenishing solvent**
- **Control cylinder temperature during filling.**

CYLINDER FILLING (2)

CYLINDER CONTAMINATION CONTROL

- Avoid moisture contamination in cylinders.
- Inspect the quality of solvent.
- Control oil contamination.
- Avoid air/nitrogen contamination.
- Use filters in the pump system for solvent.
- Use valve plugs.

CYLINDER FILLING (3)

PRE-FILL INSPECTION

Very important

Perform as per CGA, EIGA, **AIGA**, etc guidelines.

You can refer to AIGA 022/05 – Code of practice for acetylene.

Website: *www.asiaiga.org*

CYLINDER FILLING (4)

QUANTITY OF PRODUCT IN CLYINDER

- A fully charged cylinder is typically between 15 – 19 bar pressure at 15^{O}C, depending on local regulations.
- This settled pressure is directly related to acetylene/solvent ratio.

CYLINDERS FILLING (5)

SOLVENT PUMP UNIT

Pressure gauge

Temperature gauge

Cylinder connection

Weight indicator & solvent loss calculator

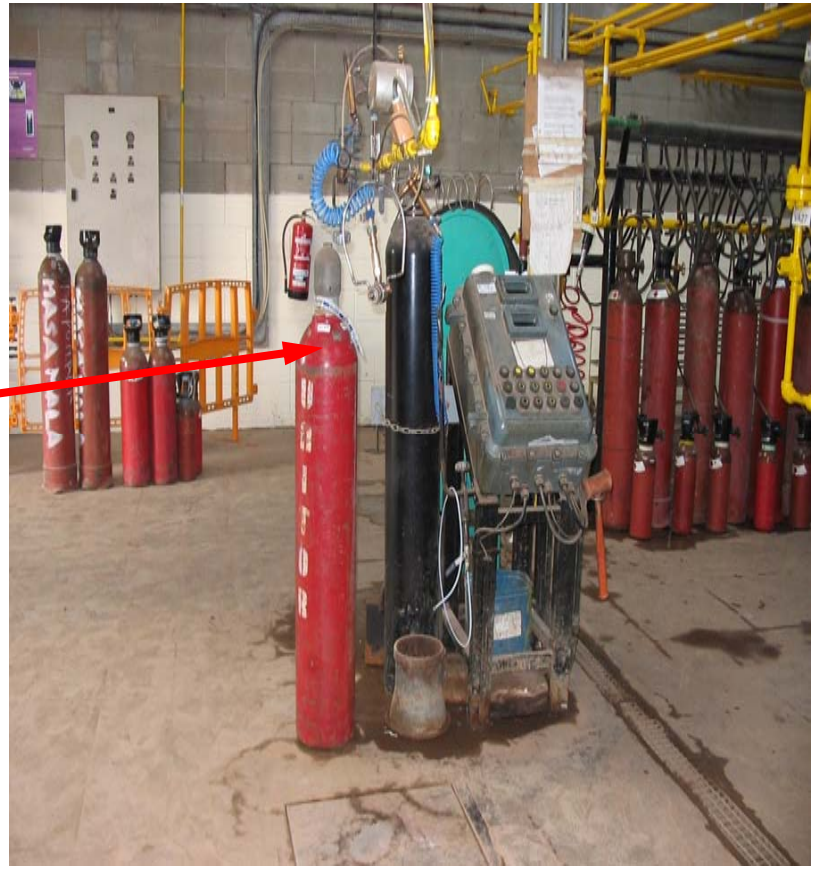
Cylinder

Scale base

CYLINDER FILLING (6)
REPLENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

Cylinder tare weight.



CYLINDERS FILLING (7)

REPLENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

- Cylinder tare weight.
- **Temperature of the cylinder.**

CYLINDERS FILLING (8)

REPLENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

- Cylinder tare weight.
- Temperature of the cylinder.
- **Pressure inside the cylinder.**

CYLINDER FILLING (9)

REPLENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

- Cylinder tare weight.
- Temperature of the cylinder.
- Pressure inside the cylinder.
- **Size of the cylinder.**

CYLINDER FILLING (10)

REPLENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

- Cylinder tare weight.
- Temperature of the cylinder.
- Pressure inside the cylinder.
- Size of the cylinder.
- **Total cylinder weight.**

CYLINDER FILLING (11)

REPENISHING OF SOLVENT

Replacement of lost solvent requires accurate measurement of the following:

- Cylinder tare weight.
- Internal temperature of the cylinders.
- Pressure inside the cylinder.
- Size of the cylinder.
- Total cylinder weight.
- **Residual acetylene calculation.**

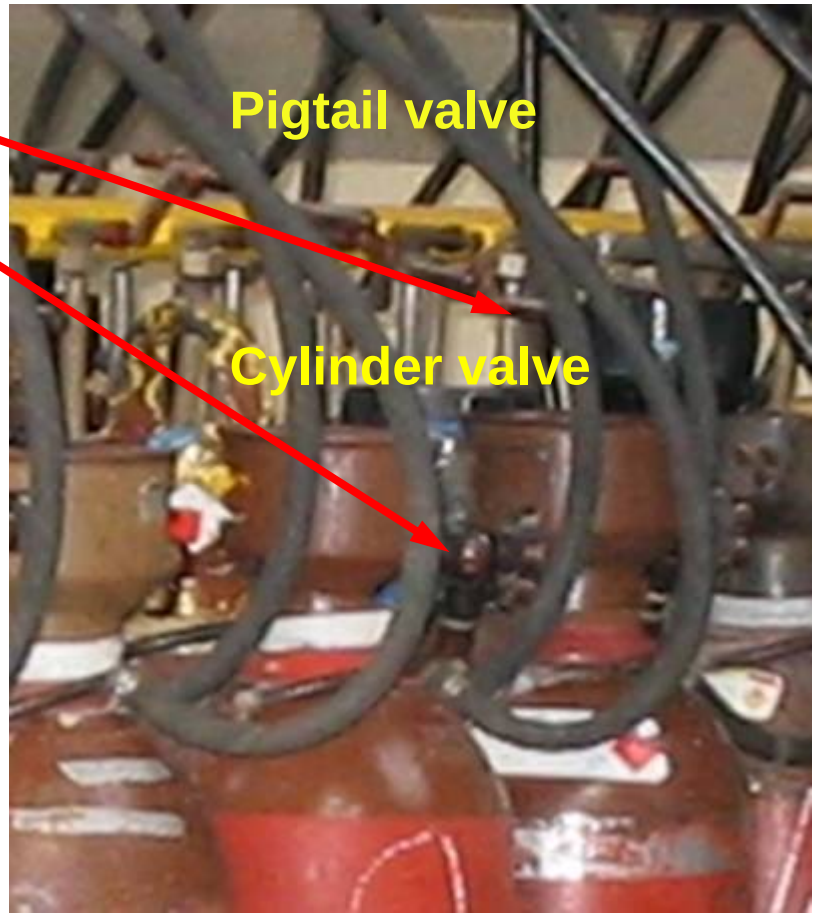
CYLINDER FILLING (12)

Safe cylinder filling (charging) requires <u>proper procedures</u> for

- Valve operating sequence.
- Adding and removing cylinders to and from a filling rack.
- Controlling the cylinder fill rate, temperature, pressure.
- Proper use of water sprays.
- Prevent solvent carry over in re-compression systems.

CYLINDER FILLING (13)
VALVES OPERATIONS

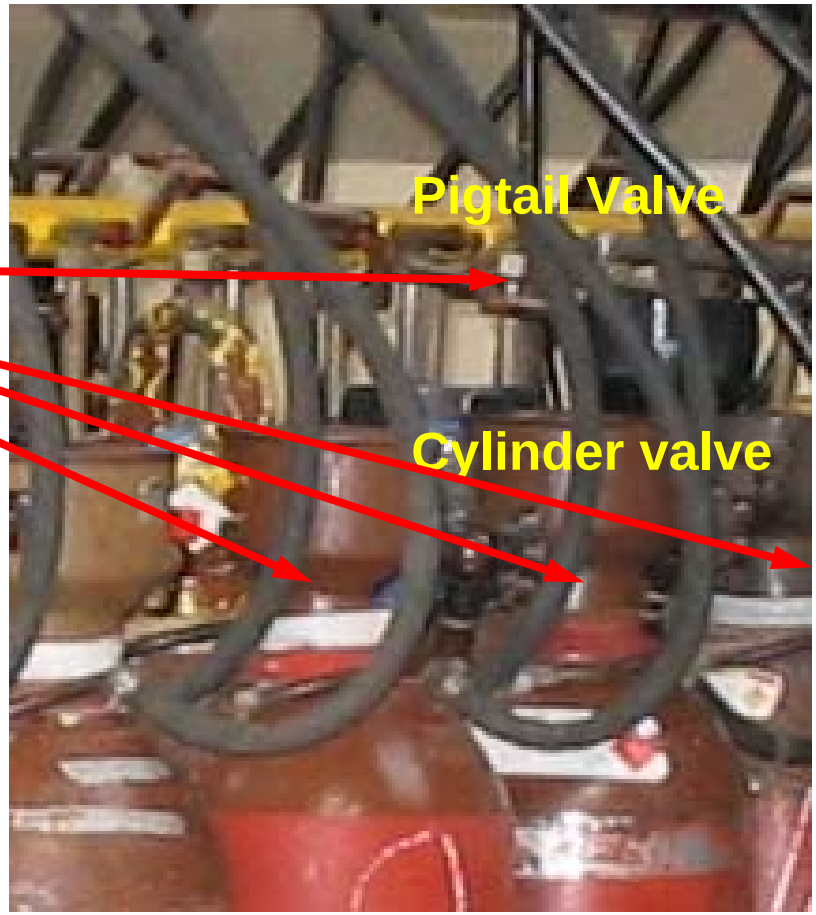
Open & close valve slowly.



CYLINDER FILLING (14)
VALVES OPERATIONS

Open & close valve slowly.

Ensure balanced flow in all cylinders.



CYLINDER FILLING (15)
VALVES OPERATIONS

Open & close valve slowly.

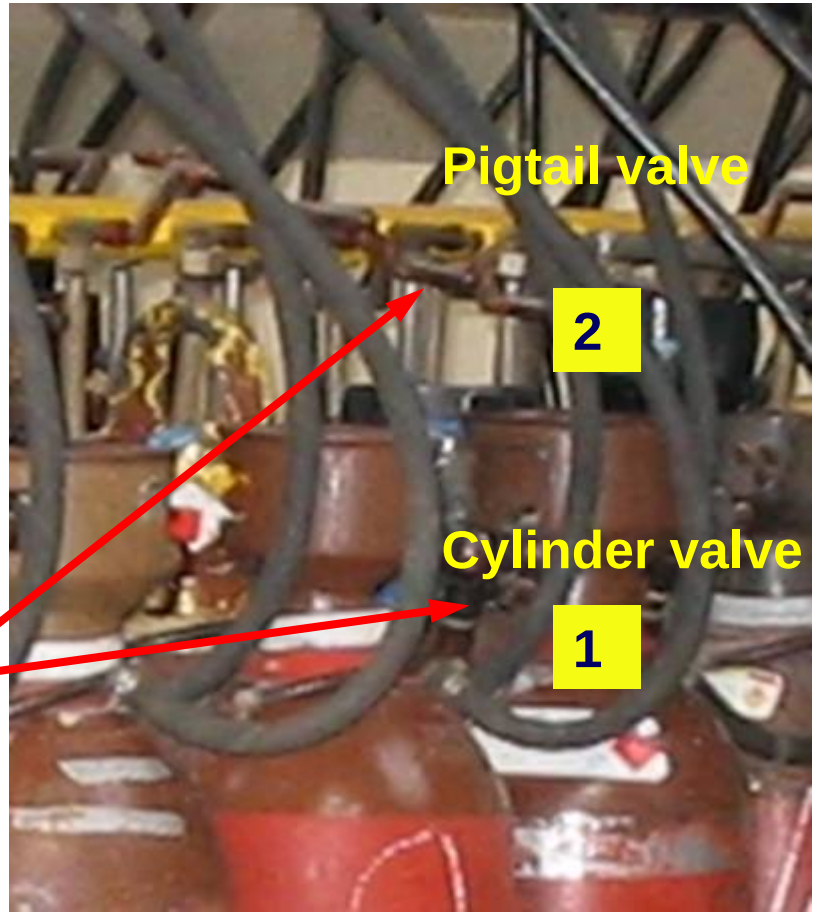
Ensure balanced flow in all cylinders.

After filling allow - settle-back and then close valves.

CYLINDER FILLING (16)
VALVES OPERATIONS

Open & close valve slowly.
Ensure balanced flow in all cylinders.
After filling allow - settle-back and then close valves.

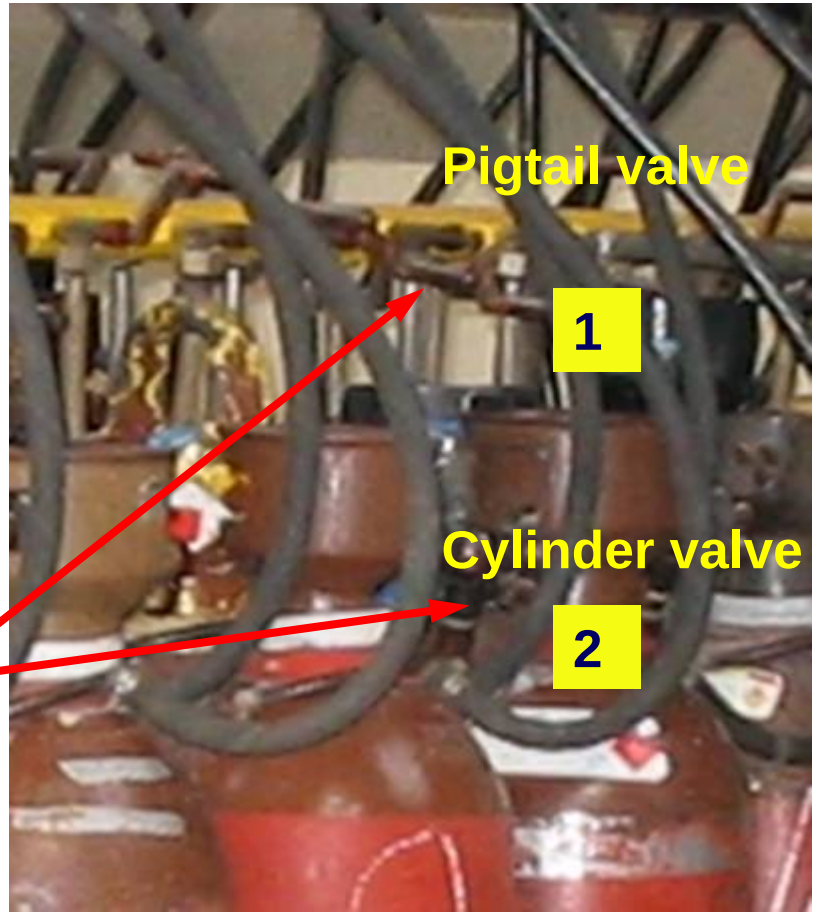
When opening a cylinder to the fill rack in filling process, open cylinder valve first and then open pigtail valve



CYLINDER FILLING (17)
VALVES OPERATIONS

Open & close valve slowly.
Ensure balanced flow in all cylinders.
After filling allow - settle-back and then close valves.
When opening a cylinder to the fill rack in filling process, open cylinder valve first and then open pigtail valve

And vice versa when removing



CYLINDER FILLING (18)
ADDING CYLINDERS TO A RACK

Cylinders should be sorted by:

- Type of porous material
- Size (capacity).
- Quantity of residual gas.

• Same sizes of cylinders to be filled on a single rack (recommended).

• Do not mix different solvents cylinders (Acetone & DMF).

CYLINDER COMPRESSION & FILLING

In conclusion

- Acetylene is an unstable gas which needs special precautions than any other flammable gas.
- Materials & systems shall be compatible to the gas and pressures.
- Avoid sources of ignition or decomposition.
- Proper system components to contain and control propagation.
- Proper procedures to avoid contamination and to keep cylinders in proper condition.
- Proper procedures to fill correct quantity of product.

CYLINDER COMPRESSION & FILLING

PRECAUTION IS KEY TO SAFE OPERATION

THANKS