AIGA 2007 MEETING

PACKAGED GASES SAFETY

AIGA

Asia Industrial Gases Association

30-31 August 2007
PATTAYA, THAILAND

Cylinder filling
Safe design and operation

Shaun LaGrange

Engineering Consultant

Global Operation Excellence

Praxair, Inc.

General

- Pipe and equipment to be adequately supported
- Distances minimized
- Product vents (including PRDs) to be piped to safe areas and separated
- Cylinders to be restrained
- Maintenance program (pigtails, fittings, valves, equipment calibrations)

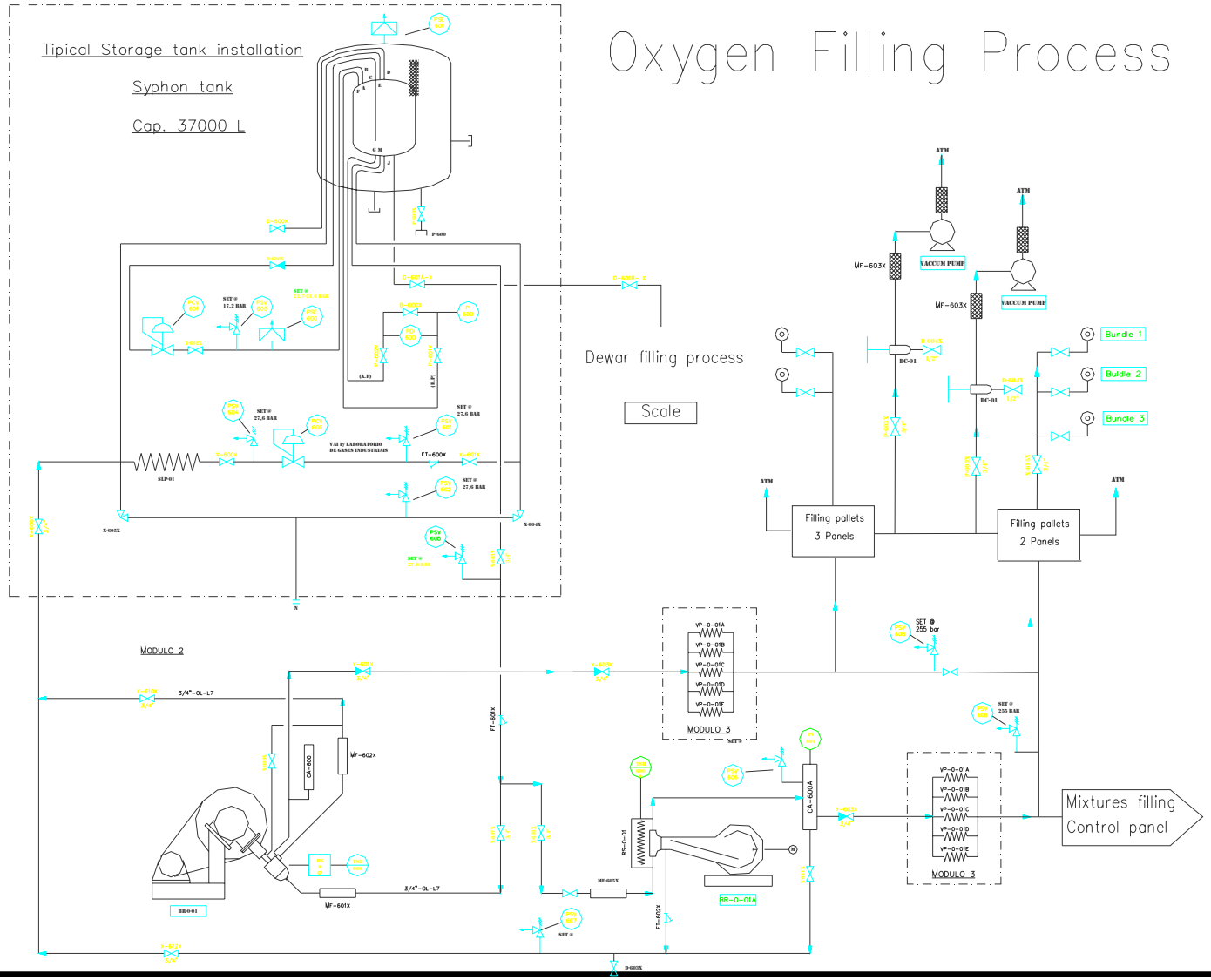
Material Selection

- When choosing materials need to consider:
  - Product compatibility
  - Design pressure
  - Design temperature
  - Product velocity (Oxygen)

System Automation

- Automation can be used to:
  - Control set points to mitigate risks
  - Reduce liability (less personnel)
  - Mitigate operator error
  - Improve reliability of system

System Overview



Bulk Tanks

- Overpressure protection
  - Relief device and burst disk
  - Back up set with diverter valve
  - Vacuum disk on outer tank

Pump Protection Systems

- Overpressure
  - Pressure switch (electrical)
  - Pressure relief valve (mechanical)
- Dry running
- Shaft seal leak detection
- Cavitation
- Overload (motor)

- Nitrogen purge
- Auto Shut-off

Pumps

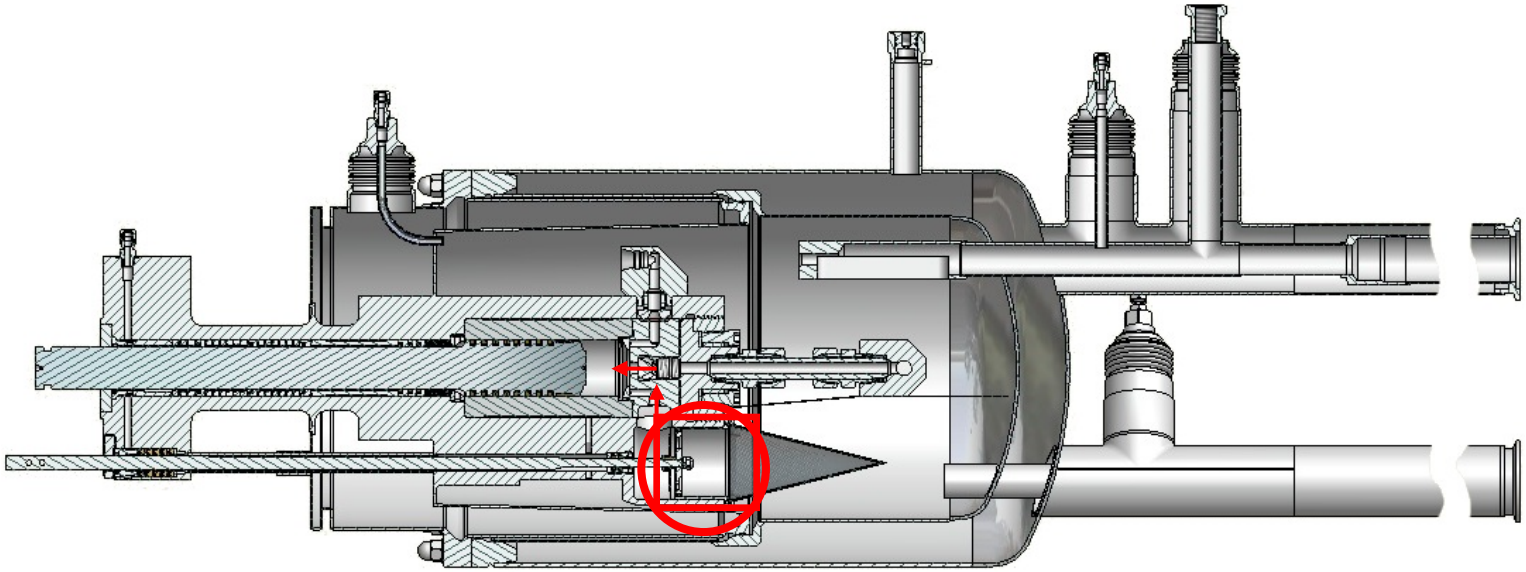
- High flow pumps
  - New generation of pump design that allows for a faster filling process
  - Variable frequency drives
    - Used to control the speed of the pump to ensure heat of compression is controlled

Pumps

- Sub-zero pumps
  - Work with low NPSH, optimizing storage tank capacity (lower losses)
  - Caution in emptying the tank

Principle of Sub-zero Pumps

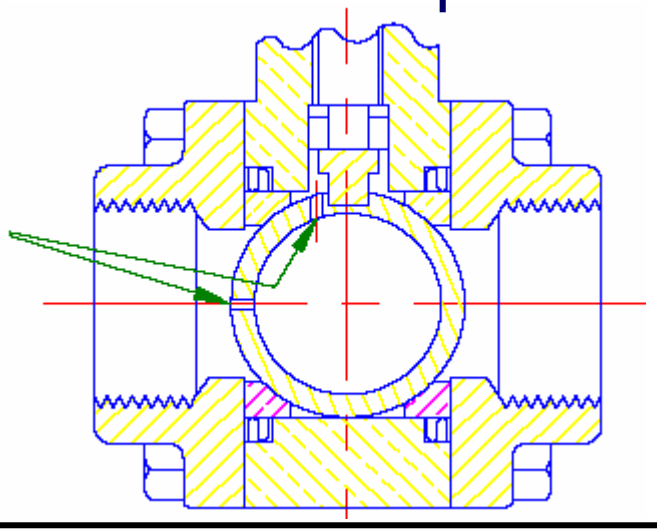
- Liquid is injected into the piston compression chamber
- The supercharged then pulls the pre-compressed liquid into its' chamber



- As the Supercharger chamber has a larger volume than the piston compression chamber, the liquid is pre-compressed providing the necessary NPSH.

Pipe Design

- Liquid trap protection
  - Ensure lines are protected from pressure build up due to vaporized liquid product
  - Consider ball valves
    - Ensure ball and stem are vented to prevent pressure build up



Pipe Design

- Low temperature protection
  - Ensure system is protected downstream of vaporizer in the event that cryogenic liquid is not completely vaporized
  - Avoid cryogenic liquid reaching carbon steel cylinders
- High pressure protection
  - Mechanical with optional electronic pressure devices

Fill Manifold Overview

- Securing cylinders, pallets and bundles
  - Ensure cylinders are secured from falling
  - Prevent removal of pallets and bundles still connected to a pressurized system
- Pressure ratings
  - Cylinder pressure ratings to be compatible with system MAWP

Fill Manifold Design

- Mixture manifold design
  - Gas compatibility considerations
    - CO_2 with oxidizers (possible hydrocarbons in CO_2)
    - Flammables with oxidizers
- Prevent contamination of source gases
- Protect low pressure sources from high pressure sources

Fill Manifold Design

- Mixture manifold design
  - Bridge (manual)
    - Maintenance program to ensure swing arm threads remain in good condition
    - Cap lines to prevent contamination and gas releases

Fill Manifold Design

- Mixture manifold design
  - Block & bleed (automated)
    - No contamination between gases
    - No over-pressurization of lines from high pressure gas

Overfill Protection

- Filling by temperature and pressure
  - Accuracy in fill charts
  - Method for measuring cylinder temperature
  - Calibrated devices
- Filling by weight
  - Ensure scale is calibrated and correct capacity
  - Automatic shut off valve (optional)

Overfill Protection

- Liquid cylinder overfill
  - Fill by weight instead of to vent
- Liquefied gases (CO_2, N_2O)
  - Ensure information on the cylinder's water capacity and tare weight is known to ensure there will be enough gas space
  - Fill individually by weight

Vacuum Pumps

- Overpressure protection
- Oil compatible with the product
- Prevent oil suck back
- Inerting of system (line/trap) in flammable service

Pigtails

- Heat sinks (oxidizing service)
- Tethers / anti-whip restraint
- Life cycle
- Material
  - H_2 and He will permeate through Teflon
- Thread inspections
- General inspections

Design Review

- Risk Assessment
  - Hazop, FEMA
- Commissioning
  - Pre-start up safety review
    - Safety controls are in place & functional
    - Material as per specifications
- Documents
  - System specifications, drawings, safety equipment checklist

Cylinder filling
Safe design and operation

THANK YOU!