# Introduction To Gas Compression

## CHERCO SOLUTIONS

# What Is a Compressor?

- A compressor is a device used to increase the pressure of a given quantity of gas by reducing its volume

# Introduction
# To Gas Compression

# Where Are Gas Compressors Used & By Whom?

- By oil and gas producers to sell or use in their production activities
- By pipeline companies to gather and transport or store gas
- By refiners and gas processors at facilities where raw oil and gas is processed and refined

# Where Are Gas Compressors Used?

- Production
- Gas well production
- Associated gas from oil production
- Gas lift
- Re-injection
- Enhanced recovery
- Sale

# Production

- Gas well production
  - Reservoir energy is not high enough to produce desired flows into the pipeline network
  - Occurs either at initial discovery or after wells have depleted
  - Compressors are located at the well as an integral part of the wellhead lease equipment
  - Compressor requirements vary depending on pipeline pressure and well productivity

# Production

- Associated gas
  - Gas is a byproduct of oil production
  - Can be produced concurrently with oil and be produced in multiple stage separation production arrangements
  - Occurs at onset of production
  - Compressors are located at the well and associated gas is compressed to commingle with high pressure wellhead gas
  - Compressor requirements vary depending on pipeline pressure and well productivity

# Production

- Gas lift
  - Reservoir energy has decreased to the point where liquid production has dropped or has stopped
  - Associated gas is compressed and injected into the production string to “lift” produced liquids
  - System is a closed loop
  - Compressors are centrally located in gas lift system
  - Operating conditions are generally static
  - Compressors are generally multiple stage

# Production - Re-injection

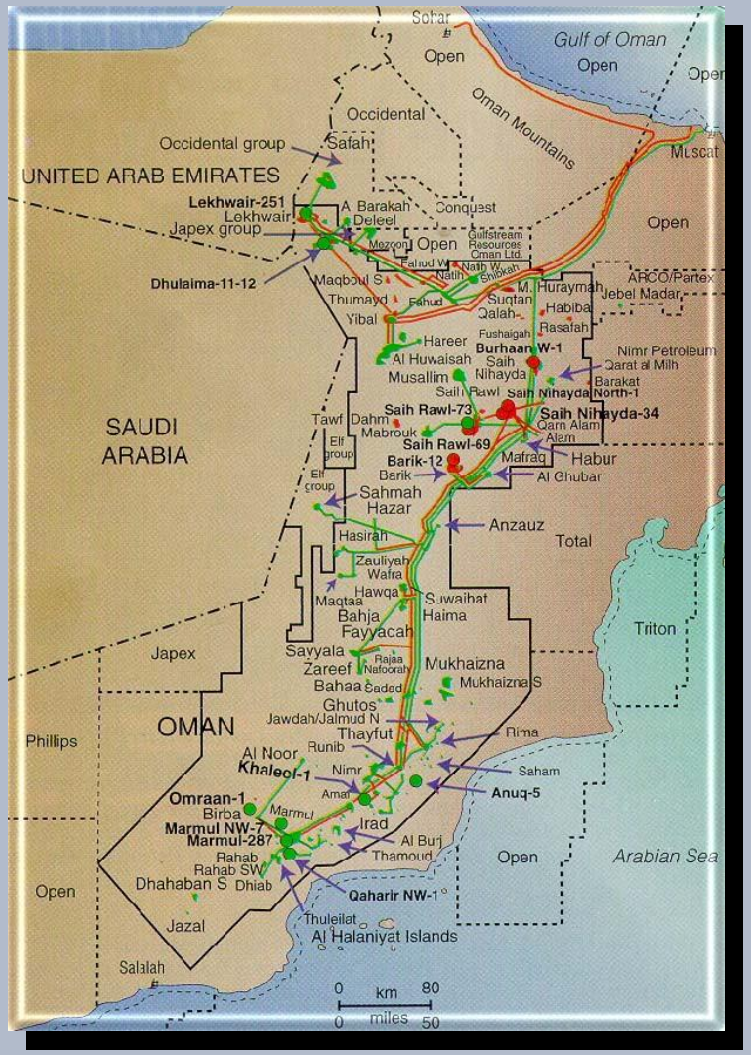
- Pressure maintenance
  - For liquid producing wells to enhance recovery
  - Produced gas is re-injected into producing formation to prevent formation pressure from decreasing to two-phase region
  - High discharge pressures – 2000 to 7000 psig
- No market
  - Gas is re-injected into formation to prevent flaring

# Transportation

- Gathering
- Transmission
- Storage

## Gathering Systems

- Tend to be made up of smaller pipelines (2-10”)
- Usually transport unprocessed or untreated gas and extend for short distances (0-50 miles)
- Can be high- or low-pressure (0-1000 psig)




## Transmission Systems

- Tend to be made up of larger pipelines (12-48”)
- Usually transport processed or treated gas and extend for long distances (50-5000 miles)
- Operates at elevated pressures (600-1200 psig)

# Transportation – Gathering

- Reservoir energy is not high enough to produce desired flows into the pipeline network
- Occurs either at initial discovery or after wells have depleted
- Compressors are centrally located in production area with multiple wells on the system
- Compressor requirements vary depending on pipeline pressure and well productivity; compressors may handle a combination of wellhead and associated gas

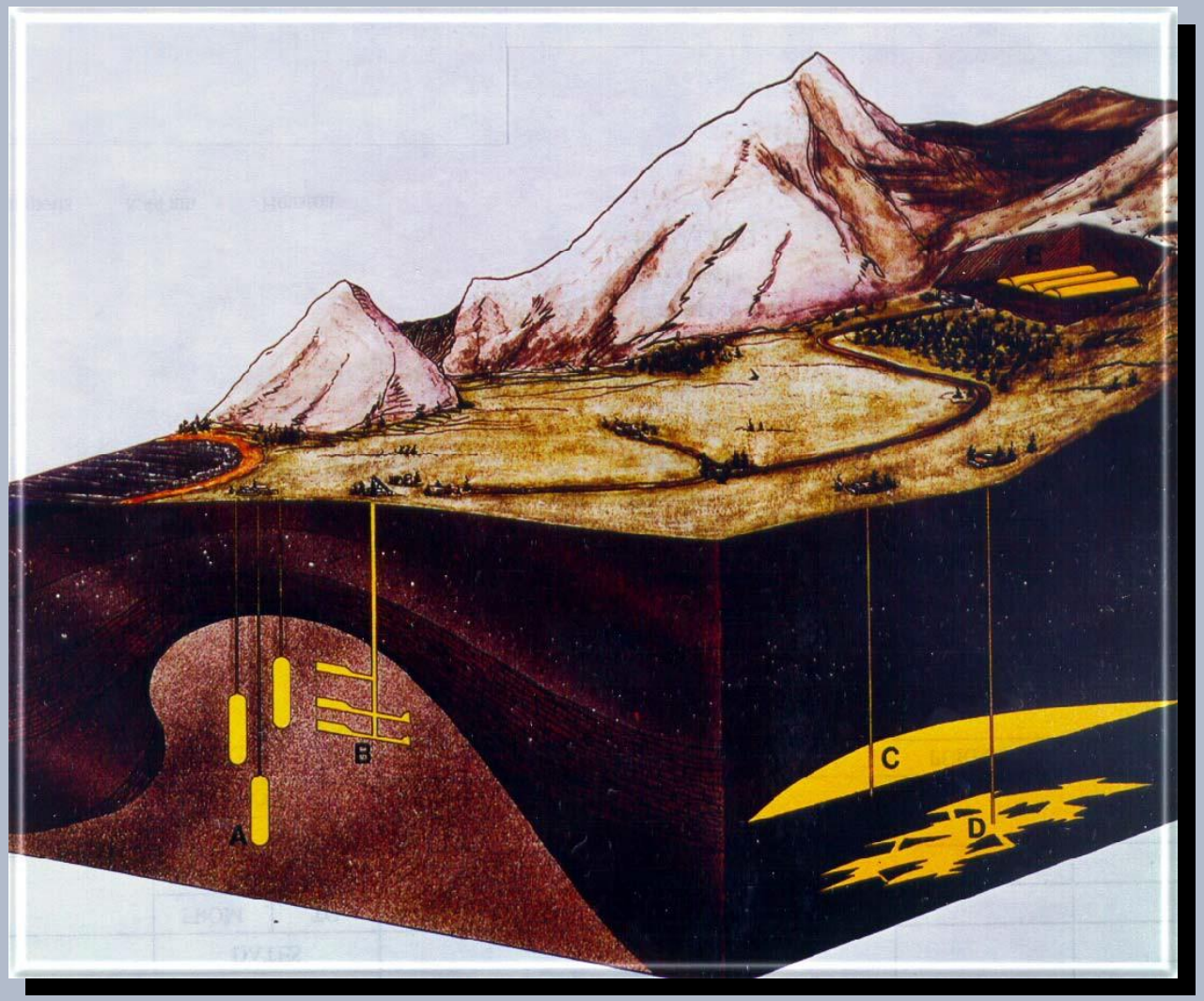
# Transportation - Transmission

- Pipeline network is required to
- distribute gas to market
- Pressure losses in pipeline system require intermediate stations to boost gas pressure
- Operate at low compression ratios
- Long-term projects
- High reliability required
- High efficiencies required

# Transportation - Storage

- Similar to peak-shaving
  - Gas is stored in salt dome caverns or formations when production exceeds demand
  - Gas is withdrawn when demand exceeds production
- Compressors must be capable of two design considerations
  - Injection
  - Withdrawal

# Introduction
# To Gas Compression



# Introduction To Gas Compression

Bednodemianovskaya UGSF Injection

Conditions Scenario I

| Operating Parameters | May | | | June | | | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII |
| Daily Volume (MMNm$^3$/day) | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 |
| Suction Pressure (Bar G) Discharge | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 |
| Pressure (Bar G) | 57.7 | 68.2 | 78.6 | 61.3 | 72.7 | 84.2 | 64.8 | 76.2 | 88.5 | 67.9 | 81.3 | 94.7 | 76.2 | 91.6 | 106 |
| **Scenario II** | | | | | | | | | | | | | | | |
| Daily Volume (MMNm$^3$/day) Suction | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 | 14 | 18 | 12 |
| Pressure (Bar G) | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 | 49.5 |
| Discharge Pressure (Bar G) | 57.7 | 68.2 | 78.6 | 61.3 | 72.7 | 84.2 | 64.8 | 76.2 | 88.5 | 67.9 | 81.3 | 94.7 | 76.2 | 91.6 | 106 |

Withdrawal Conditions

Scenario I

| Operating Parameters | December | | | January | | | February | | | March | | | April | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | Stratum II | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII | Stratum I | Stratum II | StratumIII |
| Daily Volume (MMNm$^3$/day) Suction | 15 | 18 | 14 | 21 | 25 | 18 | 21 | 25 | 18 | 21 | 25 | 18 | 15 | 18 | 14 |
| Pressure (Bar G) | 50 | 63.2 | 72.1 | 41.4 | 53.3 | 61 | 34.1 | 44 | 49.7 | 26.8 | 35.6 | 39.7 | 20.6 | 28.4 | 30.8 |
| Discharge Pressure (Bar G) | 71.8 | 71.8 | 71.8 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 71.8 | 71.8 | 71.8 |
| **Scenario II** | | | | | | | | | | | | | | | |
| Daily Volume (MMNm$^3$/day) Suction | 15 | 18 | 14 | 21 | 25 | 18 | 21 | 25 | 18 | 21 | 25 | 18 | 15 | 18 | 14 |
| Pressure (Bar G) | 50 | 63.2 | 72.1 | 41.4 | 53.3 | 61 | 34.1 | 44 | 49.7 | 26.8 | 35.6 | 39.7 | 20.6 | 28.4 | 30.8 |
| Discharge Pressure (Bar G) | 58.5 | 58.5 | 58.5 | 61.6 | 61.6 | 61.6 | 61.6 | 61.6 | 61.6 | 61.6 | 61.6 | 61.6 | 58.5 | 58.5 | 58.5 |

# Processing

- Refining
- Gas processing

# Processing - Refining

- Compression is needed to compress gas streams generated from the refining of oil
- Streams may include a variety of gas compositions
- Multiple compression services may occur in a single unit
- Long-term projects
- High reliability required
- API 618 is used as a design standard

# Gas Processing

- Processing is needed to remove heavier hydrocarbon or undesirable component, (e.g., H2S, CO2)
- Facilities are often the central facility in a gathering system and used to both gather and process gas
- Different applications may occur in a single plant
  - Refrigeration
  - Front end and / or rear end compression
  - Distillation tower overhead
- Long-term projects
- High reliability required

# The Compressor

# What Types of Compressors are Used in the Natural Gas Industry?

- Positive displacement
  - Reciprocating
  - Rotary screw
  - Rotary vane
- Dynamic
  - Centrifugal
  - Blowers

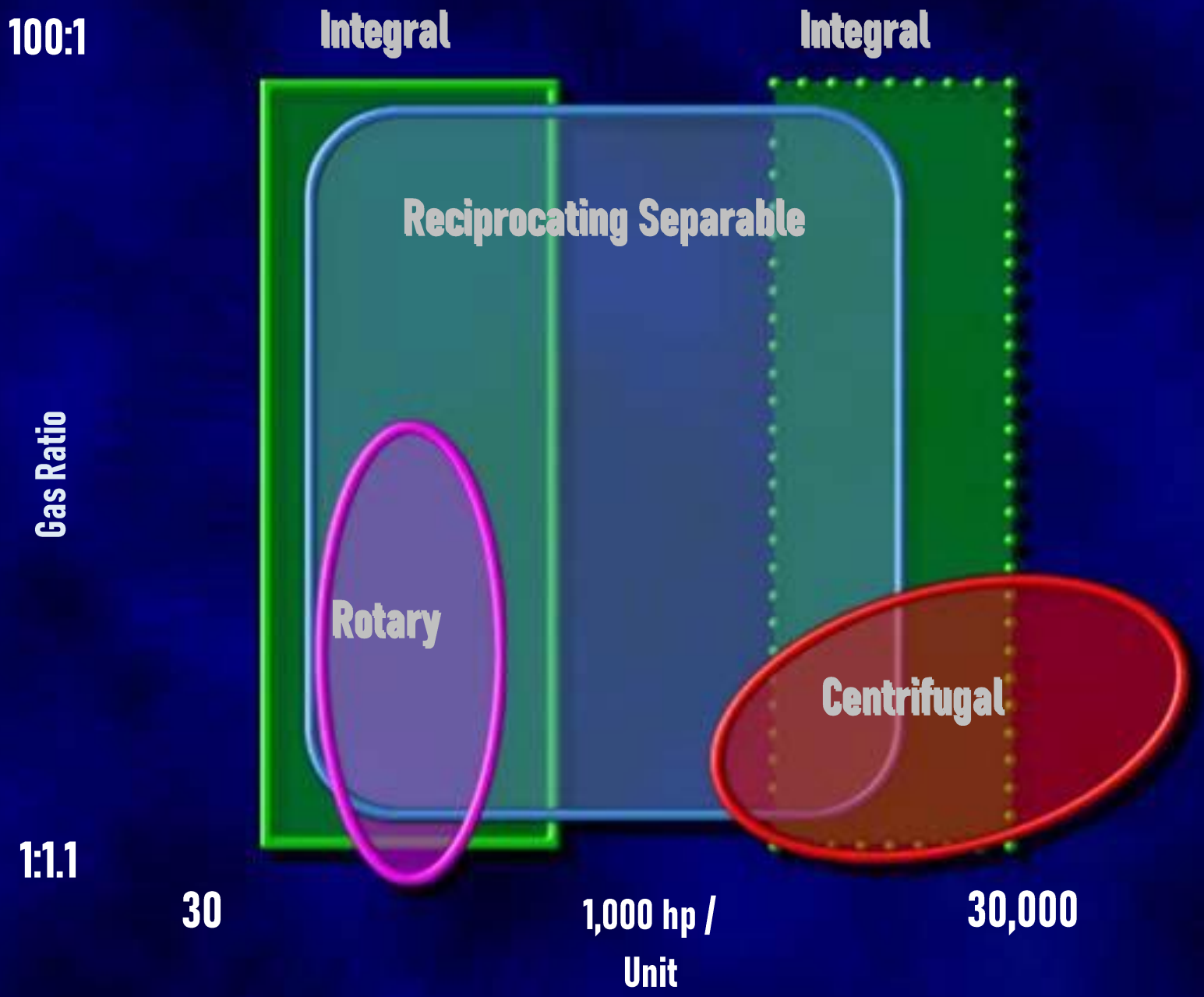
# What Is a Reciprocating Compressor?

- A compressor which consists of a piston acting within a cylinder to physically compress gas contained within that cylinder
- Can be designed to accommodate practically any pressure or capacity

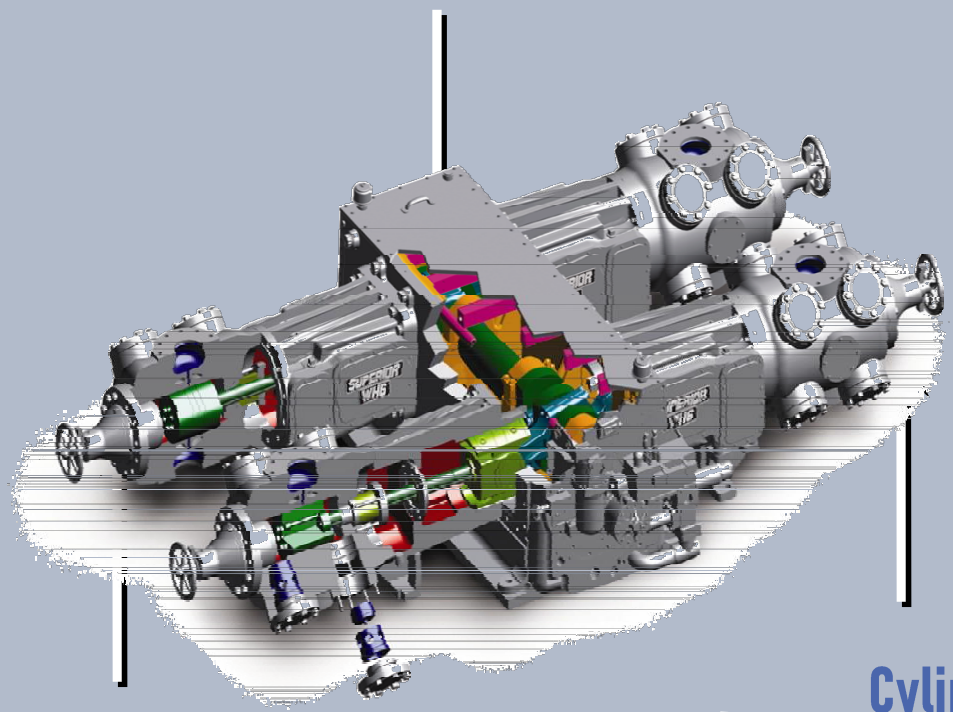
# Types Of Reciprocating Compressors

- Integral unit with power cylinders and compression cylinders sharing the same frame and crankshaft
- Separable unit with power cylinders in an engine and compressor cylinders in a separate frame directly coupled together

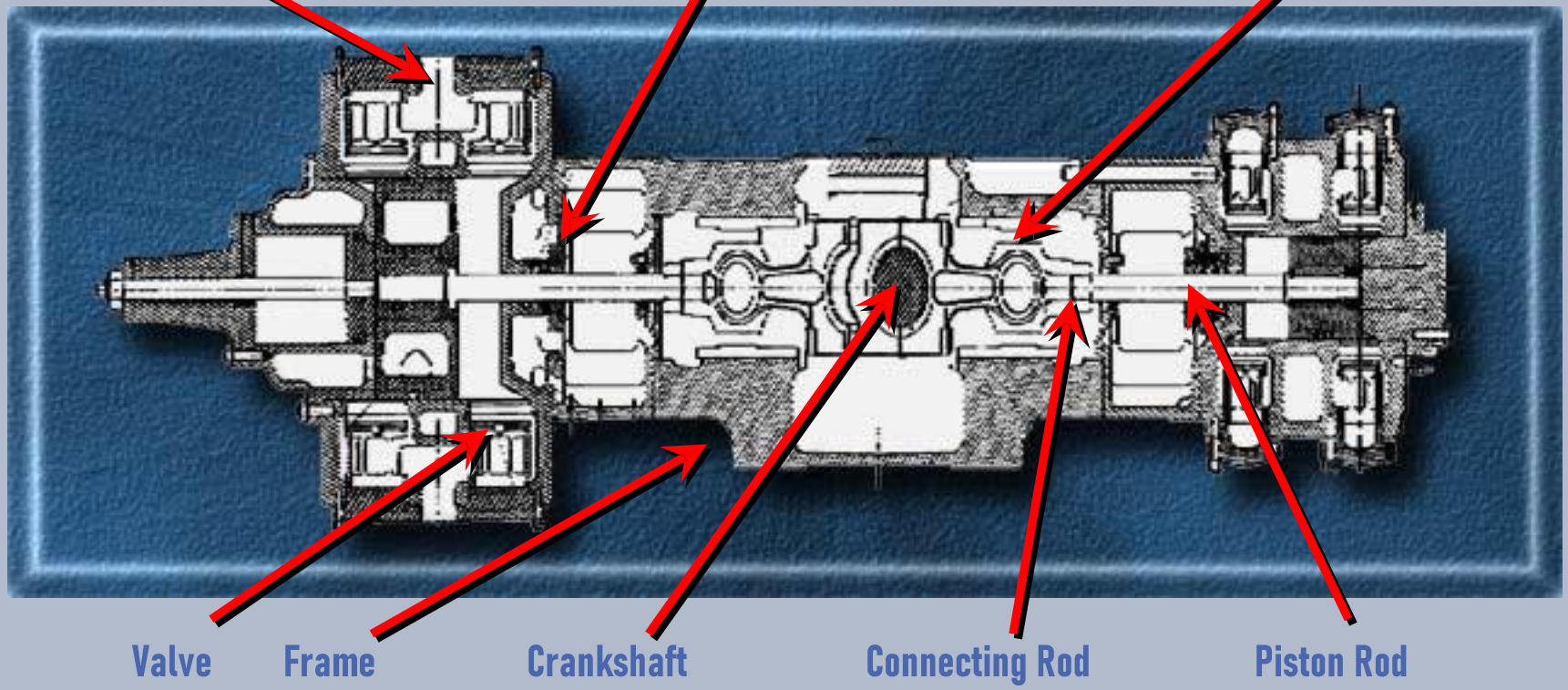
# Introduction To Gas Compression



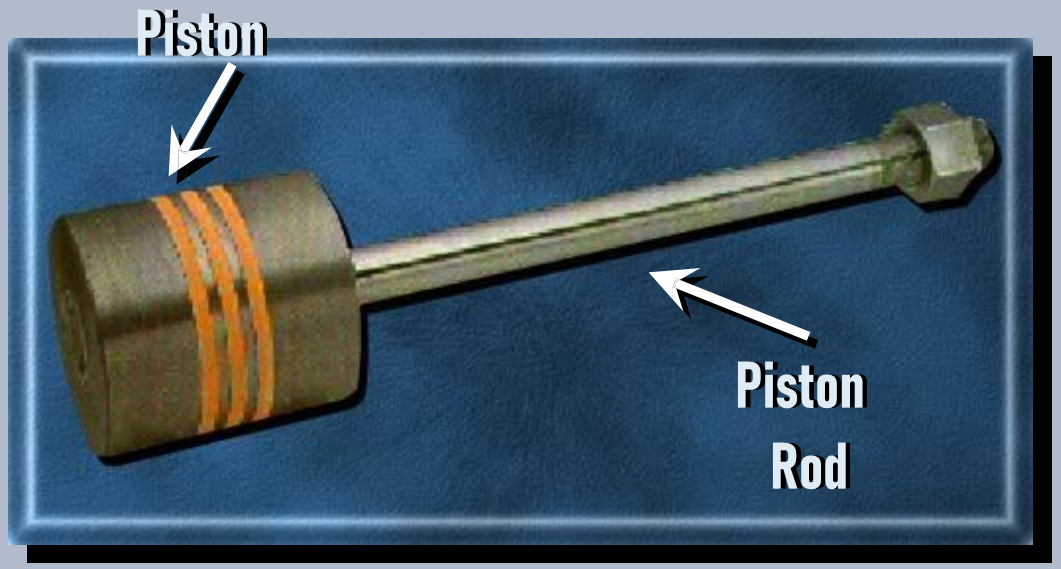
# Horizontal Balance-Opposed Compressor



# Horizontal Balance-Opposed Compressor

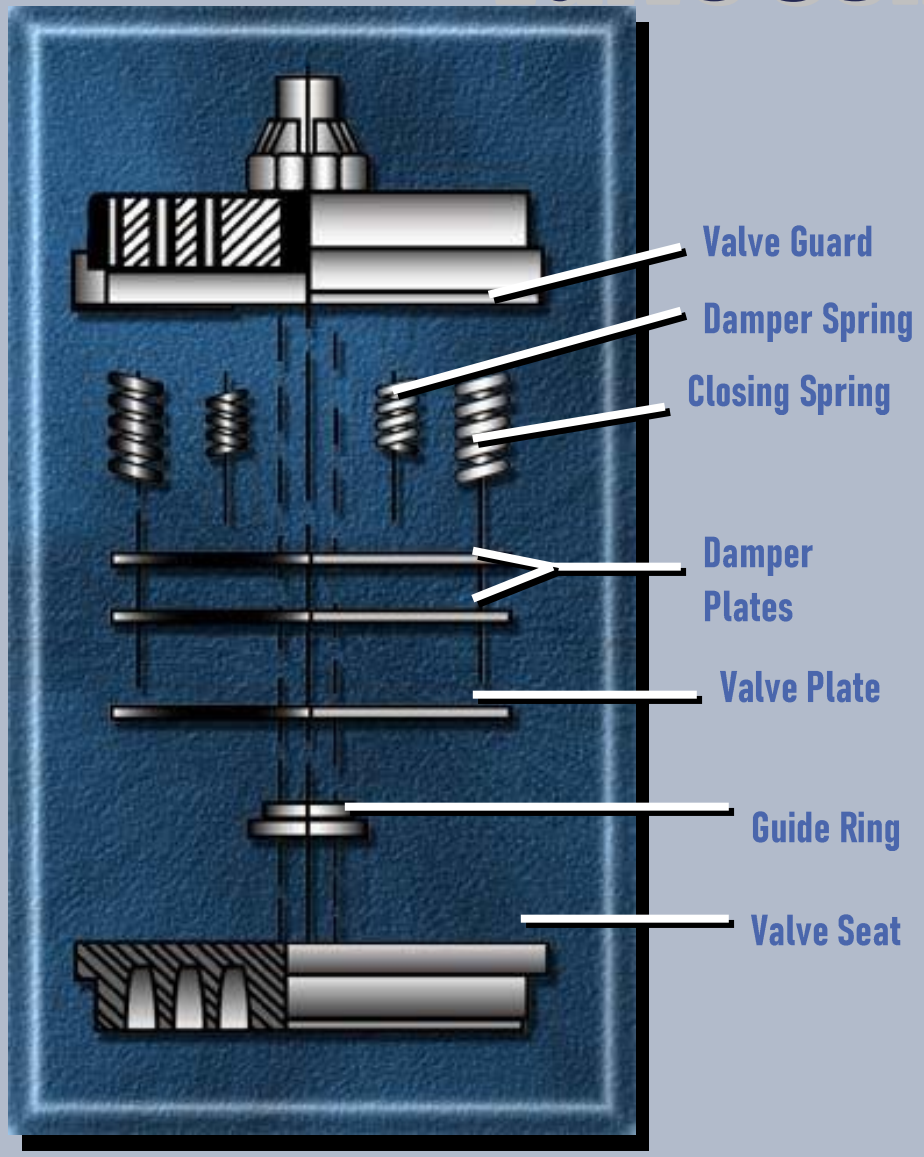


# The Piston




- Cast iron or forged aluminum, depending on size
- Used to compress gas within the cylinder
- Compression usually occurs on both the head end and crank end of the piston
- Connected to the connecting rod by a one-piece piston rod at the crosshead

# Valve Components



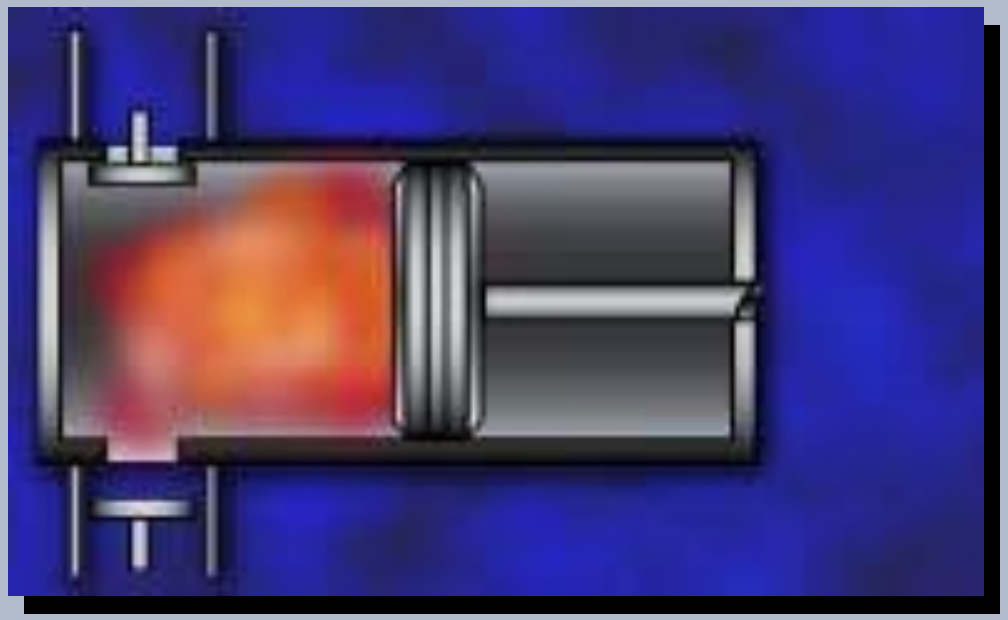

- The valve seat and valve plate work together to seal the gas with the guide ring, acting as a guide for the valve plate
- The valve guard serves to stop the valve plate limiting valve lift
- The springs dampen the movement of the valve and closes the valve at the proper moment
- Center bolt holds assembly together

# The Compression Cycle

- Position 1: Start of compression stroke, piston beginning movement toward head end; suction and discharge valves are closed

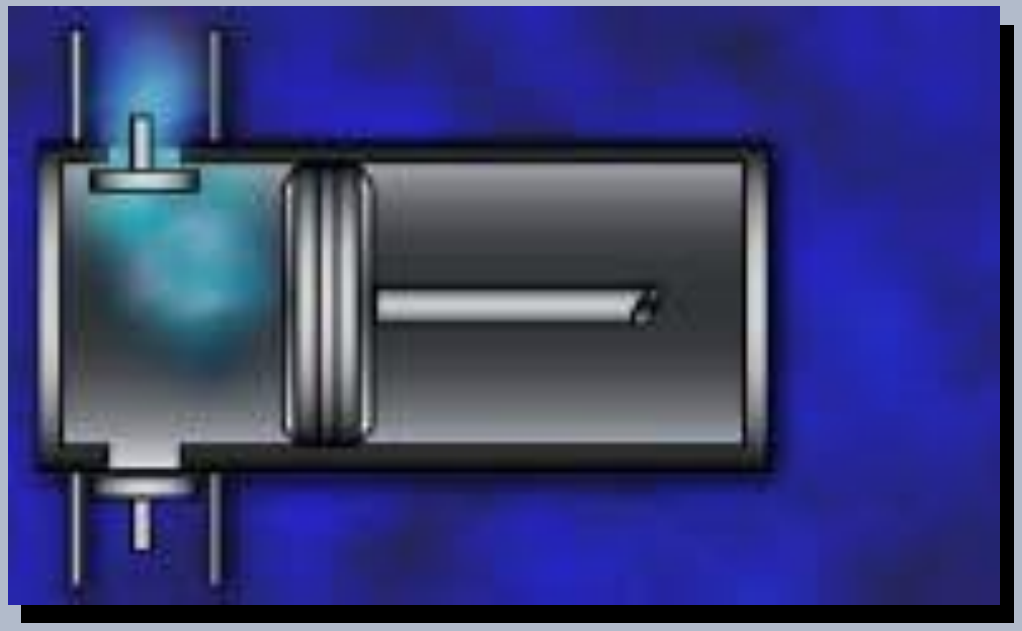
# The Compression Cycle

- Position 2: Piston moves outward; as the volume in the cylinder decreases, the pressure increases until the discharge valve opens



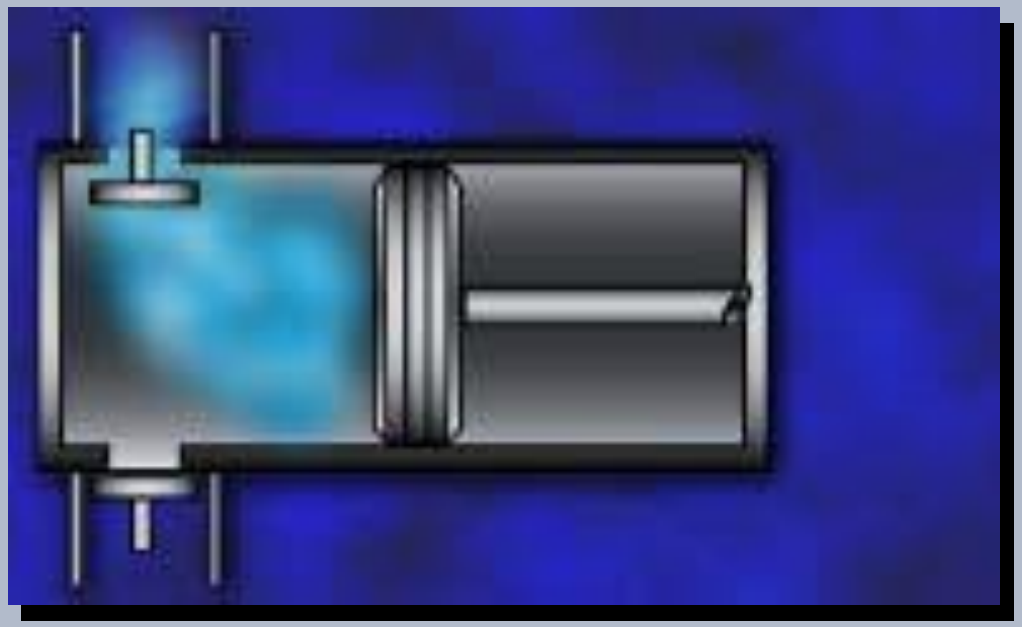
# The Compression Cycle

- Position 3: End of compression stroke; the piston begins to reverse direction starting the suction stroke; discharge valve closes



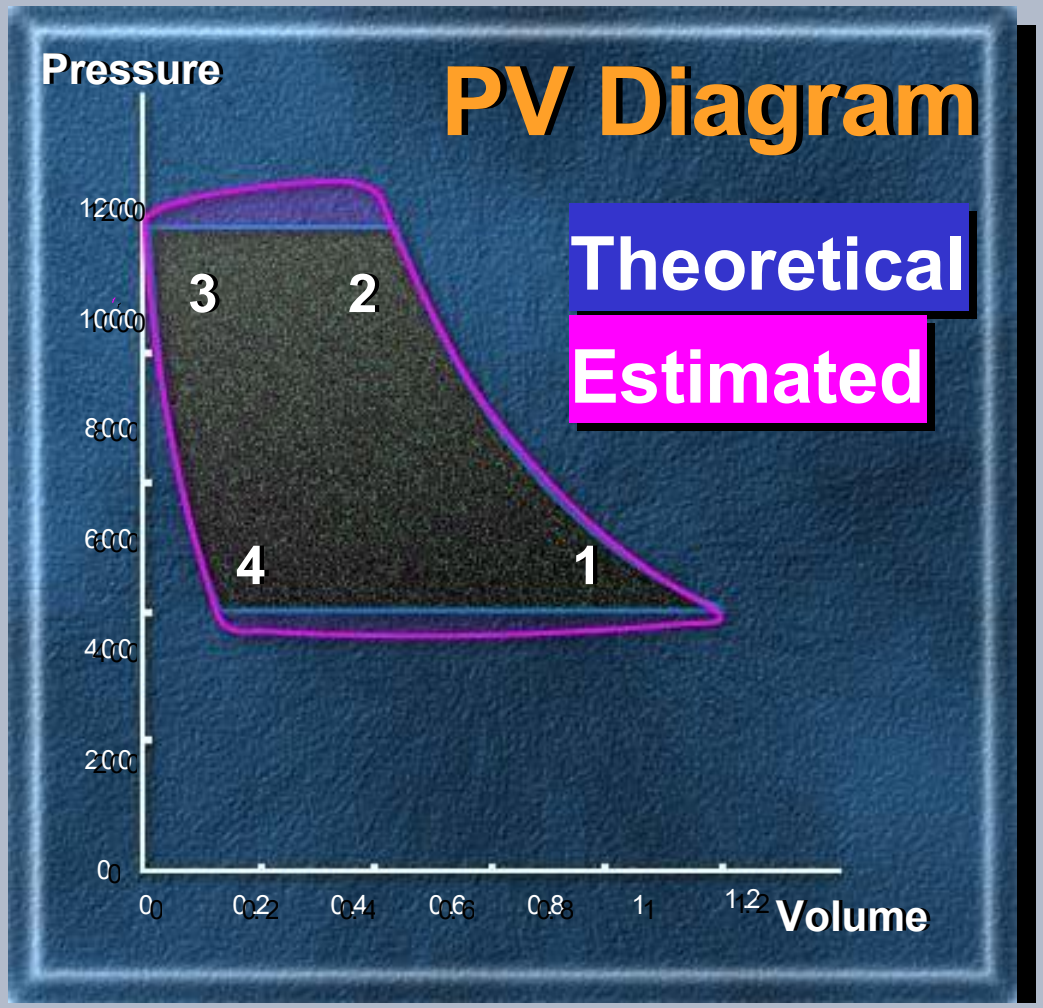
# The Compression Cycle

- Position 4: Piston moves inward; as the volume in the cylinder expands, pressure decreases and the suction valve opens allowing gas into the cylinder

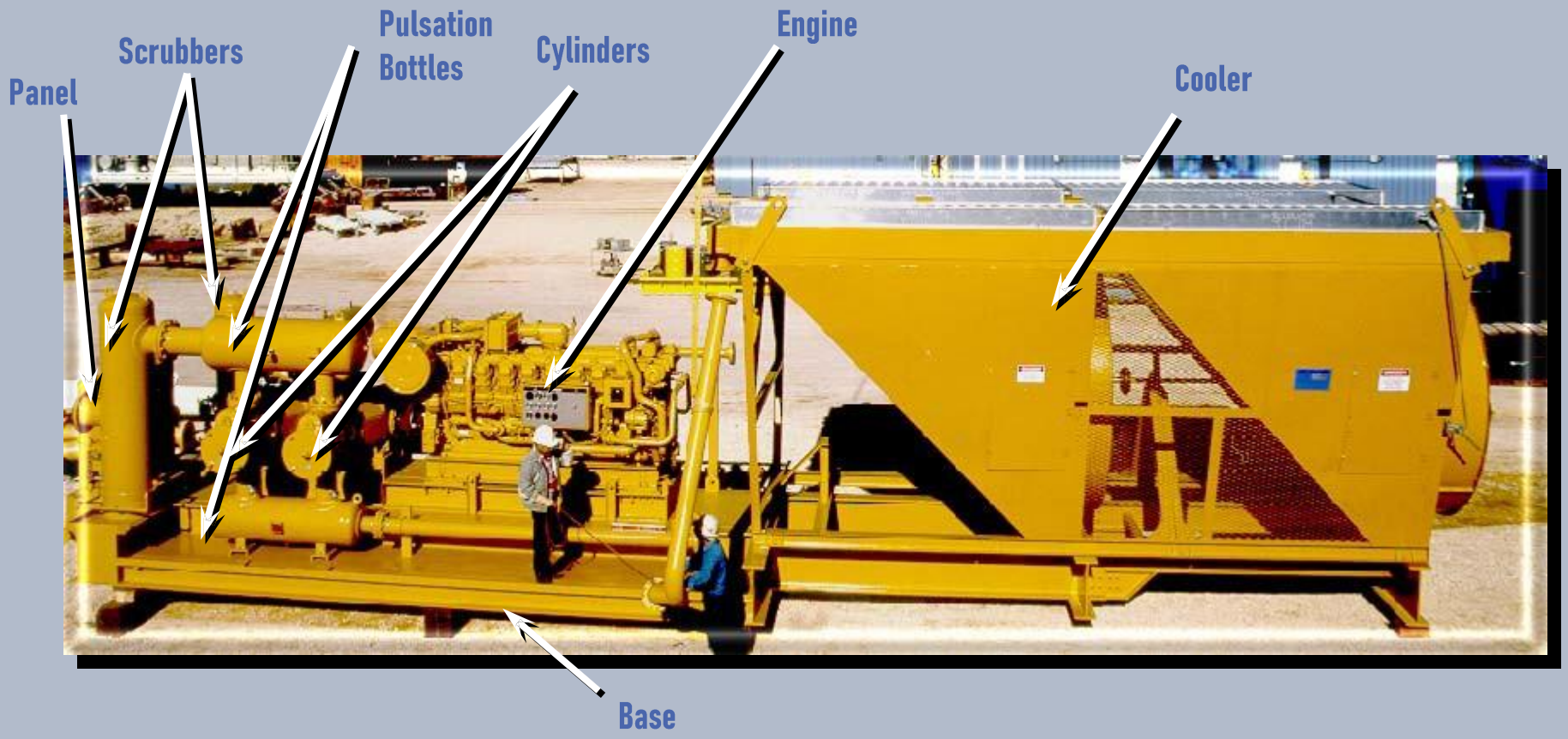


# The Compression Cycle

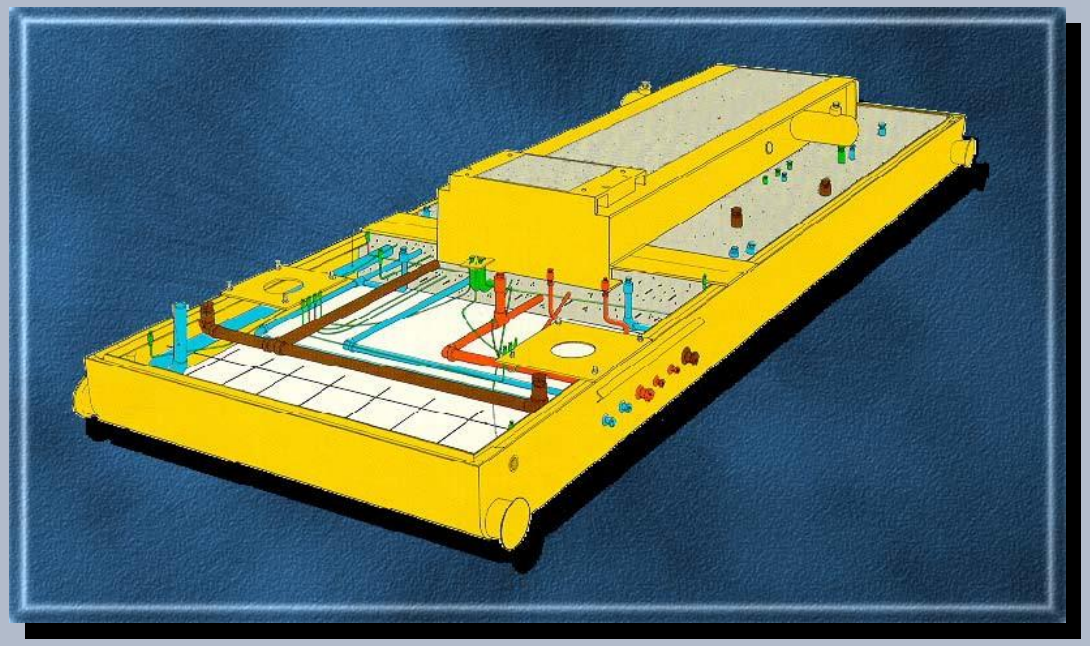
- P-V Relationship of the four positions



# The Compression Package Components



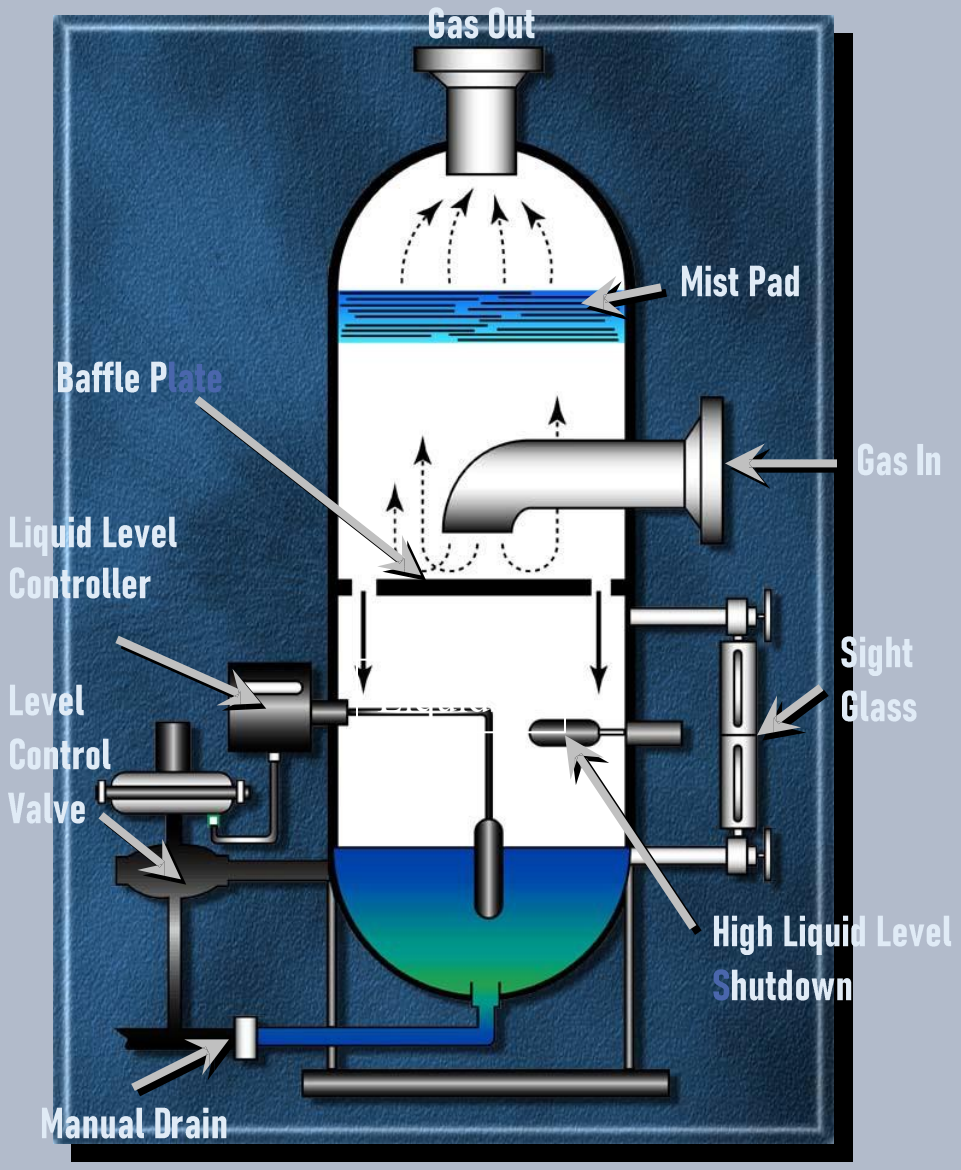
# The CCS Base



Typical Industry Base

- The base is a steel platform or sub-structure which provides an operating base for the compressor package
- The base is completely portable and designed to be set on a concrete foundation
- Dual troughs are designed on each side of the base to install piping, tubing, and conduit allowing access to the package for ease of operation and maintenance

# The Scrubber

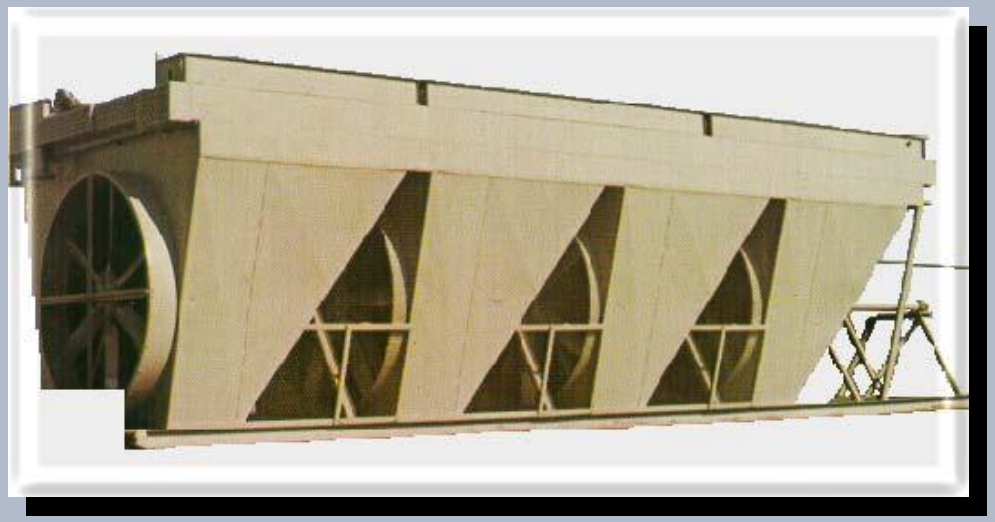



- This is the vessel where gas first enters the compressor package
- Serves as a filtering and separation device to remove liquids and solids from the gas
- These tasks are accomplished by impingement, direction change, velocity change, and a vane-mist extractor
- A scrubber is typically installed before each stage of compression

# Pulsation Bottles

- Purpose is to reduce pulsation in the gas flow which can cause severe vibration of the compressor package
- Accomplished by expansion of volume and possibly baffles or chokes to interfere with the propagation of harmonic rhythms and the frequency of the gas pulse

# The Cooler



- In the compressor, the cooler is utilized to dissipate the heat from the gas that is generated during the compression process

- Multi-stage compression units have a section or “core” to cool gas from each stage

- Multiple functions to cool various streams in both engine and compressor
- Typical coolers utilize air as a cooling medium
- For the engine, the cooler acts as a radiator cooling jacket water used to cool the engine as well as the compressor if the compressor cylinders are water-cooled
- On large units, there may also be a section to cool the lubrication oil

# Introduction to Control Panels for Natural Gas Compressors

# Overview

Control panels are the central command system of a natural gas compressor package. They monitor engine and compressor parameters, protect equipment from unsafe conditions, and allow operators to start, stop, and adjust unit performance safely and efficiently.

# Primary Functions of a Control Panel

- Engine and compressor start/stop control
- Monitoring of pressures, temperatures, and speeds
- Safety shutdown protection
- Alarm notification and fault indication
- Communication with remote monitoring systems (SCADA)
- Power distribution to sensors, actuators, and ignition systems

# Major Components Inside the Panel

Typical control panels include a programmable logic controller (PLC) or engine controller, relays and contactors, terminal blocks, circuit protection devices (breakers and fuses), power supplies (12V/24V DC), communication modules, and human-machine interface (HMI) displays. Wiring is organized to separate high-voltage circuits from low-voltage instrumentation for safety and reliability.

# Operational and Safety Considerations

- **Safety Systems**
  - Control panels continuously monitor critical shutdown points such as high discharge temperature, low oil pressure, overspeed, high vibration, and high suction or discharge pressure. If unsafe limits are reached, the control system will initiate an alarm or emergency shutdown to prevent catastrophic equipment damage.

- **Power and Grounding**
  - Proper grounding and stable DC power are essential for reliable operation. Poor grounding can cause false shutdowns, communication faults, and ignition issues. Battery systems, charging circuits, and low voltage disconnects must be maintained to ensure continuous control system availability.

# Best Practices for Maintenance

- Inspect wiring terminations regularly for looseness or corrosion
- Verify sensor calibration and shutdown setpoints
- Test safety shutdown circuits periodically
- Maintain clean panel interiors free from dust and moisture
- Confirm proper operation of cooling fans and ventilation systems

A properly designed and maintained control panel ensures safe, efficient, and reliable operation of a natural gas compressor package. Understanding the basic layout and function of the control system is the first step in mastering compressor operations.