EFRC Training Workshop Lubrication and Wear

Emissions related to wear of components

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Introduction Emissions & Wear

- Wear of gas seals increases process gas leakage
- Process gas leakage results in emissions
  - Free atmospheric vent
  - Flare system
  - Vapor recovery system

Introduction Emissions & Wear

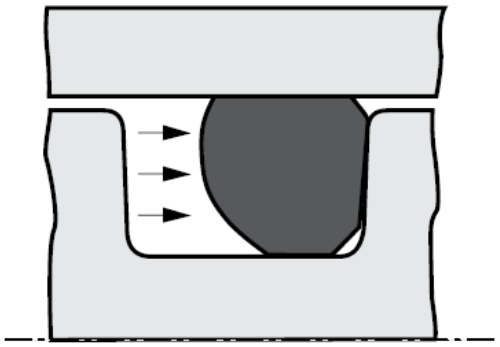
- Industry faces increasing pressure to reduce emissions from flaring and venting
  - Governments focus on reduction of greenhouse gas emissions (incl. CH_4!)
- Process gas leakage costs operators money
  - Most ‘visible’ when process gas is a sales product, e.g. natural gas compressions

Introduction Emissions & Wear

- Vapor recovery to reuse vent gas
  - Variable flow
  - Variable pressure
  - Variable molecular weight
  - “Dirty gas”
  - Often corrosive service
  - Liquid ring compressors
  - Screw compressors

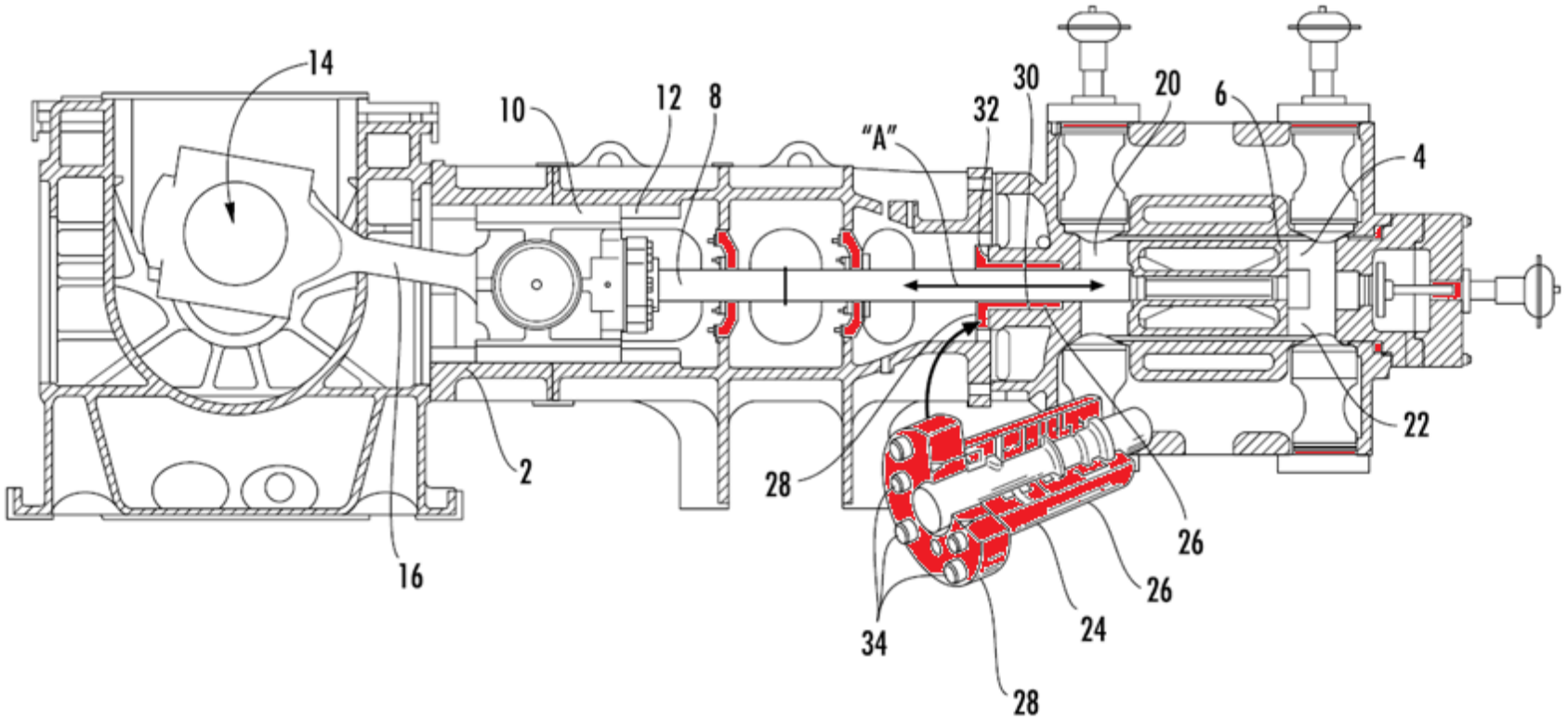
Sources of emissions

- Static gas seals “don’t” wear
  - O-rings
  - Gaskets
- Dynamic gas seals
  - Piston rod packing
  - Tail rod packing
  - Actuator rod seals



Source: Parker Hannifin O-ring Handbook

Sources of emissions



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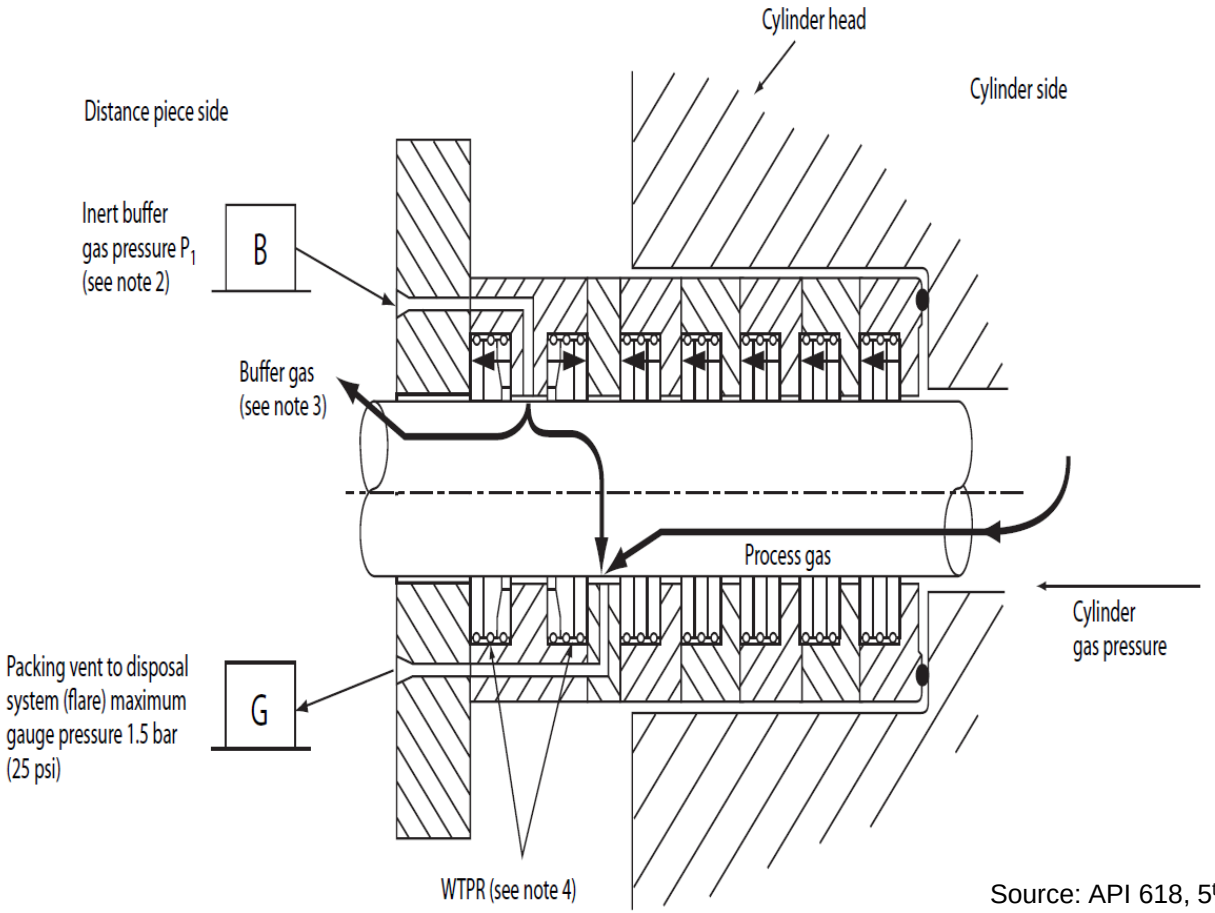


Source: API 618, 5th edition

Wear & emissions

- Piston rod packing leakage is correlated to piston rod diameter and discharge pressure and inversely correlated to gas molecular weight
- Leakage is fundamental to the operation of the piston rod packing
- Lubrication reduces leakage

Wear & emissions

Parameter		Leakage
Packing ring wear	↑	↑
Piston rod diameter	↑	↑
Discharge pressure	↑	↑
Gas molecular weight	↑	↓
Lubricated packing		↓
Non-lubricated packing		↑

Wear and emissions

- Normal leakage for lubricated piston rod packings ranges from 0.1 to 10.0 Nm^3/hr

- Normal leakage for non-lubricated piston rod packings is generally 50% higher than for lubricated packings

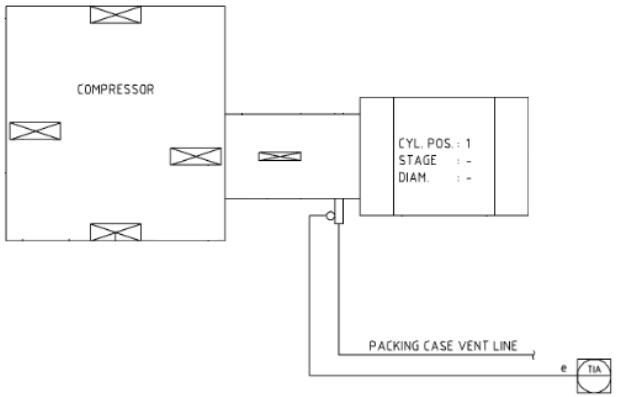
Wear and emissions

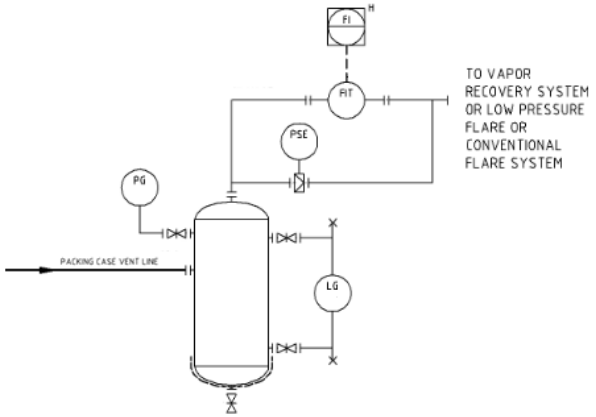
- Piston rod packing leakage can increase by a factor 10 or more before the packing is considered worn

- Leakage range from 0.1 Nm^3/hr up to 150 Nm^3/hr in case of severe wear!

Wear and emissions

- Condition monitoring of packing typically by vent gas temperature measurement
- In-line leakage flow measurement is difficult
  - High accuracy required for lower flow rates
  - Vent line shall be free of obstructions in case of high flow rate (safety!)

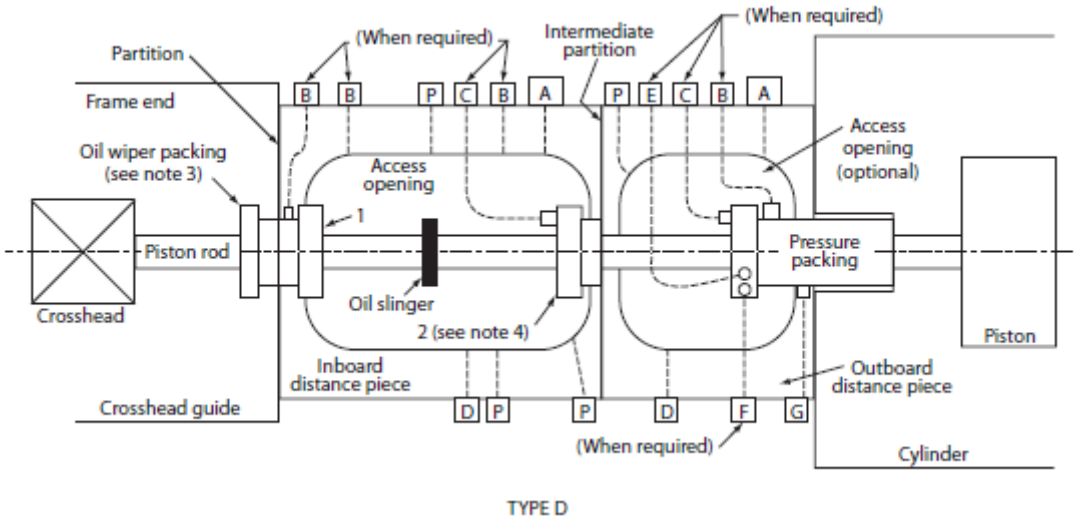




Controlling emissions

- API 618, 5th edition
  - Purpose of Distance Piece Vent, Drain and Buffer systems includes atmospheric fugitive emission control
  - If specified, to reduce process gas emissions to an absolute minimum, the cylinder pressure packing shall include venting and buffer gas cups with side-loaded packing rings in the adjacent cups.

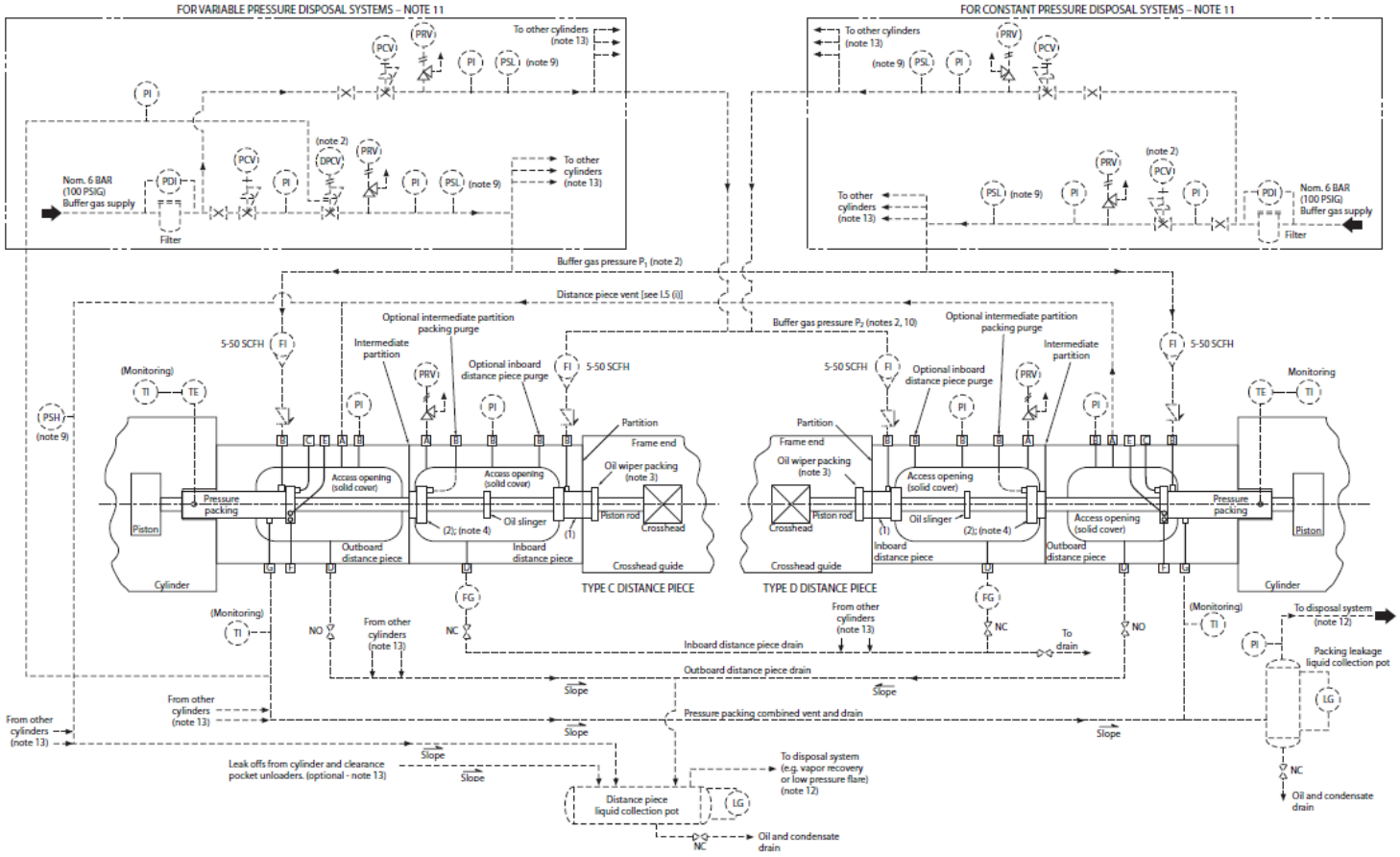
Controlling emissions



TYPE D

Source: API 618, 5th edition

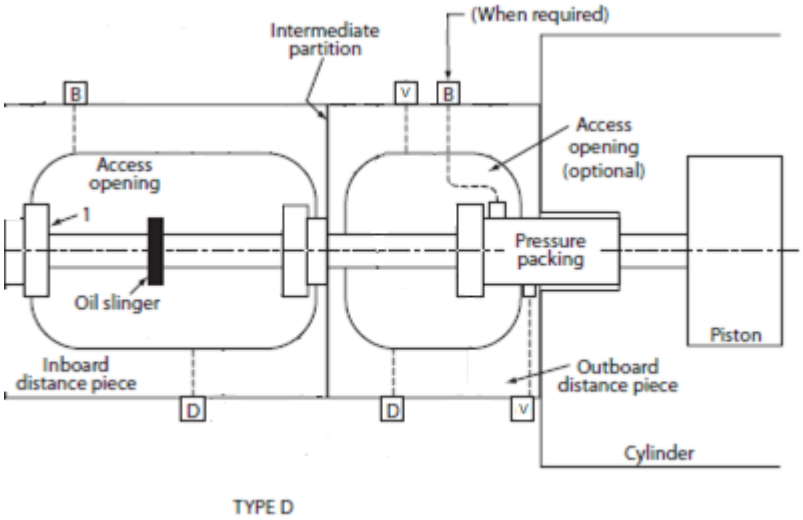
Controlling emissions



Source: API 618, 5th edition

Controlling emissions

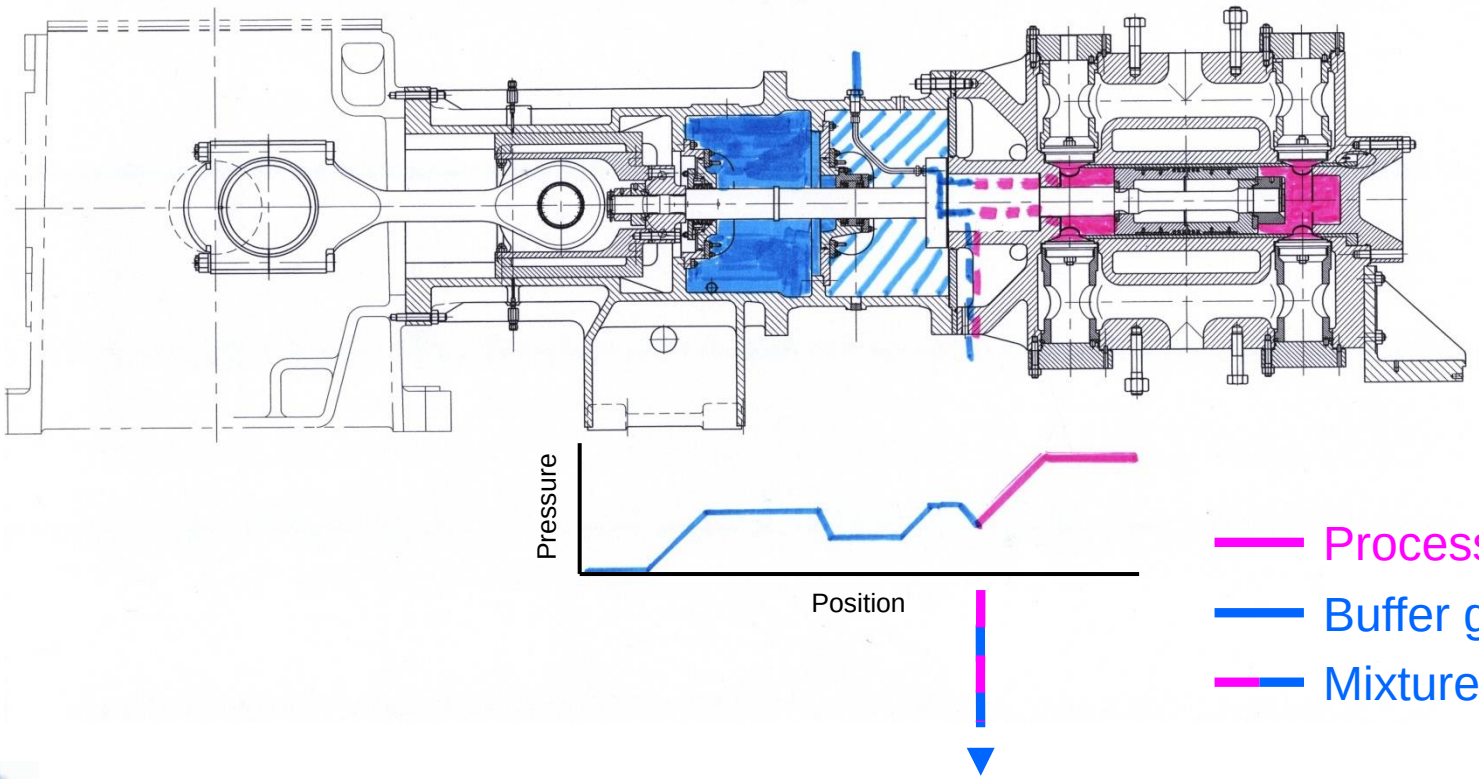
- Buffer
  - Reduce process gas emissions
- Drain
  - Separate liquids
- Vent
  - Controlled handling of residual emissions



TYPE D

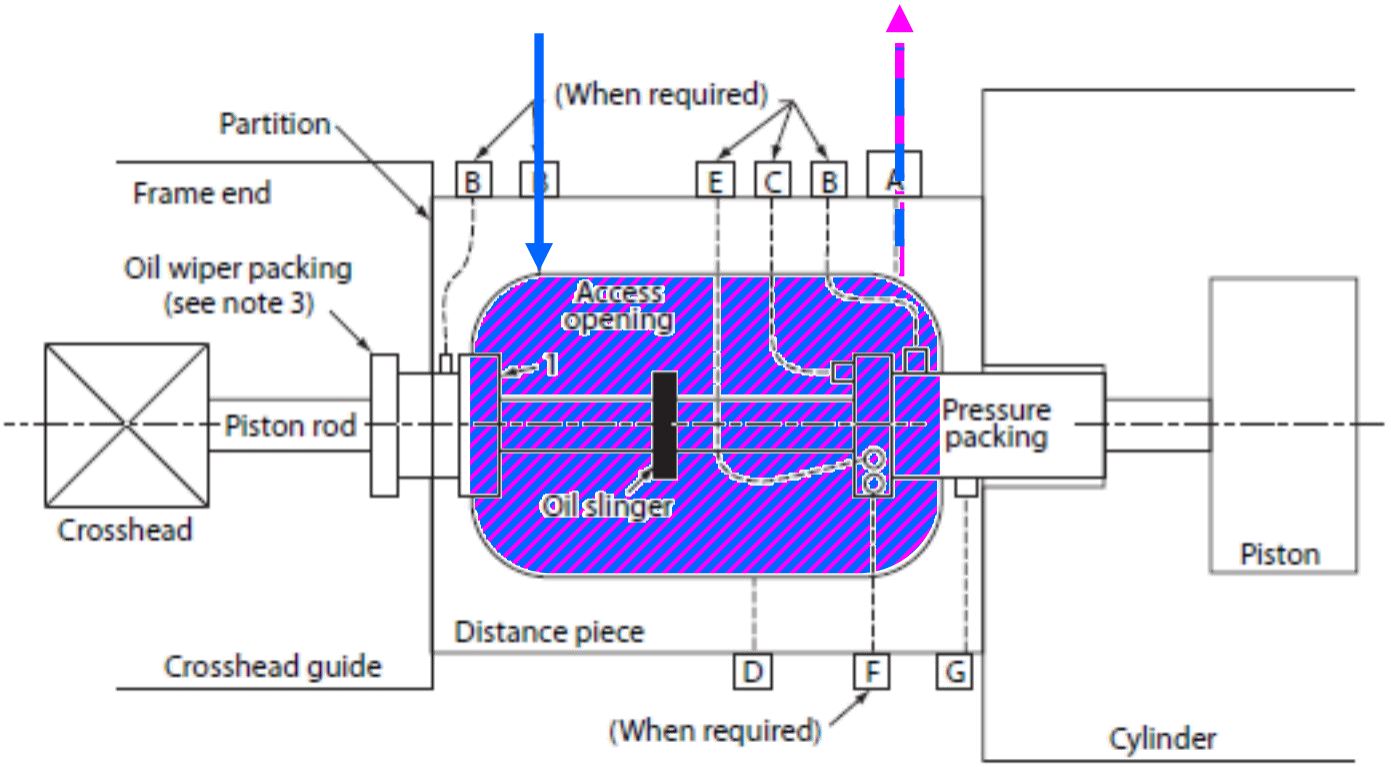
Source: API 618, 5th edition

Controlling emissions



Type C/D double compartment distance piece

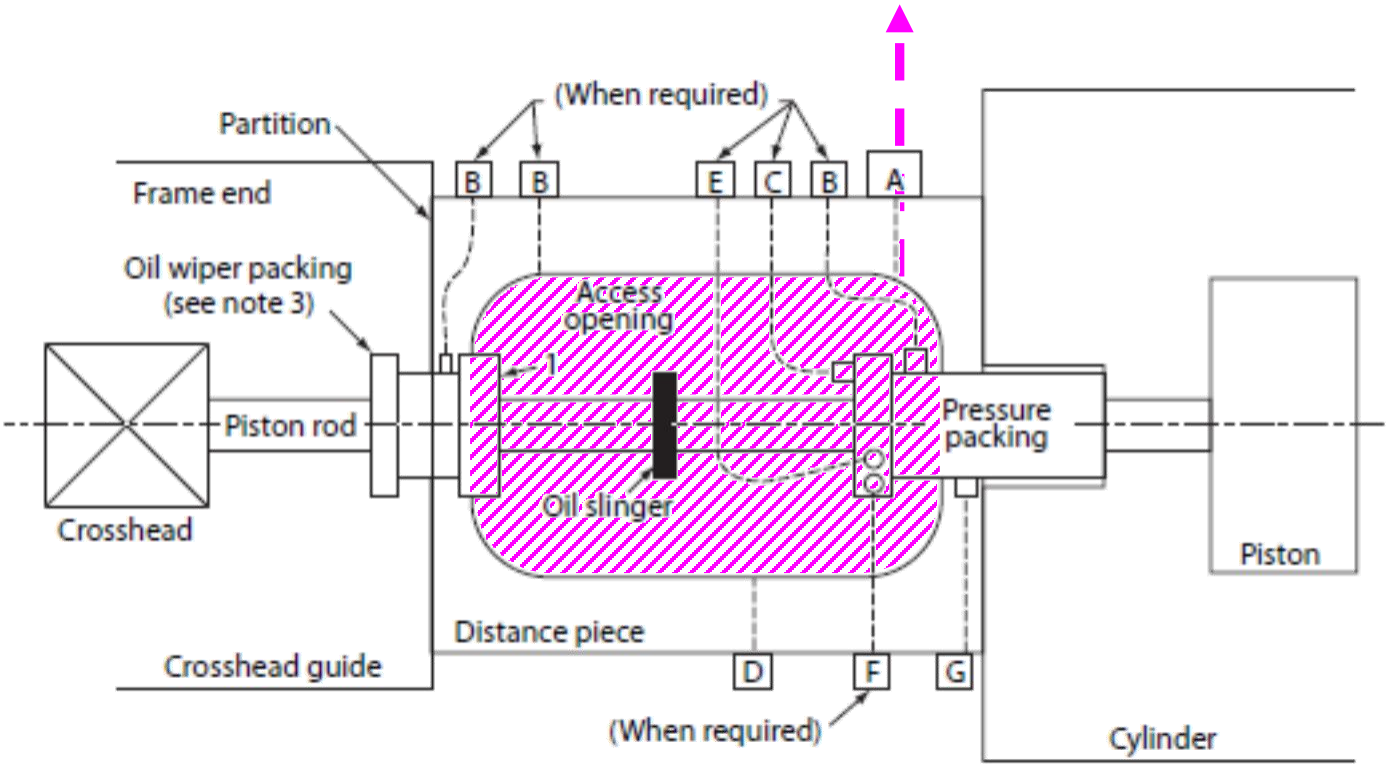
Controlling emissions



Type A/B single compartment distance piece

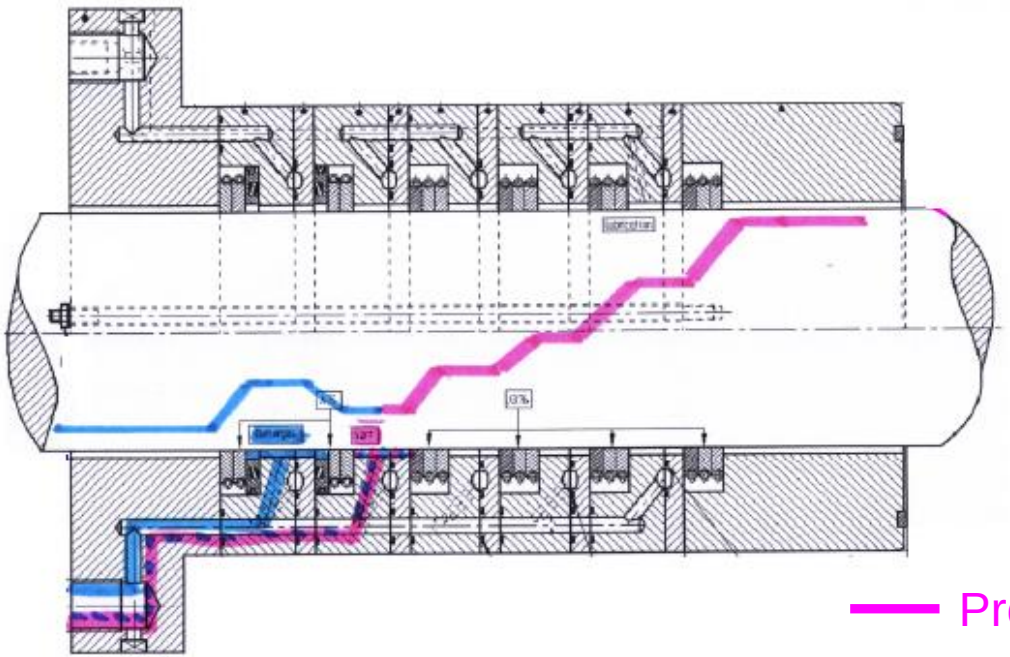
Process gas
Buffer gas
Vent gas mixture

Controlling emissions



Type A/B single compartment distance piece

Controlling emissions



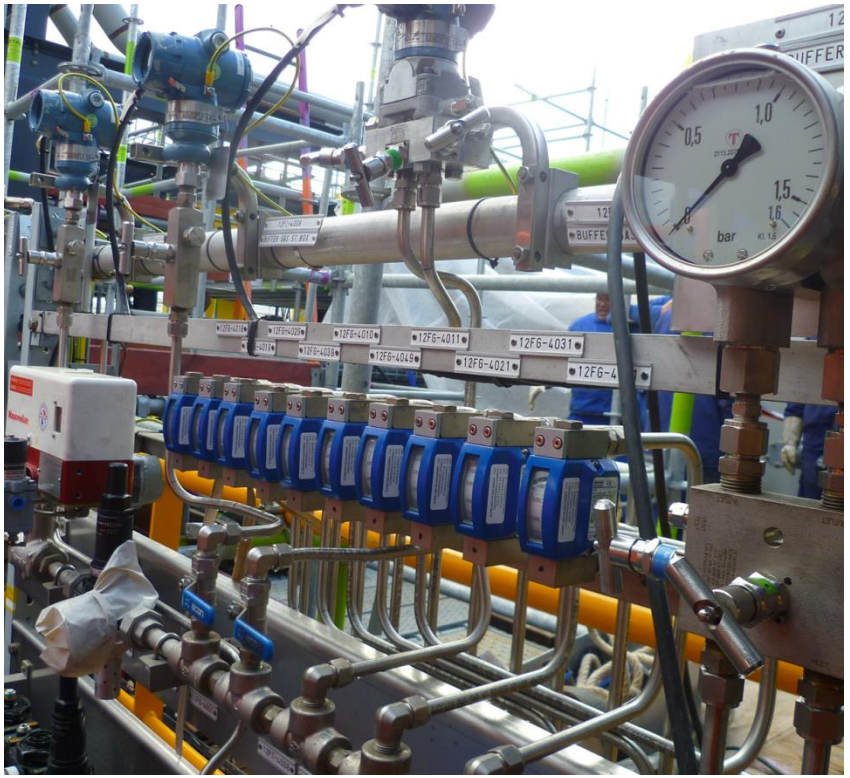
Process gas

Buffer gas

Vent gas mixture

Controlling emissions

- Buffer gas pressure regulator
- Buffer gas flow meters to individual seals and compartments



Controlling emissions

- Drain collecting lines
- Liquid collecting pot
- Vent line

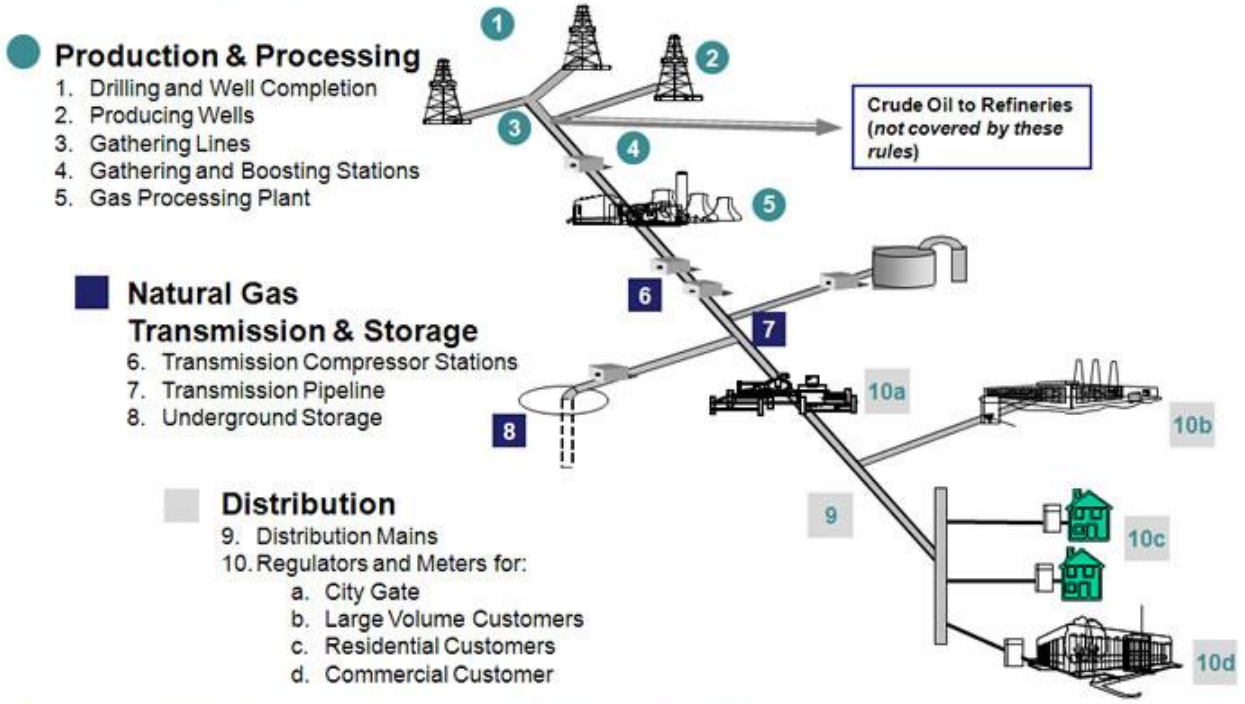
Regulatory aspects

- USA
  - EPA: Environmental Protection Agency
  - NSPS OOOO and OOOOa rules
  - Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commence After September 18, 2015
  - Covers volatile organic compounds as well as methane emissions

Regulatory aspects

The Natural Gas Production Industry

Natural gas systems encompass wells, gas gathering and processing facilities, storage, and transmission and distribution pipelines.



Source: Adapted from American Gas Association and EPA Natural Gas STAR Program

Regulatory aspects

- Mandatory periodical rod packing replacement
  - After 26.000 operating hours
  - After 36 months from last replacement
- Or collect leak gas through a closed vent system operating at a subatmospheric pressure

Regulatory aspects

- EU
  - High level sectoral emission reduction objectives defined
  - Currently no EU legislation applicable
  - Indirect reduction via EU Emission Trading Scheme, limiting CO_2 emission from flares
  - Reduction measures occasionally being imposed through license to operate

Regulatory aspects

- Trends & outlook
  - Piston rod packing development targeting ‘zero’ emissions
  - Increased focus on reduction of greenhouse gas emissions (incl. methane)
  - Increased focus on reduction of flaring
    - ‘zero routine flaring’ for oil fields
    - EPA refinery emissions rules
    - Global Gas Flaring Reduction partnership

Conclusion

- Piston rod packing is the main source of process gas leakage
- Process gas leakage depends on a number of factors and can very significantly
- A well designed vent, drain and buffer system can prevent leakage from becoming emission

Questions