Hydrocarbon processing

Utility systems

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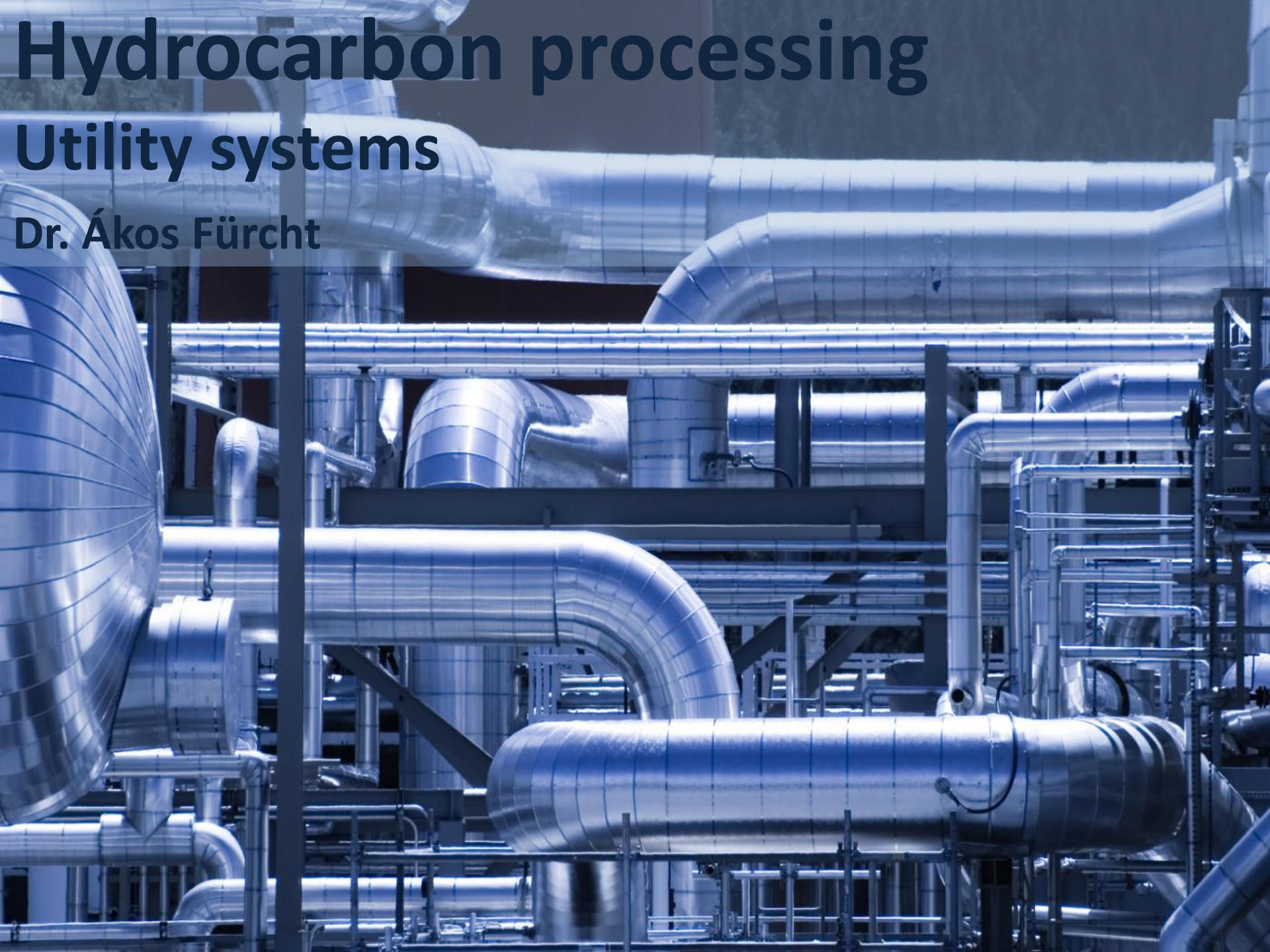


Definition

- Utility systems are supplementary systems which help the smooth operation of the processing units, help safe operation, help to avoid emergency situations
- The process units are not operational without the proper operation of the utility systems
- Prior to the process unit start-up all utility systems must be on-line


Emergency
situation

Types 1

- **Flare system**
  - Safety issues, incineration of blown-down hydrocarbon waste
- **Boiler feed water (BFW) system**
  - Ion-free water produced by reverse osmosis and ion exchange
  - Main usage: feeding the boilers to produce steam
  - Process usage: ETBE unit (LPG washing)
- **Steam systems – LP, MP, HP**
  - Process
    - SMR: hydrogen production
    - Crude distillation: distillation column – bottom stripping
    - FCC: catalyst stripping, fluidization in the riser bottom
    - DCU: furnace – feed dilution to delay coke formation
  - Pipeline heating – external heating of the pipes, covered by insulation
  - Flare system – smoke suppression system
- **Condensate system**
  - Designed to collect the steam condensate (BFW recycle)

Types 2

- **Cooling water system**
  - Used to remove heat from process streams (temperature usually around 20-25°C)
  - Heat exchangers – coolers: used for liquid streams
  - Heat exchangers – condensers: used for vapor streams
- **Process water system**
  - Cooling water make-up
  - DCU: Coke cutting
- **Fire-fighting system**
- **Tap water system**
- **Sewage system**
  - Used to collect waste water from
    - Process
    - Rain
  - Waste water treatment facility (physical, chemical biological treatment)

Types 3

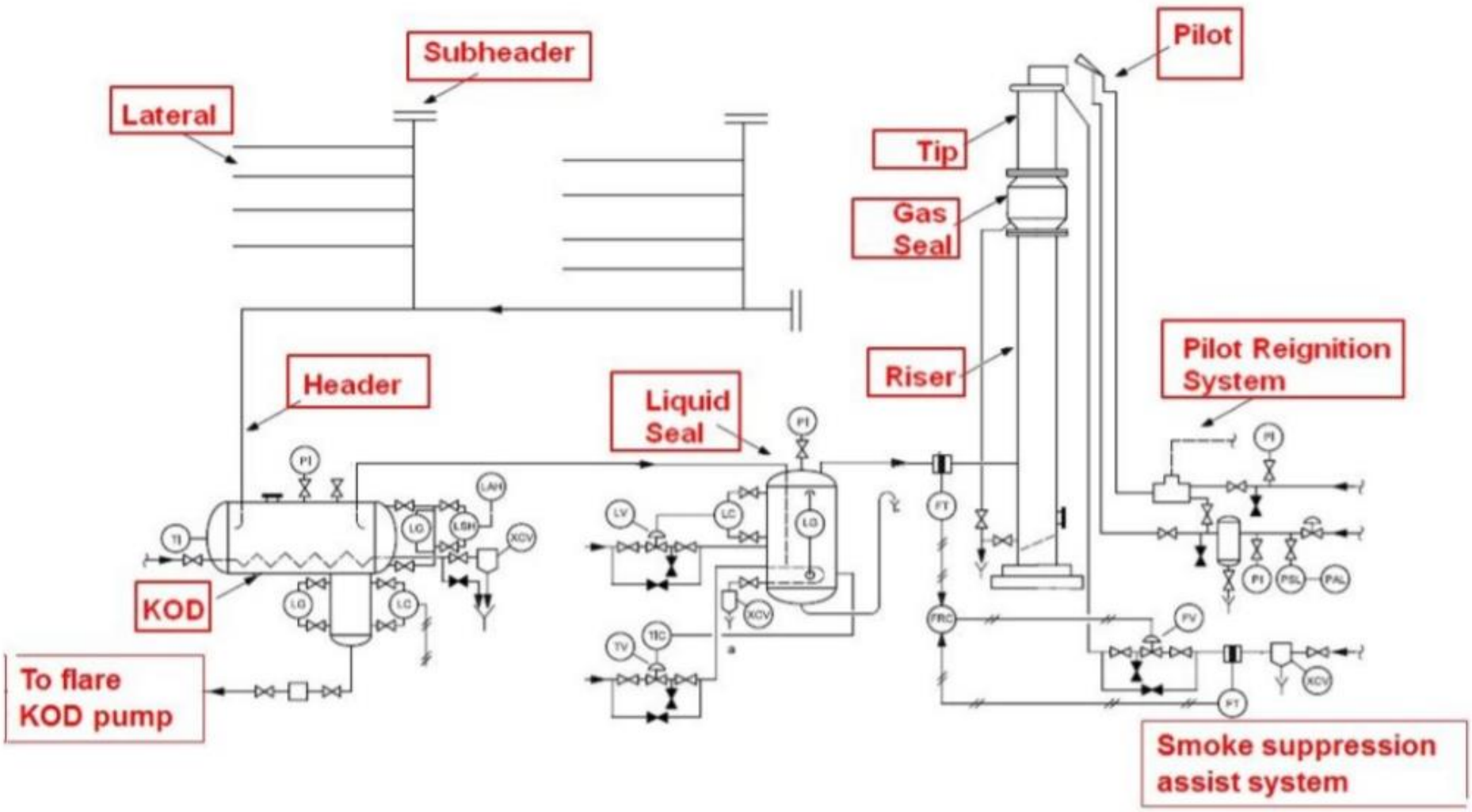
- **Fuel system**
  - Uses fuel gas/fuel oil to run the furnaces, boilers
  - Basically comes from own production, but may be supplemented by natural gas
- **Electric energy system**
  - Electric driven pumps, compressors
  - Lighting, etc.
- **Instrument air system**
  - Low dew point, particle free air is used
  - Used by pneumatic control valves
- **Process technical gases**
  - Process air (could be ambient)
    - FCC: used to burn off coke from catalyst surface
    - Burners: simply taken from the environment
  - Nitrogen
    - Used for pressure tests
    - inertizing

Flare system

The Flare System

- **Definition**: The flare system is a system consisting pipelines and special devices, which collect the emitted hydrocarbons from safety valves, blow-down valves, pressure control valves, manual purge valves and incinerates them via burning at a distant, safe location.
- It is used in the crude oil refineries, petrochemical locations, natural gas and crude oil fields (onshore and offshore)
- **Emitting hydrocarbon into the environment in prohibited!** (safety, environmental and legislative considerations)
- If it is economically feasible, we try to reuse the hydrocarbons as much as possible

Flare system **scheme**



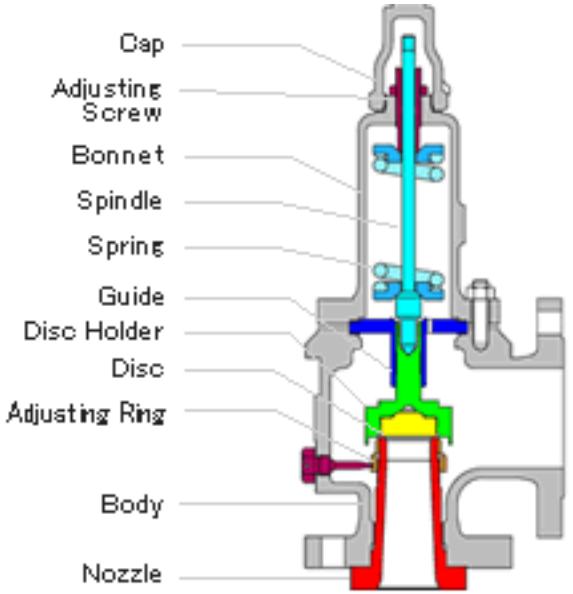
Elements of the flare system

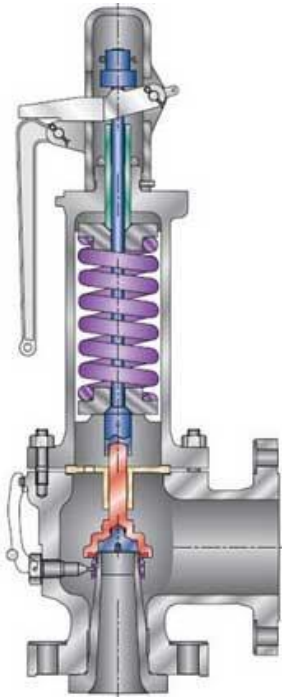
- **Pressure safety valves, blow-down valves, rapture discs:** they are attached to the proteced vessels and guarantee the safe operating pressure (PSV)
- **Headers, subheaders, laterals:** collect the emitted gases
- **Knock out drums:** separate the waste liquid hydrocarbons from the gases (the liquid is reuseable, the gases not sure) and protect the flare from liquid load (KOD)
- **Liquid seal:** prevent the gases to backflow to the system
- **Flare (riser):** ensures the burning of the gases at safe elevation
- **Flare tip:** this is the location of burning
- **Pilot burners:** ensures the operation (burning) of the pilot flame using continous natural gas addition
- **Flame guard:** monitors the existance of the pilot flame
- **Ignition system:** allows the original/reignition of the pilot burners

Pressure safety valves

Flaring situations

- **Emergency blow-down:** in case of abnormal pressure increase on any vessel the PSV will open and limits the actual pressure below the design pressure. Possible cases:
  - overheating
  - Feed increase
  - Draw reduction
  - Composition change
  - Standing in fire
  - Cooling water malfunction
  - Chemical reaction runaway
  - etc.





Flaring situations

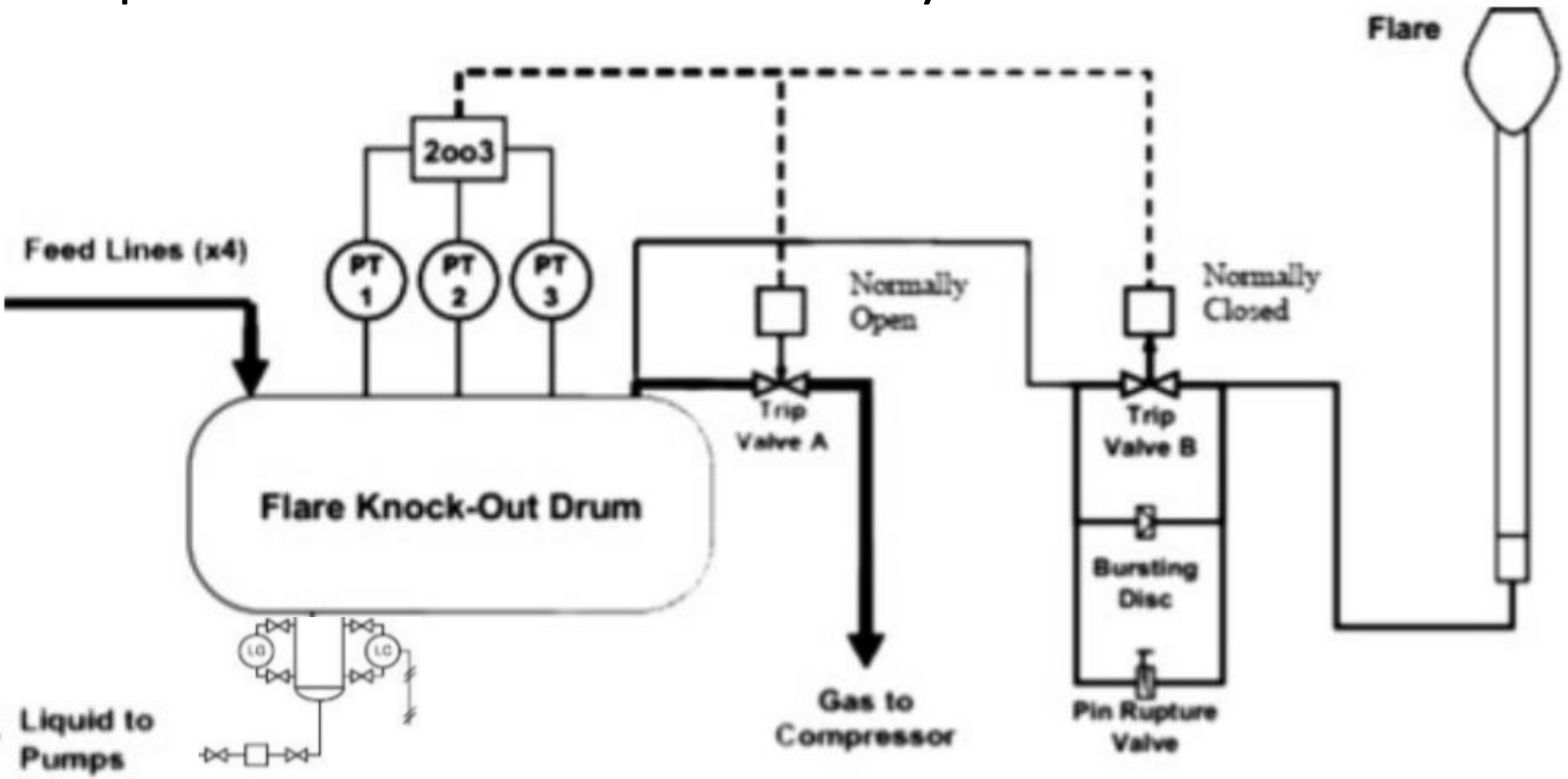
- **Plant start-up:** during the transition period of unit start-up (max. 1-2 day) we need to remove some gases
- **Pressure control:** gas space pressure control of storage tanks (eg. during filling-up, day-and-night pressure movements)
- **Manual blow-down:** eg. During shut-down period for maintenence

Design considerations

- Design capacity – according to emergency scenarios
  - PSV sizing (spare)
  - Pipeline sizing
  - Flare sizing
- Design temperature – according to the temperature of the protected vessel
- Smoke supression – usually by added steam
- Fuel gas system – fueling the pilot burners
- Header purge system – fuel gas or inert gas purge in order to ensure the continuous one-way flow
- Location in the refinery (heat load calculations)

The knock-out drum (KOD)

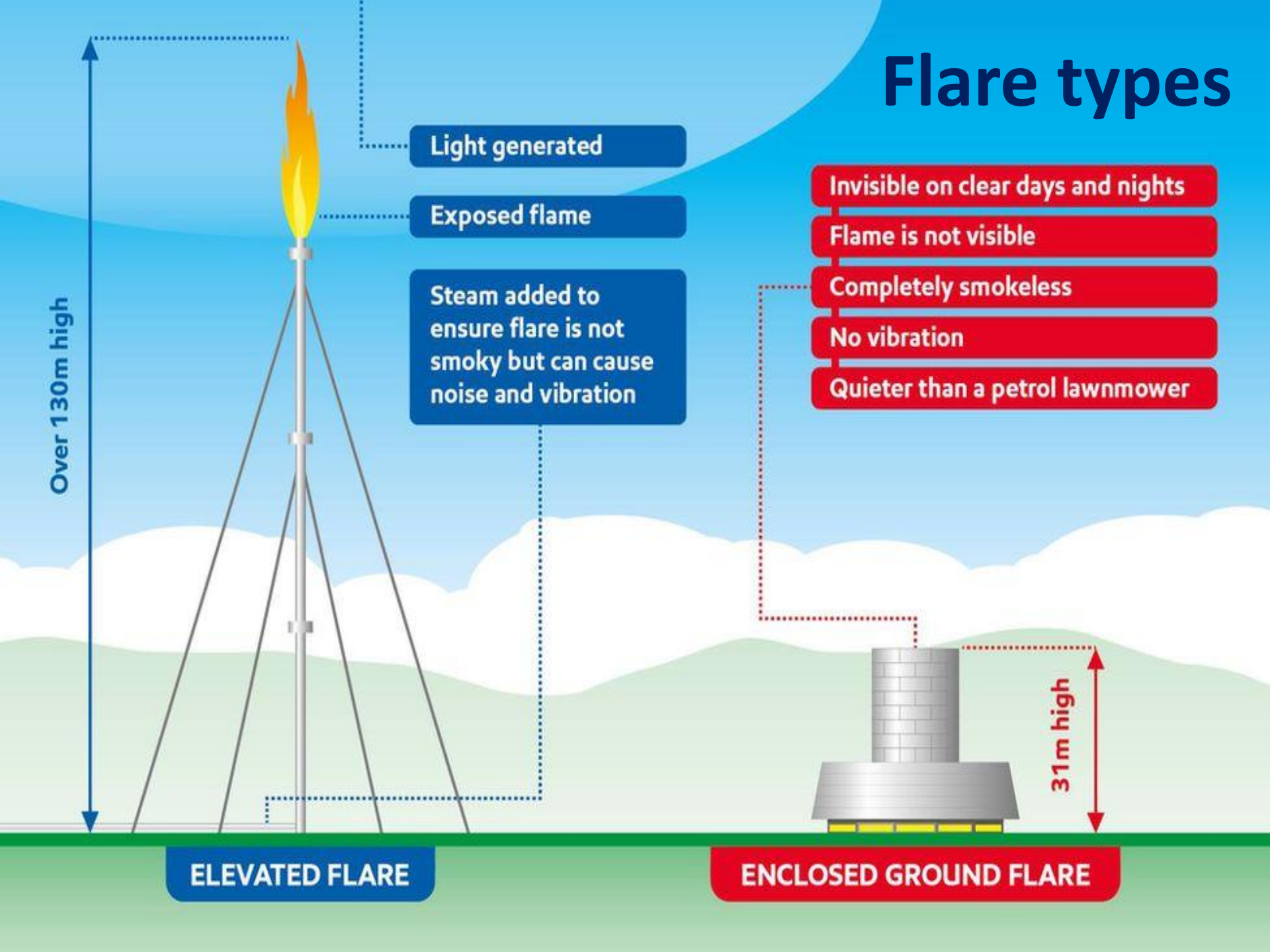
- The goal is to reduce the liquid load of the flare, to reduce the particle size of the entrained droplets, to provide residence time of the hydrocarbons



Operation of the trip system

- 2oo3 ≠ 2003
- Two out of three = 2 out of 3 = 2oo3
- Three transmitters (pressure, temperature, level, etc.) are combined into one control loop. They give signal to the intervening device(s), if at lest two of the transmitters reach the set critical value
- „An **automatic trip** is an action performed by some system, usually a Safety Instrumented System, Programmable Logic Controller or Distributed Control System, to put an industrial process into a safe state. It is triggered by some parameter going into a pre-determined unsafe state. It is usually preceded by an alarm to give a process operator a chance to correct the condition to prevent the trip, since trips are usually costly because of lost production.”
- In the above example: the pressure increase of the KOD (PT1-3) will activate the trip system, which will close the „normally open” valve A, and opens the „normally closed” valve „B”. Thus, during normal operation the flared gases will recycled by a compressor and will be flared only in emergency situation.

Flare types


Over 130m high
Light generated
Exposed flame
Steam added to ensure flare is not smoky but can cause noise and vibration
Invisible on clear days and nights
Flame is not visible
Completely smokeless
No vibration
Quieter than a petrol lawnmower
31m high
ELEVATED FLARE
ENCLOSED GROUND FLARE


Elevated
flare

Closed ground flare

Open ground flare (OGF) is a ground mounted array of burners located within a bund and/or a wind fence designed to minimize flame visibility and emitted radiation


Off-shore flare


The End