

# OIL & GAS TECHNOLOGY

## Chapter 3 : Midstream Operations

by

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# Chapter Description

- Aims
  - This course introduces the concept of midstream activities
- Expected Outcomes
  - Describe the fundamental concept of gas processing and type gas treatments
  - Understand the gas and liquid pipeline and pipeline management
- References
  - Devold, H. Oil and Gas Production handbook: An Introduction to Oil and Gas Production, Transport, Refining and Petrochemical Industry, 2013.
  - J. Stell. North America's top gas processors consolidate in 2015. Retrieved from <http://gasprocessingnews.com/features/201602/north-america%E2%80%99s-top-gas-processors-consolidate-in-2015.aspx> at 20th of January 2016.

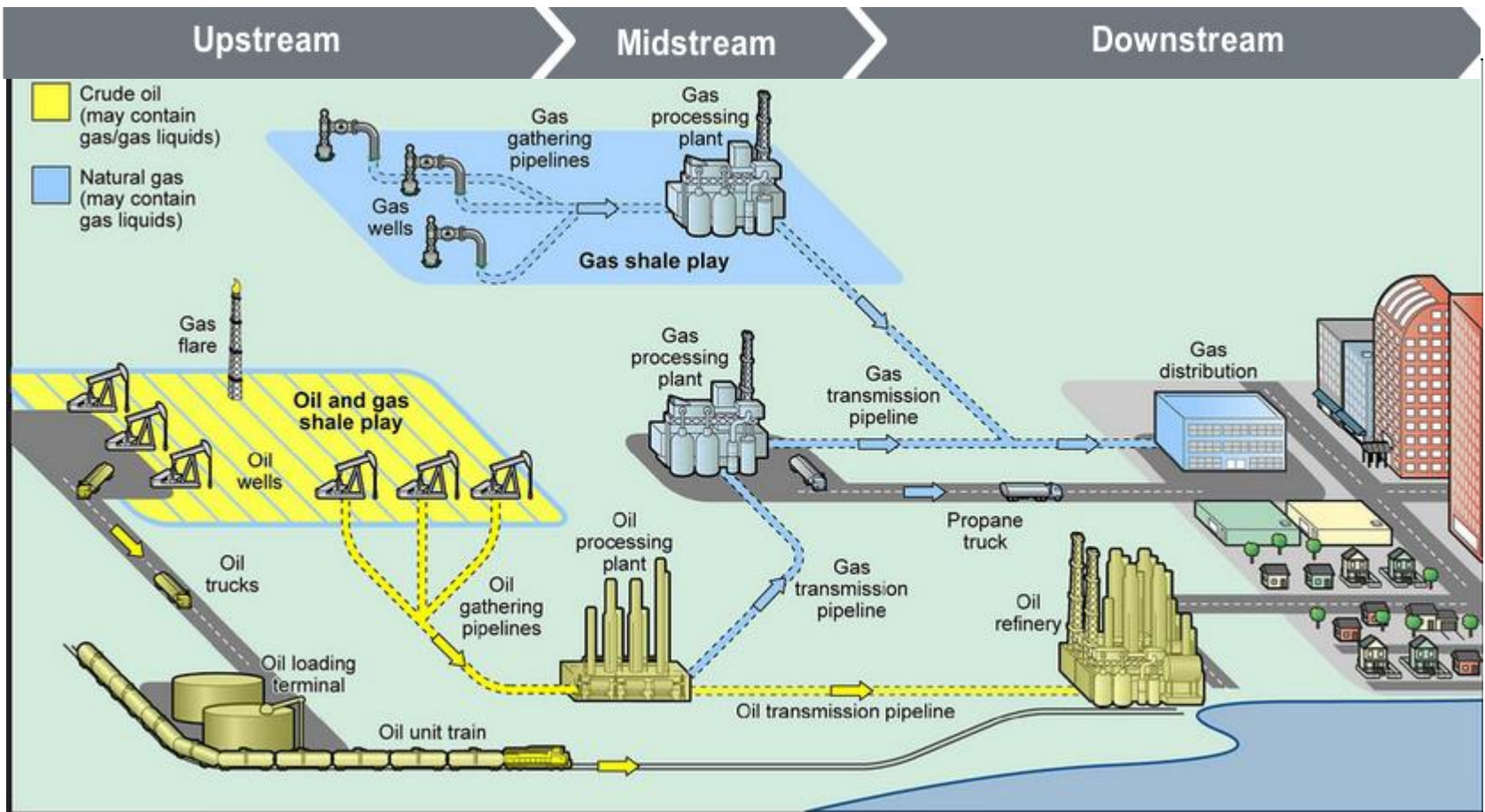


# Subtopic

- 3.1 Gathering
- 3.2 Gas Plants
- 3.3 Gas Processing
- 3.4 Pipelines
- 3.5 LNG
- 3.6 Conclusion



# 3.1 Overview of O&G Value Chain



Source: <https://www.flickr.com/photos/usgao/15340360702>



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# 3.1 Gathering

## Flowlines

- Lines connecting well-pad and FGS
- Mobile type pig launcher ( fixed or mobile type)

## FGS (Field Gathering Station)

- System of pipelines gathering
  - Permits transmission combined stream to CPF
  - Measures oil:water:gas ratio

## Trunkline

- Pipeline connecting FGS with CPF(Central Processing Facility)
- Has a pig receiver at the end





Source: [https://commons.wikimedia.org/wiki/File:Tokyo-gas\\_Negishi\\_LNG\\_Tarminal.JPG](https://commons.wikimedia.org/wiki/File:Tokyo-gas_Negishi_LNG_Tarminal.JPG)



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## 3.2 Gas Plants

- Further gas processing:
  - **Sweetening/acid removal**
    - Remove unwanted materials: acids, eg: H<sub>2</sub>S & CO<sub>2</sub>
  - **Calibration**
    - To achieve certain specification
    - Usually located @ common point
      - Eg: System of pipelines gathering and pipeline at onshore terminal



# Natural gas composition from the well

**Methane**

**Heavier HC**

- Propane, Butane
- Higher order HC – alkenes & aromatics

**Acid gases**

- H<sub>2</sub>S, CO<sub>2</sub>, mercaptans

**Other gases**

- N<sub>2</sub>, Helium

**Other components**

- Water
- Trace pollutants:  
Mercury & Chlorides





# Natural Gas Characterization

**Wet gas**

- Raw gas
- <85% methane

**Dry gas**

- Raw/treated gas
- <15L condensate per 1000SM<sup>3</sup>

**Sour gas**

- Raw gas
- >5.7mg H<sub>2</sub>S per scm @4ppm

**Acid gas**

- High content acidic gas

**Condensates**

- Mixture of HC with other compounds



# Natural Gas products/fractions

**NG**

- Natural Gas

**NGL**

- Natural Gas Liquids

**LPG**

- Liquefied Petroleum Gas

**LNG**

- Liquefied Natural Gas

**CNG**

- Compressed Natural Gas



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# 5.3 Gas processing

## 1. Acid gas removal

Remove acid gas, eg: CO<sub>2</sub>, H<sub>2</sub>S

Acid gas + water → acid

Why? Prevent corrosion, some acids are toxic

Principles:

Absorption

Adsorption

Cryogenic Removal

Membrane Removal

Sulfur Unit

Tail Gas Treatment

## 2. Dehydration

- Glycol-based scrubbers
- Pressure-swing adsorption (PSA)
- Membrane based

## 3. Mercury removal

- Based on molecular sieves



## 5.3 Gas processing

### 4. Nitrogen rejection

- By cryogenic distillation; removes excess N<sub>2</sub>

### 5. NGL recovery and treatment

- By cryogenic turbo expander-based process
- Then, fractioning
- Lastly, mercaptans removal



# Sales gas specifications

- Set by pipeline operators & distributors
- Parameters:
  1. Volume
  2. Calorific value
  3. Wobble Index
  4. Methane Number
  5. Hydrogen sulphide & Overall sulphur content
  6. Mercury
  7. Dew point
  8. Particles & Other Substance
  9. Additives



# 3.4 Pipeline



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## (a) Pipeline terminal

- Transport gas/liquid at high pressure due to compressors or pumps
- Consists of;
  - ✓ driving compressors
  - ✓ pumps
  - ✓ valve stations
  - ✓ pig receive/launch facilities.



## (b) Gas pipelines, compressor & valve stations

- The starting pressure must be high to maintain design capacity flow up to the final terminal.





## (c)Liquid pipelines, pump & valve stations

- Have higher specific gravity, higher pressure drops uphill, and increases downhill.
- Additional pumping capacity uphill is required & depending on downhill capacity due to pressure reducing turbines (brakes station).



## (d) Pipeline management, control & safety

- Supervisory control is to monitor the entire operation of pipeline system by using pipeline modeling models. The pressure, temperature and flow will be monitored.
- Demand forecasting is used to model demand in future (days) in relation with several parameters.
- across the system Safety systems are used to ensure that the system shut down in case of malfunctions and out-of-bounds conditions.



# 3.5 LNG



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# (a) LNG liquefaction

## Cascade cycle

- Separate refrigerant cycles with propane, ethylene and methane (ConocoPhillips)

## Mixed refrigerant cycle

- Single mixed refrigerant (SMR) (PRICO)
- Single mixed refrigerant (LIMUM®) (Linde)
  - Propane pre-cooled mixed refrigerant: C3MR (sometimes referred to as APCI: Air Products & Chemicals, Inc.)
- Shell dual-mixed process (DMR) (Shell)
- Dual mixed refrigerant (Liquefin Axens)
- Mixed fluid cascade process (MFCP) (Statoil/Linde)

## Expander cycle

- Kryopak EXP® process



# (a) LNG liquefaction

## Pre-cooling

Cools the gas around -30°C to -50°C

Cooling element usually propane/ mixture of propane, ethane & other gases.

## liquefaction

Takes the gas down from -30°C to -100,-125°C

Mixture of methane, ethane & other gases

## Sub-cooling

Bring the gas to final stable around -162°C

The refrigerant usually methane/nitrogen



## (b) Storage, transport & regasification

- At the receiving terminal, LNG is stored in local cryogenic tanks.
- It is regasified to ambient temperature on demand, commonly in a sea water heat exchanger, and then injected into the gas pipeline system.
- The tanks are insulated, but will not keep LNG cold enough to avoid evaporation.

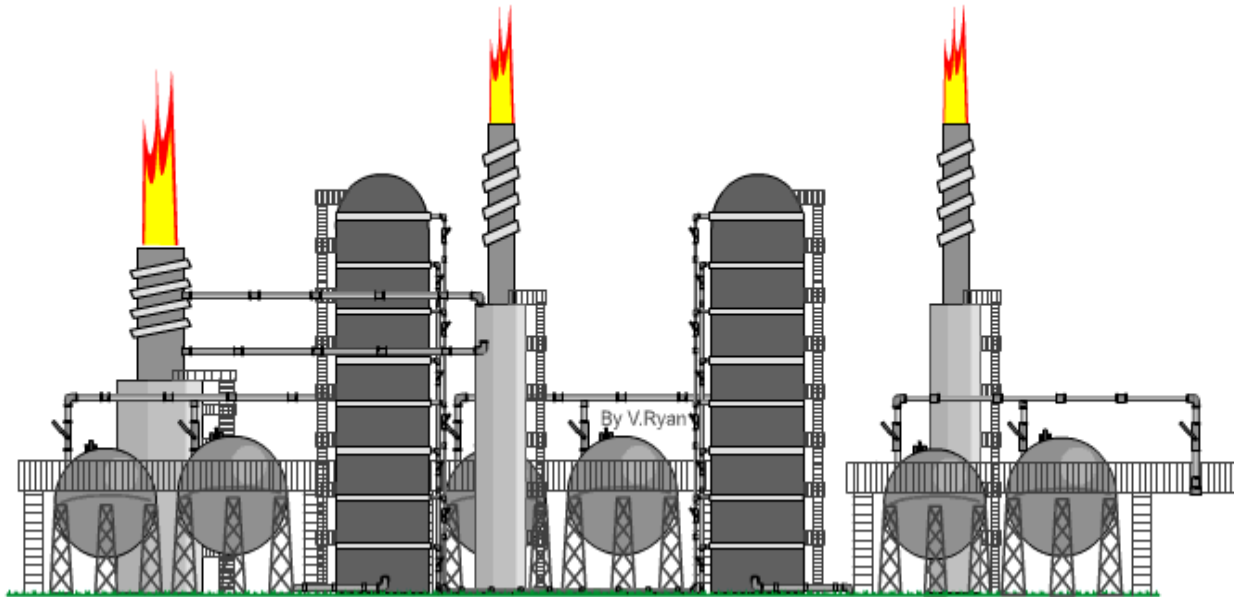


## 3.5 Conclusion

- Pipeline management is important at midstream operation
- Acid gas removal is important to remove undesired components from raw natural gas.
- LNG process consists of pre-cooling, liquefy and sub-cooling process



# THANK YOU



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# Authors Information

Credit to the authors:  
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