Upstream Oil and Gas
The Role of Facilities Engineers
Presentation Outline

- Introduction
- Simple Business Flow / simplified schematics
- Why treating – Oil, Gas and Water
- What do engineers do?
- Oil & Gas Processing Facilities - Flowstations, Gas Plants, Terminals, SPMs, etc
  - Simplified schematics to explain processing required and typical installed facilities
- Typical Costs and Schedules
- Regulations and Standards
- Safety
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  • B.Sc. (Hons) Chemical Engineering, Unilag, 1982.
  • Worked in Upstream Oil & Gas, etc 1984 – 2014.
  • Fellow, NSChE.
  • MNSE.
  • Married with Children.
Industry Structure

- **Upstream**
  - Exploration, Develop oil & gas, oil & gas production, etc

- **Midstream**
  - Refining, Petrochemicals, Gas & Power, LNG

- **Downstream**
  - Distribution, Marketing, Retailing, Storage
- Other models exist, e.g. PSC
PETROLEUM RESOURCE LIFE CYCLE
RELATIVE ACTIVITY

- Explore
- Appraise
- Develop
- Produce
- Abandon

Exploration
Petroleum Engineering
Field Engineering
Operations
•**WELLHEAD**
- Small diameter pipelines that carry oil from a well to the nearest flowstation. There is a flowline for every producing oil. SPDC has more than 1,000 producing wells. Land flowlines are on the surface. Swamp flowlines are buried.

•**FLOWLINE**
- Collects oil from all the wells in one or more fields, separates the gas and sends the oil and water along pipelines to a coastal oil terminal. The gas is mostly flared but some is used to power facilities. SPDC operates 86 flowstations.

•**FLOWSTATION**
- Oil is collected in tanks and water separated before export to tankers waiting offshore. The distance between wellhead and terminal may be more than 150 kilometers.

•**OIL TERMINAL**
- Takes place some five kilometers offshore. A buried undersea pipeline takes the oil to a single Buoy Mooring which loads the tanker through a flexible, floating hose.

•**TANKER**
- Take the oil and water from the flowstation to the terminal. They are always buried.

•**DELIVERY and TRUNK PIPELINES**
- The flare is enclosed by an earth bundwall which contains any accidental spills caused by oil getting into the gas flare pipeline.

**THE HISTORY OF OIL PRODUCTION**
We need to treat oil, gas and water to meet required specifications before they are used or disposed off.
Why Process the Wellstream?

- Oil and Gas need separate transport
- Oil and Gas have different Customers
- Different Customers have different specifications
- Handling requirements:
  - HSE
  - Transport and Logistical
Oil Specification

• For Transport:
  - Allowed gas content (Vapour Pressure)
    » Different for Pipeline, Terminal, Tanker
  - Allowed water content

• For Customer:
  - Allowed water content
  - Allowed ‘Blend’ / API grade
  - Allowed ‘Contaminants’
Gas Specification

• For Transport in pipeline:
  - Pressure
  - Temperature
  - Hydrocarbon Dewpoint
  - Water Dewpoint

• Customer:
  - All above +
  - Compositional Specification
  - Energy content (Heating Value)
  - Quantities at specific times (Swing factor)
Customer's Gas Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>H₂O Dewpoint Spec</td>
<td>15 Degrees C</td>
<td>15 Degrees C</td>
</tr>
<tr>
<td>HC Dewpoint</td>
<td>15 Degrees C</td>
<td>15 Degrees C</td>
</tr>
<tr>
<td>Delivery Pressure</td>
<td>45 - 60 barg</td>
<td>45 - 60 barg</td>
</tr>
<tr>
<td>Delivery Temperature</td>
<td>20 - 50 Deg C</td>
<td>20 - 50 Deg C</td>
</tr>
<tr>
<td>Gross Heating Value</td>
<td>37.6 MJ/sm³ (1010 BTU/scf)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Composition</th>
<th>Min %</th>
<th>Max %</th>
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<tbody>
<tr>
<td>C₁</td>
<td>86</td>
<td>97</td>
</tr>
<tr>
<td>C₂</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C₃</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>C₄</td>
<td>0.1</td>
<td>1.5</td>
</tr>
<tr>
<td>C₅</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>C₆⁺</td>
<td>0.2</td>
<td>1</td>
</tr>
<tr>
<td>Total Inert</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>CO₂</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>H₂S</td>
<td>6 ppm</td>
<td>6 ppm</td>
</tr>
<tr>
<td>Total Sulfur</td>
<td>9 ppm</td>
<td>9 ppm</td>
</tr>
<tr>
<td>Particles</td>
<td>10 Micron</td>
<td>10 Micron</td>
</tr>
</tbody>
</table>
So to meet the specs, we need to do the following:

- **Customer requirements:**
  - Delivery P and T.
  - Composition.
  - Energy content.
  - When and Where.

- **Handling requirements:**
  - HSE.
  - Transport & Logistical.
  - Legislation.

Thus we must:

- Dehydrate.
- Compress.
- Sweeten.
- Remove CO2.
- Recover liquids.
- Store.
- Fractionate.
- etc…. 
ROLE OF FACILITIES ENGINEER

Facilities Engineers’ role is to plan, design, construct and maintain the surface facilities required directly or indirectly for hydrocarbon prospecting, production and evacuation. It covers both Oil & Gas and Non Oil and Gas facilities eg

Oil and Gas Infrastructures:

- Flowstations
- Gasplants
- Flowlines /pipelines with manifolds.
- Terminals, including tanks, CLPs, SPMs, etc

Non oil & Gas infrastructures:

- Roads and hardstands, Drilling Locations for land rigs, Dredging slots for swamp rigs, Jetties and quaywalls, Helipads and runways, Office and residential buildings, etc.
• **ROLE OF FACILITIES ENGINEER**
  FE roles span the entire phases

![Diagram showing the roles of facilities engineer across different phases: Identify, Assess, Select, Define, Execute, Operate. Each phase is divided into Divergent and Convergent Thinking sections with specific tasks and considerations.](image)
Concept Selection, Basis for Design & Project Specifications

Fig 2

- Concept Selection Report(s)
- Basic Design Premise Data
- Design Proposal Review/Report
- Field Development Plan
- Operations Philosophy
- Preliminary Project Execution Plan
- Preliminary Asset Reference Plan
- Preliminary Project Schedule

Inputs to the BFD

Project Basis for Design (specifies design intent)

Output from the BFD

Project Specification
(specifies how design intent will be achieved)
- design details
- engineering details
- procedures and project requirements
- cost estimates
- schedules

ORP Phase 1 and 2

ORP Phase 3

Project Specification in relation to the Basis for Design
Development of the Project Specification

Fig 3

Engineering Design Information

- Basis for Design
- Equipment List
- Heat and Mass Balance
- Materials Selection
- Major Equipment
- Layouts Equipment Arrangements MTO

- Pipelines Routing Sizing
- Electrical Routing Sizing
- Mechanical Routing Sizing
- Control and Instruments
- Civils and Structural
- Other disciplines

- Philosophies Functional Specs
- HSEQ Requirements Procedures
- Manpower and service estimates

- Capex estimate
- Opex estimate
- Planning and Schedules
- Production Profile

Long Lead Items

Input to economic analysis

VAR 4 and ITT
Typical Construction Sites
A Team work, various disciplines

Surface Engineering Team

- Process
- Piping
- Lay-out
- Materials
- Instrument
- Procurement
- Rotating Equipment
- Electrical
- Mech Eng
Vapour / Liquid Separation

Dehydration

De-Oiling

Well Stream

Gas Treatment

Gas

Oil

Water

A Modular Approach
Typical Standard Flowstation

Well Stream -> HP Separator 11 Bara -> Gas Treatment

Well Stream -> LP Separator 4 bara -> Oil + Water

Gas
Associated Gas Plant Design

GAS Plant

11 bara

4 bara

95 bar
Associated Gas Plant

Compression

Dehydration
Typical NAG Plant

DEG injection

LTS

Gas to Customer

Fuel & Flare

DEG Regen.

LTS

Liquids to flowstation

wells

120 bar

twister

120 bar
WATER INJECTION SCHEMES

1. At the terminal

2. At the flowstation

Less water in the production and flowlines frees up more capacity for oil

3. At the wellhead

4. In well

Water injection wells
TYPICAL ONSHORE WATER TREATMENT SCHEME

1. **FROM WELLS**
   - Corrugated Plate Interceptor
   - Skimmed Oil to Export Tanks
   - Continuous Dehydration Tank
   - Crude to Final Settling and Export Tanks

2. **GAS FLOTATION VESSEL**
   - Blanket Gas
   - LP Flare
   - Skimmed Oil to Export Tanks
   - To PWRI

3. **HOLDING BASIN**
   - Holding Basin
   - Clean Water Disposal
Typical Land Flowstation
Typical Swamp Flowstation
Typical Swamp Flowstation
Typical Offshore Wellhead Jacket
Typical Land Pipeline

ROW through forest
Typical Pipeline Manifold

PL Manifold in Village
Typical Gas Plant
Typical Offshore Platform
Rules of Thumb for Major Projects:

Costs:
- A 60,000 bbl/d Flowstation costs 30 Mln US$
- A 100 mmscfd AG plant costs 100 mln US$

Manpower for a 100 Mln $ Project:
- During FDP you need One Multidiscipline Facilities Engineer
- During Conceptual Design (FEED) you need 5 Facilities Engineers
- For Detailed Design of a 100 mln $ plant a Contractor needs 100 Designers
- For Construction of a 100 mln US$ plant I need 1000 Construction staff (on land)

- A 30 MW Power Generator consumes 10 MMscfd Fuelgas
Regulations & Standards

STANDARDS:
- NATIONAL
- COMPANY STANDARDS
- INDUSTRY STANDARDS

- Summary of bad experiences & good practices.
- Important to understand and use them
- Establish a Technical Change Control system to manage deviations.
### SOME KEY EXTERNAL APPROVALS REQUIRED

<table>
<thead>
<tr>
<th>Approval, license or Permit type</th>
<th>Responsible External Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Awards</td>
<td>NAPIMS</td>
</tr>
<tr>
<td>Annual JV Budget and Expenditure</td>
<td>NAPIMS</td>
</tr>
<tr>
<td>Asset Development Plan / Field Development Plan</td>
<td>DPR</td>
</tr>
<tr>
<td>Environment Impact Assessment</td>
<td>Department of Petroleum Resources (DPR), Federal Ministry of the Environmental (FMENV)</td>
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<tr>
<td>Permit to survey</td>
<td>DPR</td>
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<tr>
<td>Co-ordinates of Marine structures</td>
<td>DPR obtains clearances from other agencies</td>
</tr>
<tr>
<td>Road crossings</td>
<td>(Federal) Ministry of Transport</td>
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<tr>
<td>River Crossings</td>
<td>(Federal) Ministry of Transport and In-Land Waterways</td>
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<tr>
<td>Permit to Dredge</td>
<td>(Federal) Ministry of Transport and In-Land Waterways</td>
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<tr>
<td>Oil Pipeline License</td>
<td>DPR</td>
</tr>
<tr>
<td>Conceptual Design</td>
<td>DPR</td>
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<tr>
<td>Detailed Design / Start of Fabrication and Construction</td>
<td>DPR</td>
</tr>
<tr>
<td>Fabrication of Construction stages</td>
<td>DPR, (DPR Procedure Guide needs clarification)</td>
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<tr>
<td>Start of Commissioning</td>
<td>DPR</td>
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<tr>
<td>Start Up</td>
<td>DPR</td>
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<tr>
<td>Hydrocarbon Custody Transfer Metering Facilities</td>
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<tr>
<td>Tank Calibration</td>
<td>DPR</td>
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<tr>
<td>Permit to generate own power</td>
<td>(Federal) Ministry of Mines and Power/NEPA PLC</td>
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</table>
Why must we follow standards?

Because we want to prevent major incidents like these.
THANK YOU FOR LISTENING

DISCUSSIONS