Outlook of Heavy Crude Oil in Arab Countries: Challenges & Opportunities

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1. OAPEC in brief
2. Objectives of the presentation
3. Definitions and characteristics of heavy crude oils.
4. Heavy oil Resources and Production in the Arab Countries
5. Major heavy oil projects in the Arab Countries.
6. Challenges of processing heavy crude oils.
7. Factors affecting the selection of heavy crude oil processing scheme.
8. Drivers behind upgrading and refining heavy crudes in Arab countries.
9. Conclusions and recommendations
1. To review the statistics of heavy oil resources and production in the Arab Countries

2. To highlight major heavy oil exploitation projects in the Arab Countries

3. To briefly explain simple and complex refineries

4. To demonstrate why and when refineries in the Arab Countries are required to be upgraded.
The Organization of Arab Petroleum Exporting Countries (OAPEC)
The Organization of Arab Petroleum Exporting Countries (OAPEC) in Brief

The Organization of Arab Petroleum Exporting Countries (OAPEC) is a regional inter-governmental organization.

**Member Countries**
- Algeria
- Bahrain
- Egypt
- Iraq
- Kuwait
- Libya
- Qatar
- Saudi Arabia
- Syria
- Tunisia (Frozen)
- United Arab Emirates

**Founded in 1968**

**Domiciled in Kuwait**
The Organization of Arab Petroleum Exporting Countries (OAPEC) in Brief

The Organization carries out its functions and responsibilities through the following four organs:

- Ministerial Council
- Executive Bureau
- General Secretariat
- Judicial Tribunal
The General Secretariat is composed of the following:

- **The Secretary General’s Office**
  The General Secretariat is headed by the Secretary General who carries out the tasks assigned to him by the Council.

- **The Arab Center for Energy Studies:**
  The Technical and the Economics Departments, together, comprise the Arab Center for Energy Studies, whose formation was called for by the Council of Ministers in 1982.

- **The Information and Library Department**

- **Finance and Administrative Affairs Department**
Definitions

• Light Oil: Oil with > ~25° API gravity
• Medium Oil: Oil with API gravity of ~20-25°API
• Heavy Oil: Oil with API gravity between 10 and 20° API (viscosity 1,000-5,000 cP)
• Extra Heavy Oil or Natural Bitumen:
  – Oil with API gravity less than 10° and viscosity is commonly between 5,000 to 10,000 cP.
• In short, heavy oil is defined as any type of crude oil that does not flow easily
• Resources means original oil in place
Definitions of Heavy Crude Oil and Bitumen

- **Heavy oil**
  - API Gravity: 10°
  - Viscosity at reservoir conditions: <10,000 cp

- **Extra-heavy oil**
  - API Gravity: 22°
  - Viscosity at reservoir conditions: >10,000 cp

- **Conventional**
- **Unconventional**
- Based on the economic developments in 2011-2012, oil demand continues to be moderate and will remain so over the short term. However, over the medium and long term oil demand growth will resume to fulfill the needs of developing non-OECD countries, especially China, India, Russia and Brazil. On this basis,

Heavy crude oil volume growth is robust.

- Currently, 85% of heavy oil production is from conventional sources; by 2030, 50% will come from unconventional sources.

- The highest growth will come from the Canadian oil sands

- A second major source of supply growth is the Orinoco extra-heavy crude oil from Venezuela.

Source: Heavy Crude Oil: A Global Analysis and Outlook to 2035 (Hart Energy, 2012)
- The Middle East has several giant underdeveloped heavy oil fields and it assumes to begin producing before 2020; this region will experience the highest heavy oil production growth in percentage terms (11% per year through 2025).

- Africa will continue to develop heavy oil through 2025, while in Europe, Russia and Central Asia the heavy crude oil production will slowly decline.

- The heavy crude oil will be traded globally; it enters the export market in all regions through 2025, after which it goes to zero in Asia-Pacific and declines from all regions except North America and South America.

- Conventional heavy crudes and unconventional extra-heavy crudes and bitumen will be a significant source of future liquid supplies over the next 25 years.
Characteristics of Heavy Crude Oil

Viscosity (CP)

Light Crude

Heavy Crude

Extra Heavy Oil (Tar Sand Oil & Bitumen)

Gravity, °API

Density @ 15°C > 0.993 or API gravity < 20

High Viscosity (100 to 10,000 CP)
Characteristics of Heavy Crude Oil

Sulfur content, wt%:

<table>
<thead>
<tr>
<th>Type</th>
<th>Sulfur Content, wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>0</td>
</tr>
<tr>
<td>Light Sour</td>
<td>0.5</td>
</tr>
<tr>
<td>Medium Sweet</td>
<td>1.0</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>1.0</td>
</tr>
<tr>
<td>Heavy Sweet</td>
<td>60</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>10</td>
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</table>

Gravity, °API:

<table>
<thead>
<tr>
<th>Type</th>
<th>Gravity, °API</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>0.5</td>
</tr>
<tr>
<td>Light Sour</td>
<td>1.0</td>
</tr>
<tr>
<td>Medium Sweet</td>
<td>26</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>26</td>
</tr>
<tr>
<td>Heavy Sweet</td>
<td>35</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>10</td>
</tr>
</tbody>
</table>

Comparison of Typical Crude Oil Assays

Crude Oil Assays

<table>
<thead>
<tr>
<th></th>
<th>Light</th>
<th>Medium</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light end</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Gasoline</td>
<td>30</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>Middle distillate</td>
<td>34</td>
<td>26</td>
<td>22</td>
</tr>
<tr>
<td>Residue</td>
<td>33</td>
<td>50</td>
<td>63</td>
</tr>
</tbody>
</table>

Comparison of Typical Heavy Crude Oils

°API Gravity and Sulfur Levels of Some Crude Oils

°API

- °API
- Sulfur wt%

Hassi Messaoud, Algeria
Bu Attifel, Libya
Basra, Iraq
Arab Light, S. Arabia
Arab Medium, S. Arabia
Ratawi/Burgan, Kuwait

°API gravity and Asphaltene levels of some crude oils

- Basra, Iraq
- Kuwait
- Ratawi/Burgan, Kuwait
- Eocene, Kuwait

World Crude Oil Production by Quality 1995-2010 (Thousand B/D)

Source: WOGR, Eni, 2011
The average quality of crude oil is getting worse

Source: WOO,opec,2011
Development of Crude Oil Production by Quality in Arab Countries (1000 B/D)

Source: WOGR, Eni, 2011
Despite of the increase in light crude share in Arab countries during the last two decades, the share of heavy crude oil production increased from 1% to 3% of the total oil production.
Development of Crude Oil Production by Quality in OAPEC’s M.C (1000 B/D)

- Algeria
- Egypt
- Iraq
- Kuwait
- Libya
- Qatar
- Saudi Arabia
- Syria
- UAE
- D. Zone

- Light API>35
- Medium API 26-35
- Heavy API<26

## Heavy Oil Resources & Daily Heavy Oil Production in the Arab Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Discovered Resources (Bn Bbl)</th>
<th>Daily Production (KBbl/d)</th>
<th>API (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iraq</td>
<td>447</td>
<td>65</td>
<td>16-22</td>
</tr>
<tr>
<td>Kuwait</td>
<td>190</td>
<td>60</td>
<td>14-20</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>190</td>
<td>40</td>
<td>14-19</td>
</tr>
<tr>
<td>Neutral Zone</td>
<td></td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>25</td>
<td>72</td>
<td>12-20</td>
</tr>
<tr>
<td>Oman (not OAPEC)</td>
<td>25</td>
<td>135</td>
<td>10-19</td>
</tr>
<tr>
<td>Syria</td>
<td>14</td>
<td>20</td>
<td>15-20</td>
</tr>
<tr>
<td>Bahrain</td>
<td>2</td>
<td></td>
<td>8-14</td>
</tr>
<tr>
<td>UAE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algeria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qatar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Schlumberger, UXGS, World Energy Council
Partitioned Neutral Zone (Kuwait and KSA):

Heavy oil is producing in Wafra field through thermal methods.

• The challenges to implement the plan are: finding energy (gas) and fresh water to generate steam.

Source: Hamid Majid, Canadian Natural Resources Limited, Calgary, Alberta, Canada.
Oman

1. Mukhaizna field: utilizing a modified SAGD method with vertical steam injectors around horizontal producers. The field produces about 120,000 bbl/d (2012).
2. PDO at Marmul field (90 cP viscosity) using a small polymer flood
3. PDO at Harweel field, is injecting miscible sour gas to enhance recovery
4. PDO at Qarn Alam, is utilizing steam injection to improve production of 16 API
Kuwait:

- KOC is focused on developing its extensive heavy oil resources of sandstone host rock at Ratqa field. KOC’s plan is to produce 60,000 bbl/d by 2013 and then to increase it to 170,000 bbl/d. Currently Kuwait producing heavy oil through primary recovery methods.

- Kuwait has been trying to exploit its heavy oil since middle of 1980s. So far no heavy oil production exists except through primary recovery.

Egypt:

- At Issaran Field, heavy Oil 10-12 API: producing from carbonate and sandstone host rocks utilizing Cyclic Steam Stimulation where sufficient fracturing exists to distribute the steam within the host rocks.

- Egypt produces about 70,000 bbl/d heavy oil mainly on primary recovery method.
**Syria:**

- Syrian Petroleum Company is producing about 20,000 bbl/d of 15-20 API. Some of the production utilizes steam injection.
  - i.e.: Oudeh, Tishrine oil fields are on Cyclic Steam Stimulation. Tanganyika Oil implemented CSS pilot study in 2004. After the steam injection, the production in both fields increased to 3,500 bbl/d from 1,400 bbl/d. Presently, CNPC is continuing the project.

**Bahrain:**

- is planning to exploit the heavy oil reserves of the Awali oil field. The steam injection trial commenced in 2012.
Iraq:

• Most of the heavy oil production (60,000 bbl/d) is by primary recovery. No thermal or any other techniques are utilized.

Other OAPEC members

• Libya, Qatar, Algeria, Tunisia and UAE do not have economic amounts of heavy oil resources for consideration.
Increase in the refinery operating costs

Processing heavy crude oil requires upgrading the refinery metallurgy to handle high acid crude oils.

Relationship of corrosion rate and crude sulfur content
High contents of Asphaltenes enhance the potential for fouling of heat exchangers and reactors.
The heavier feedstock require substantially more hydrogen to produce products with a limited amount of sulfur.
Catalysts Deactivation

Metals such as Nickel and Vanadium in the heavy crude deactivate the hydroprocessing catalysts.
Challenges to dehydration and desalting technologies
Environmental challenges, due to the increase in air emissions, water use and solid wastes.
Options for Upgrading Heavy Crudes

1. Selling directly to refineries that can handle heavy crude oils
2. Diluting with a lighter crude to create a higher quality crude
3. Upgrading to create a higher quality crude
4. Producing high quality finished products
Options for Upgrading Heavy Crudes

Heavy crudes

- Diluents
  - Natural gas
  - Boiler
    - Steam
  - Extractor
    - Steam methane reformer
      - Water
      - Hydrogen
  - CDU/VDU/HDS/RHCU/DCU
    - Synthetic diluent
      - Blender
        - Blender
          - Different grade of synthetic crude
Factors Affecting the Selection of Upgrading and Refining Scheme

• Location, logistics and utilities availability.

• Available and proven technology at the time of decision.

• Market demand for the petroleum products quality.

• Possible integration between partial upgrading on site and refining.

• Economics consideration.
Incentives for OAPEC Refiners to Process Heavy Crudes

- Turn low-quality crude oil into valuable clean products.

- Produce higher value by products like paraffin oils.

- Achieve higher refining margins.
Projected Refineries in OAPEC Member Countries for Processing Heavy Crudes

- Deir Alzor, 140
- Fruglos, 100

- Nasiriya, 300
- Kerbala, 140
- Misan, 150
- Kerkuk, 150
- East Baghdad, 100
- Mina Alzour, 615

- Jubail, 400
- Yasref, 400
- Ras tanoura, 400
- Jazan, 400

- Ain Al-sukhnah, 130
Maximizing Distillates Yield to Meet the Market Demand

Global product demand, 2010 and 2035

Source: WOO, opec, 2011
Conclusions and Recommendations

• There are about 900 B barrels of heavy oil resources in the Arab countries.

• Exploitation of heavy oil in the Arab countries is still in the early stage except in the Neutral Zone of Kuwait and Saudi Arabia as well as Oman.

• High grading, experience/expertise, choice of technique, patience.

• Utilizing the right technology and expertise, heavy oil can be effectively and economically produced in this region particularly, in KSA, Iraq, Kuwait, Egypt, Oman and Syria.

• Due to future environmental regulations, Arab countries need to upgrade their refineries to refine the heavier fuel oil products outputs.

• Feasibility studies to determine economics of processing heavy oil in the Arab countries should be initiated.

• NOCs of the Arab Countries should consider utilizing the expertise and proven experience of International Oil companies when considering the exploitation and refining of heavy oil resources.
Conclusions

- Refineries worldwide tend to cope with greater quantities of heavy oil as the world is shifting slowly towards sour and heavier oils.

- Processing of heavy crudes pose different challenges for the refiners.

- Advanced technologies help refiners to convert marginal heavy crude into valuable products.

- Refineries with the flexibility to process sour and heavier crude oils will continue to show positive margins.

- Arab countries have decided to upgrade and expand their refineries to maximize its flexibility to process heavier crude oils.
Organization of Arab Petroleum Exporting Countries (OAPEC)

Thanks