Petroleum Refining

Fourth year

Chemical Engineering Department /College of Engineering/Al-Qadissiya University

Husham Al.Tameemi

2015-2016
REFERENCES

TEXT BOOK:


HAND BOOK:

- Internet Sites.
POTROLEUM REFINING SYLLABUS

Curriculum:

1. Introduction
2. Crude oils and their chemical composition
3. Physical and chemical characteristics of crude oil and its products
4. Evaluation of crude oil
5. Preparation of crude oil for refining
6. Crude oil refining
7. Thermal processes
8. Cracking
9. Coking
10. Steam cracking
11. Catalytic processes in oil refineries
12. Catalytic cracking
13. Hydro cracking
14. Desulphurization by hydrogen
15. Reforming
16. Isomerization
17. Polymerization
18. Steam reforming
19. Conventional chemical treatment of refinery products
20. Treatment with sulfuric acid
21. Treatment with earth
22. Lubricating oils
23. Properties and needs
24. Production techniques
25. Removal of asphalt by solvents
26. Extraction by furfural
27. Dewaxing
28. Production of different types of fuels and oil products
29. Gas oil
30. Solvents
31. Car and aero plane gasoline
32. Jet fuel
33. Kerosene
34. Diesel
35. Asphalt
36. Wax

Practical:

37. Density
38. Flash point
39. Viscosity
40. Aniline point
41. Sulfur content
42. Water content
43. Carbon content
44. Salt content
Introduction

Crude oil or (petroleum) is becoming increasingly important in the world, day after day and exceed uses and derive strategic importance of crude oil from two facts:
1. It is being a source of energy.
2. It is being the basic raw material for the chemical industry and the branches of various petrochemical. Exhorts crude oil good position between the different energy sources for the following reasons:
1. Contain many products can be separated from each other by refining and represent a variety of sources in fuel use and production assistant lubrication oils products and asphalt and petroleum solvents, as some of its derivatives important materials in Petrochemical industries.
2. The presence of natural gas with crude oil under the surface of the earth.
3. It can be transferred to long distances easily.
4. Low cost of production, transportation and refining.

Husham Al.Tameemi
Petroleum (Crude Oil)

Introduction:
Petroleum is perhaps the most important substance consumed in modern society. It provides not only raw materials for the ubiquitous plastics and other products but also fuel for energy, industry, heating, and transportation.

Fig.(1) Crude Oil Uses

✅ 98% of the transport market is dependent on oil
✅ EU oil import dependence could reach 90% in 2030

Fig.(2) Different Types of Sources Energy

Husham Al.Tameemi
The word petroleum, derived from the Latin petra and oleum, literally means rock oil and refers to hydrocarbons that occur widely in the sedimentary rocks in the form of gases, liquids, semisolids, or solids. From a chemical standpoint, petroleum is an extremely complex mixture of hydrocarbon compounds, usually with minor amounts of nitrogen-, oxygen-, and sulfur-containing compounds, as well as trace amounts of metal-containing compounds.

There are two theories on the origin of carbon fuels: the abiogenic theory and the biogenic theory (Kenney et al., 2001, 2002). The two theories have been intensely debated since the 1860s, shortly after the discovery of widespread occurrence of petroleum.

Husham Al.Tameemi
Abiogenic Origin

There have been several attempts at formulating theories that describe the detail of the origin of petroleum, of which the early postulates started with inorganic substances as source material. For example, in 1866, Berthelot considered acetylene the basic material and crude oil constituents were produced from acetylene. Initially, inorganic carbides were formed by the action of alkali metals on carbonates after which acetylene was produced by the reaction of the carbides with water.

Biogenic Origin

Petroleum is a naturally occurring hydrocarbon mixture but hydrocarbons that are synthesized by living organisms usually account for less than 20% of the petroleum (Hunt, 1996). The remainder of the hydrocarbons in petroleum is produced by a variety of processes that converts other organic material to hydrocarbons as part of the maturation processes generally referred to as diagenesis, catagenesis, and metagenesis. These three processes are a combination of bacteriological action and low-temperature reactions that convert the source material into petroleum. During these processes, migration of the liquid products from the source sediment to the reservoir rock may also occur.

Most geologists view crude oil and natural gas as the products of compression and heating of ancient vegetation over geologic timescales. According to this theory, it is formed from the decayed remains of prehistoric marine animals and terrestrial plants. Over many centuries this organic matter, mixed with mud, was buried under thick sedimentary layers of material. The resulting high levels of heat and pressure cause the remains to metamorphose, first into a waxy material known as kerogen and then into liquid and gaseous hydrocarbons in a process known as catagenesis. These then migrate through adjacent rock layers until they become trapped underground in

Husham Al.Tameemi
porous rocks called reservoirs, forming an oilfield, from which the liquid can be extracted by drilling and pumping.

Fig.(4) Biogenic Origin of crude oil
Petroleum Refining (Petroleum Purification):

Petroleum refining plays an important role in our lives. Most transportation vehicles are powered by refined products such as gasoline, diesel, aviation turbine kerosene (ATK) and fuel oil. The recent price rise of crude oil from $50 to $150 per bbl over the last 2 years has affected the refining industry in three ways: **First** is an increased search for fuel products from non-fossil sources such as biodiesel and alcohols from vegetable sources. **Second** is the development of better methods to process tar sand, coal gasification and synthesis of fuels by Fischer–Tropsch (FT) technology and **Third** is the initiation of long-term plans to look for renewable energy sources. However, crude oil prices are still a cheap source for transportation fuels and petrochemicals.

**petroleum refining** is the separation of petroleum into fractions and the subsequent treating of these fractions to yield marketable products. In fact, a refinery is essentially a group of manufacturing plants that vary in number with the variety of products produced (Figure 7). Refinery processes must be selected and products

Husham Al.Tameemi
manufactured to give a balanced operation in which petroleum is converted into a variety of products in amounts that are in accord with the demand for each. For example, the manufacture of products from the lower-boiling portion of petroleum automatically produces a certain amount of higher-boiling components. If the latter cannot be sold as, say, heavy fuel oil, these products will accumulate until refinery storage facilities are full. To prevent the occurrence of such a situation, the refinery must be flexible and be able to change operations as needed. This usually means more processes: thermal processes to change an excess of heavy fuel oil into more gasoline with coke as the residual product, or a vacuum distillation process to separate the heavy oil into lubricating oil stocks and asphalt.

Fig.(6) Simplified form illustrates the process of converting crude oil into products

Husham Al.Tameemi
Fig. (7) the process of converting crude oil into petroleum Products in details

Husham Al.Tameemi
History of World Refineries:

- Old human was used of oil to prehistoric times, where used by the Sumerians and Babylonians in Mesopotamia and raised the oil has been found in other places in the world and in the eastern Mediterranean Sea and the Dead sea was known asphalt lake, which dates back to the term asphalt.

- The discovery of oil due to the presence of petroleum reservoirs close to the surface of the earth, which was liberated them vapors and erupt into flames, which was called (fire timeless) and serve them were some of the doctrines of Zoroastrianism.

- In 1859, Drake was drilled in the state of Pennsylvania in the United States the first well in search of oil at a depth of 21.11 meters, and petrol is found in general at different depths ranging between 20-20 thousand meters.

- The first refinery was built in 1860 in the United States a cost of $ 15000.

- Historically the first distillation of Petroleum took place in Russia in 1735 AD.
التقطير المستمر (Batch Distillation) 
- المصافي الأولية كانت تستخدم نظام التقطير (على شكل وجبات).
- في بدايات عام 1860م تم استخدام نظام التقطير المستمر، وقد استمر تطوير طريق الإنتاج المستمر وقد سجل بصورة واسعة استخدام وحدات الإنتاج المستمر عام 1912م.
- حاليا و حدات الإنتاج المستخدمة جميعها تعمل بطريقة التقطير المستمر.

التكسير الحراري (Thermal Cracking) 
- يقصد بالتكسير الحراري في مجال تكنولوجية البترول استخدام الحرارة وحدها أو مع وجود عوامل مساعدة معينة لتغير مكونات البترول وآسر الأواصر للحصول على مكونات جديدة.
- أول تسجيل لعملية التكسير الحراري عام 1861م.

التقطير التجزئي (Fractionation) 
- يقصد بها عملية فصل المزيج السائل إلى عدد من النواتج لها مدى غليان ضيق.
- في المصافي الأولية كانت عملية الفصل تتم بعد من عمليات التقطير المتعاقبة.
- لاحقا حدث تطور في طريقه الإنتاج حيث استخدمت أبراج تقطير تعمل فيها يتم استخدام عملية التكثيف الجزئي 使用 (Partial Condensation) باستخدام المكثفات لتكتيف خليط البخار بدرجات حرارة مختلفة.

العمليات الكيميائية (Chemical Processing) 
- عام 1927م تم تطوير طريقه الهدارجة وهي عبارة عن عملية تكسير حراري في ضغوط عالية بوجود الهيدروجين.
- عام 1937م هودري استخدم العامل المساعد في هذه الطريقة (سيليكات الألمنيوم).
Petroleum Refineries in Iraq (General View)

**Current Companies of Refining:**

1. **North Refineries company**: it represent largest company for petroleum refining in Iraq:
   A. Establishing Date: **1976**
   B. Current Capacity: **402000 Bbl./day**
   C. No. of Refineries and other units:
      - **Large Refineries**: *(Baggy Refinery)*
        - **North Refinery** with capacity: 170000 Bbl./day
        - **Salahaldeen1 Refinery** with capacity: 70000 Bbl./day
        - **Salahaldeen2 Refinery** with capacity: 170000 Bbl./day
        - **Oils Refinery** with capacity: 125000 ton/year for different types of oils.
        - **Factory production and mobilization of metal drums**
          1100 Drum/h (200 lit.)
        - **Factory production and mobilization of plastic cans**
          1250 Can/h (5 lit.), 1000 Can/h (1 lit.)
      - **Small Refineries**
        - **Kirkuk Refinery** with capacity: 30000 Bbl./day
        - **Asseeniay Refinery** with capacity: 20000 Bbl./day
        - **Alkisk Refinery** with capacity: 10000 Bbl./day
        - **Hadeethah Refinery** with capacity: 16000 Bbl./day
        - **Algiarah Refinery** with capacity: 16000 Bbl./day

D. The company produces various types of products such as **unleaded gasoline**, jet fuel, kerosene, gas oil and black oil for export and various types of oils, such as motor oil, gasoline and motor oil for diesel and oils Sewing Machines and Transformers products, asphalt, sulfur, fuel gas and liquid gas ... etc..
2. **Midland Refineries Company**: it represent oldest company for petroleum refining in Iraq:

   E. Establishing Date: **1953**
   F. Current Capacity: **210000 Bbl./day**
   G. No. of Refineries and other units:
      - **Large Refineries**:
        - **Adora Refinery** with capacity: 130000 Bbl./day
        - **Adora Oils Refineries** with capacity: 121000 ton/year for different types of oils.
        - **Other units for nitrogen production** (liquid and gas)
      - **Small Refineries**:
        - **Asimawa Refinery** with capacity: 30000 Bbl./day
        - **Adiwania Refinery** with capacity: 20000 Bbl./day
        - **Annajaf Refinery** with capacity: 30000 Bbl./day

   H. The company produces various types of products such as gasoline, jet fuel, kerosene, gas oil and black oil for export and various types of oils, such as motor oil, gasoline and motor oil for diesel and oils Machines and Transformers products, asphalt, fuel gas and liquid gas ... etc..

3. **South Refineries Company**: it represent smallest company for petroleum refining in Iraq:

   I. Establishing Date: **1998**
   J. Current Capacity: **100000 Bbl./day**
   K. No. of Refineries and other units:
      - **Large Refineries**:
        - **Bassra Refinery** with capacity: 70000 Bbl./day
        - **Oils Refinery** with capacity: 125000 ton/year for different types of oils.
      - **Small Refineries**:
        - **Thi Qar Refinery** with capacity: 10000 Bbl./day
        - **Misan Refinery** with capacity: 10000 Bbl./day
L. The company produces various types of products such as **unleaded gasoline**, jet fuel, kerosene, gas oil and black oil for export and various types of oils, such as motor oil, gasoline and motor oil for diesel.

**Future Refineries:**

![Future refineries in Iraq](image)

An organization consisting of the world's major oil-exporting nations. The Organization of Petroleum Exporting Countries (OPEC) was founded in 1960 to coordinate the petroleum policies of its members, and to provide member states with technical and economic aid. OPEC is a cartel that aims to manage the supply of oil in an effort to set the price of oil on the world market, in order to avoid fluctuations that might affect the economies of both producing and purchasing countries. OPEC membership is open to any country that is a substantial exporter of oil and that shares the ideals of the organization. As of 2011, OPEC had 12 member countries, including founder members Iran, Iraq, Kuwait and Venezuela.
Organization of Arab Petroleum Exporting Countries
"OAPEC"

OAPEC was established in 1968 by Kuwait, Libya and Saudi Arabia. Its other members include: Algeria, Bahrain, Egypt, Iraq, Qatar, Syria, Tunisia and the United Arab Emirates. Although they have several members in common, OAPEC is a separate and distinct entity from OPEC (the Organization of the Petroleum Exporting Countries), the 12-nation cartel that plays a pivotal part in determining global petroleum prices.

An inter-governmental organization based in Kuwait that seeks to foster cooperation among the 11 Arab oil-exporting nations that are its members, and develop their petroleum industry.

تأسست منظمة الدول العربية المصدرة للبترول(أوبك) في عام 1968 من قبل الكويت وليبيا والسعودية. وتشمل أعضاء آخرين: الجزائر، البحرين، مصر، العراق، قطر، سوريا، تونس والإمارات العربية المتحدة. على الرغم من أنها لديهم عدة أعضاء من القواسم المشتركة، أوبك هو كيان مستقل وتمييز عن أوبك (منظمة الدول المصدرة للنفط)، والمنظمة 12 دولة والتي تلعب دورا محوريا في سوق النفط الخام.
# World's Largest Refineries

<table>
<thead>
<tr>
<th>Name of Refinery</th>
<th>Location</th>
<th>Barrels per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamnagar Refinery</td>
<td>Jamnagar, India</td>
<td>1,240,000</td>
</tr>
<tr>
<td>SK Energy</td>
<td>Ulsan, South Korea</td>
<td>1,120,000</td>
</tr>
<tr>
<td>Paraguana Refinery (PDVSA) Complex</td>
<td>Paraguana, Falcon, Venezuela</td>
<td>940,000</td>
</tr>
<tr>
<td>GS Caltex Yeosu Refinery (GS Caltex)</td>
<td>Yeos, South Korea</td>
<td>730,000</td>
</tr>
<tr>
<td>S-Oil Onsan Refinery (S-Oil)</td>
<td>Ulsan, South Korea</td>
<td>670,000</td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>Singapore</td>
<td>605,000</td>
</tr>
<tr>
<td>(Motiva Port Arthur Refinery Enterprises)</td>
<td>Port Arthur, Texas, USA</td>
<td>600,250</td>
</tr>
<tr>
<td>Baytown (ExxonMobil)Refinery</td>
<td>Baytown, TX, USA</td>
<td>560,500</td>
</tr>
<tr>
<td>(Saudi Ras Tanura Refinery Aramco)</td>
<td>Saudi Arabia</td>
<td>550,000</td>
</tr>
<tr>
<td>(Marathon Garyville Refinery Petroleum)</td>
<td>Garyville, LA, USA</td>
<td>522,000</td>
</tr>
<tr>
<td>Baton Rouge (ExxonMobil)Refinery</td>
<td>Baton Rouge, LA, USA</td>
<td>502,500</td>
</tr>
</tbody>
</table>