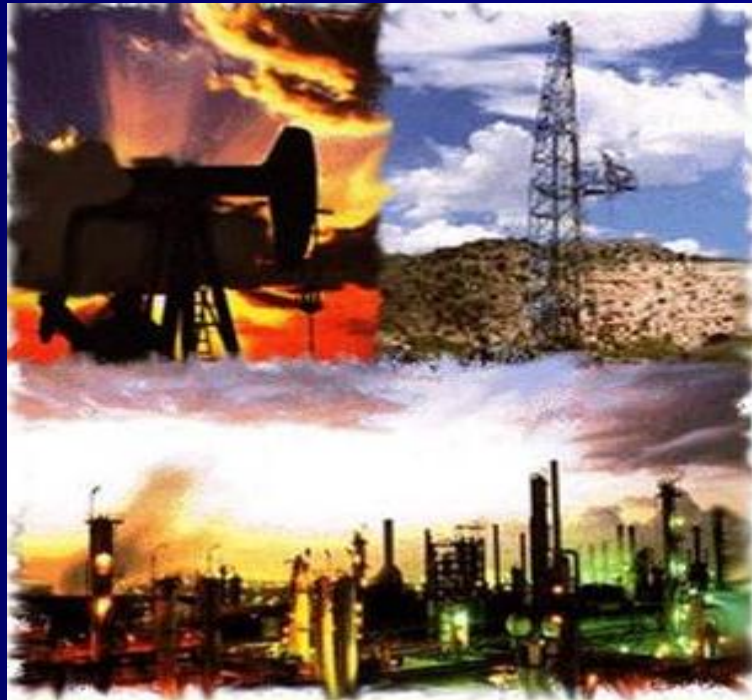


PGE-251

Introduction to Petroleum and Natural Gas Engineering



PGE 251

Introduction to Petroleum Engineering

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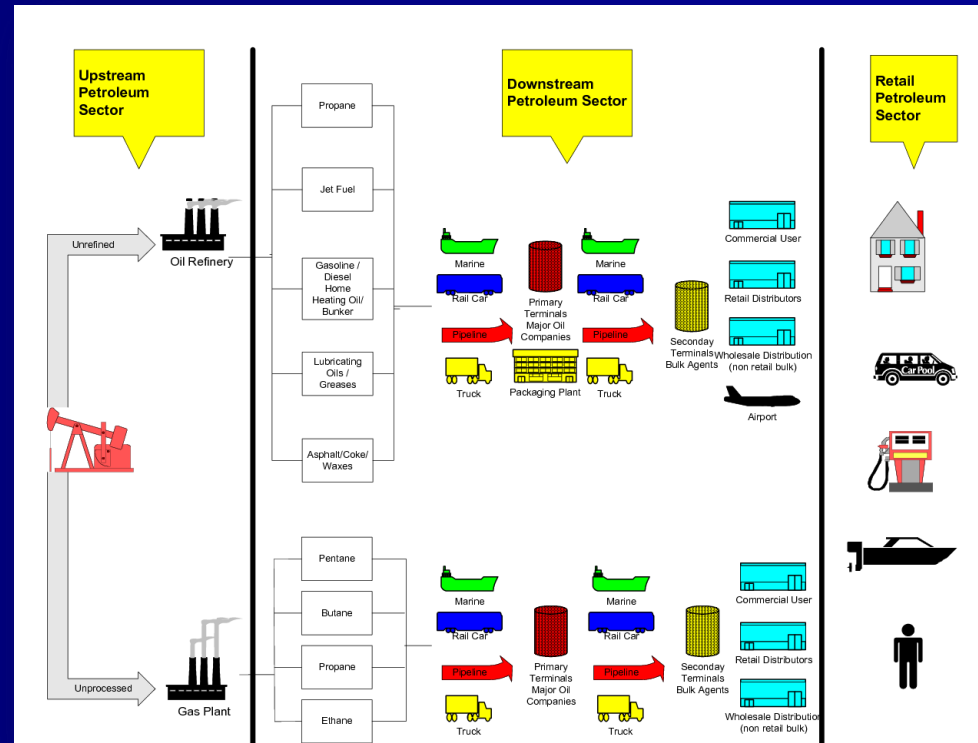
Room # 2B80

0509226831

Chapter One: Background and Objectives

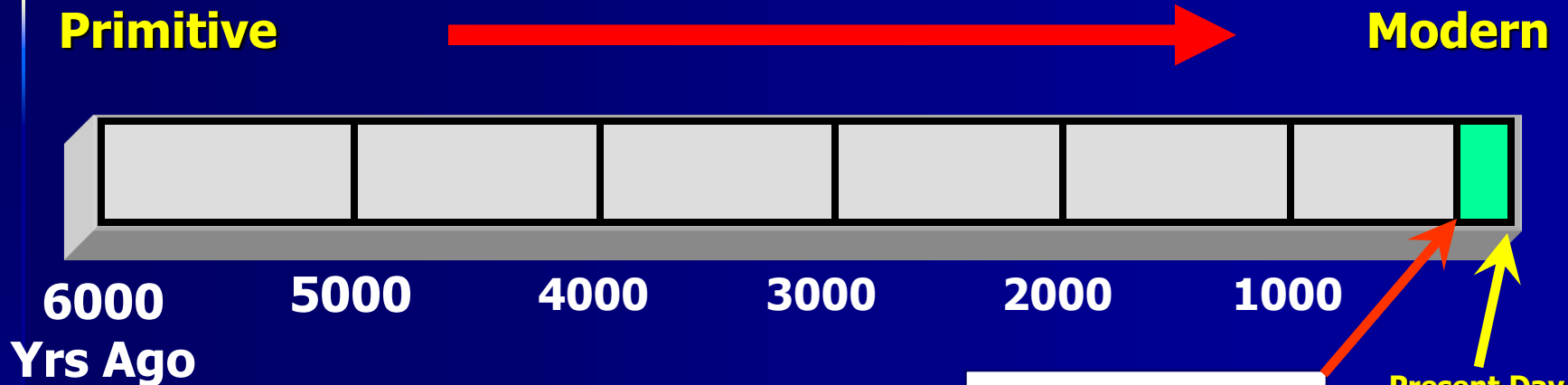
This course provides the student with an extensive knowledge covering all areas of petroleum and natural gas engineering necessary for understanding upstream activities (all the extensive activities preceding shipment of stabilized crude oil or sales gas).

At the end of this course the student will have a complete image about this important engineering field.



Chapter Two: History of Oil and Natural Gas

introduction



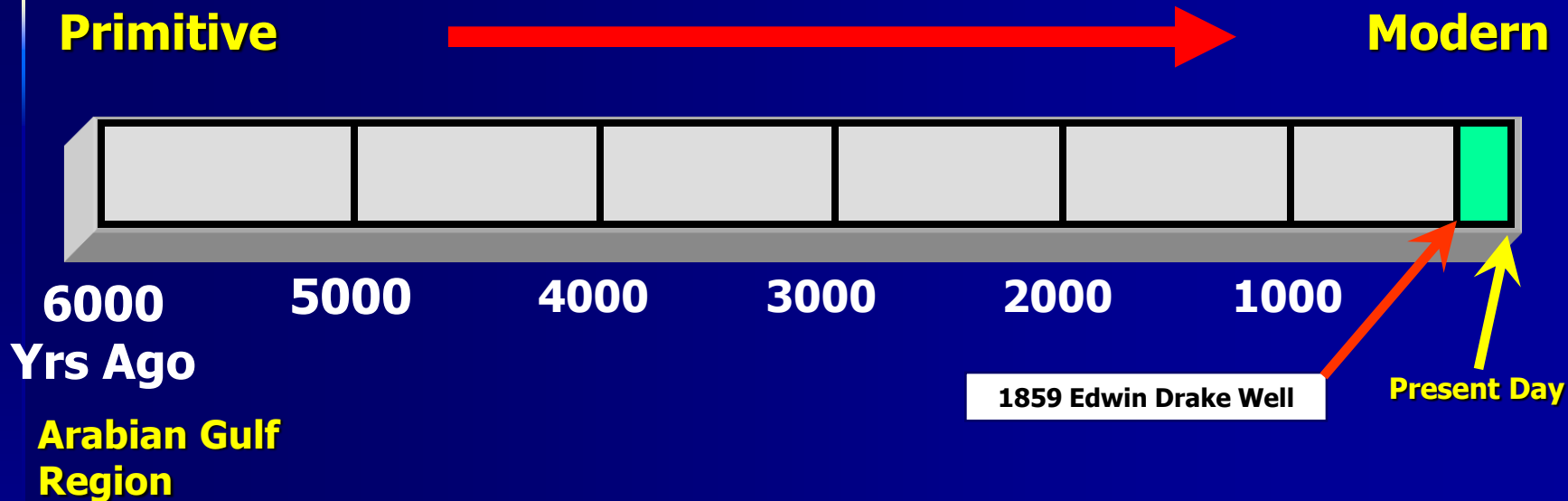
Arabian Gulf Region

The oil industry began at least 6,000 years ago around the Arabian Gulf region, where oil was found flowing slowly to the surface thru natural seeps (it was used as a mortar for construction, a sealant for vessels containing liquids, a medicine & as a lubricant for simple mechanisms).



Chapter Two: History of Oil and Natural Gas

introduction



This primitive industry spread from the Middle East to China, where the discovery of oil came while drilling wells to produce salt water for salt.

About 2,000 years ago, the use of oil was extended in the Middle East with the discovery of petroleum distillation techniques, resulting in many flammable/explosive products – weapons of war.

The “Modern” oil industry began in 1859 in the US when a man named Edwin Drake drilled for oil.

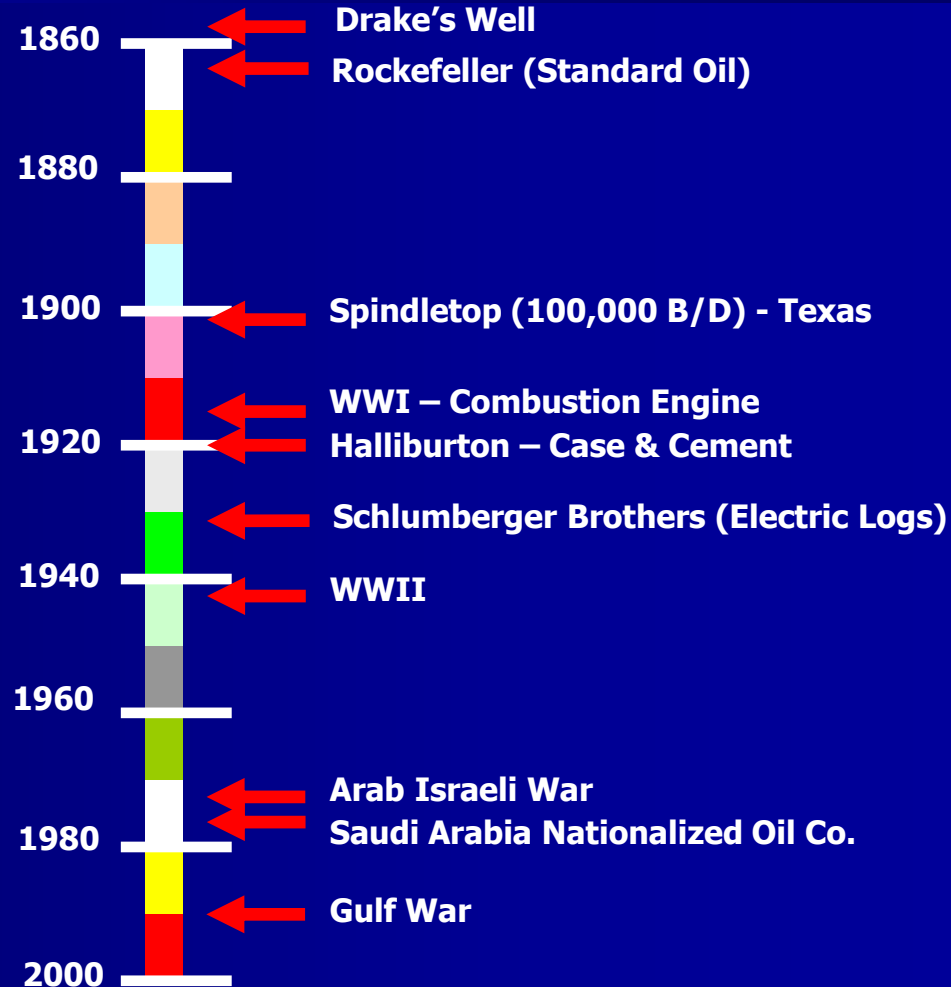
Chapter Two: History of Oil and Natural Gas

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1857 the first oil well was drilled in Bend, northeast of Bucharest, on the Romanian side of the Carpathians.

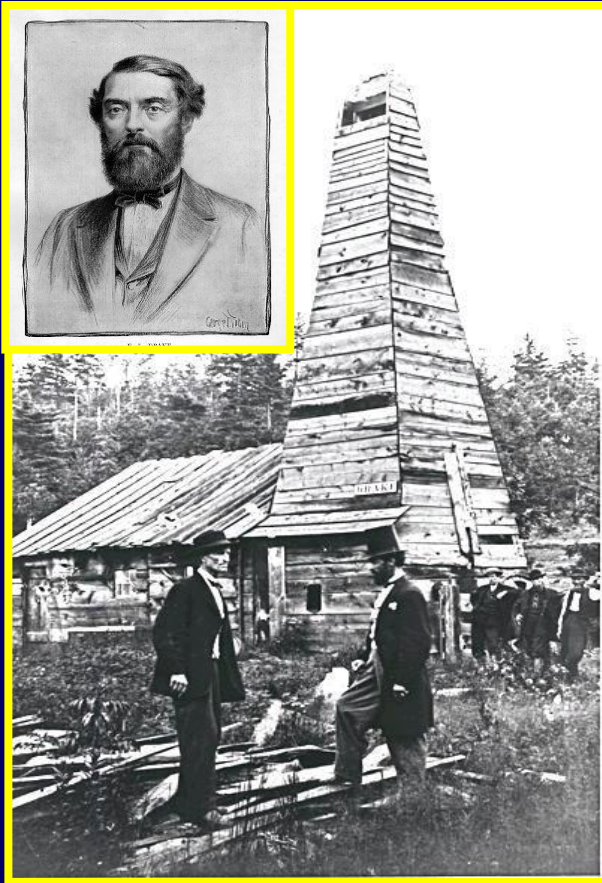
1858, the first oil well in North America was drilled in Ontario, Canada.

1859, Colonel Edwin Drake produced oil from 69 ft below the surface of the ground in Titusville, Pennsylvania.



Chapter Two: History of Oil and Natural Gas

introduction



Col. Edwin Drake

Drilled the first well to mark the beginning of the "modern" oil industry

- Well drilled in 1859
- Pennsylvania (U.S.)
- Depth: 69½ feet
- Rate: 8 BOPD

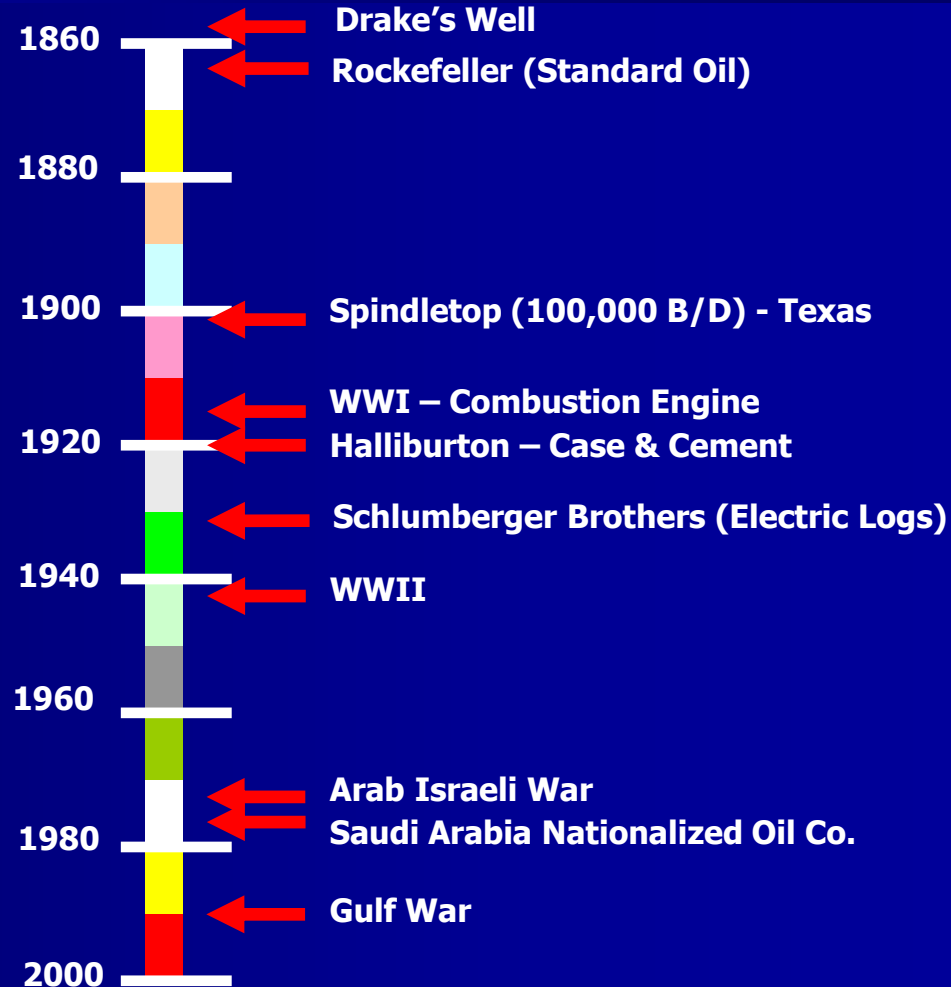
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1878, the first oil well was drilled at Lake Maracaibo in Venezuela.

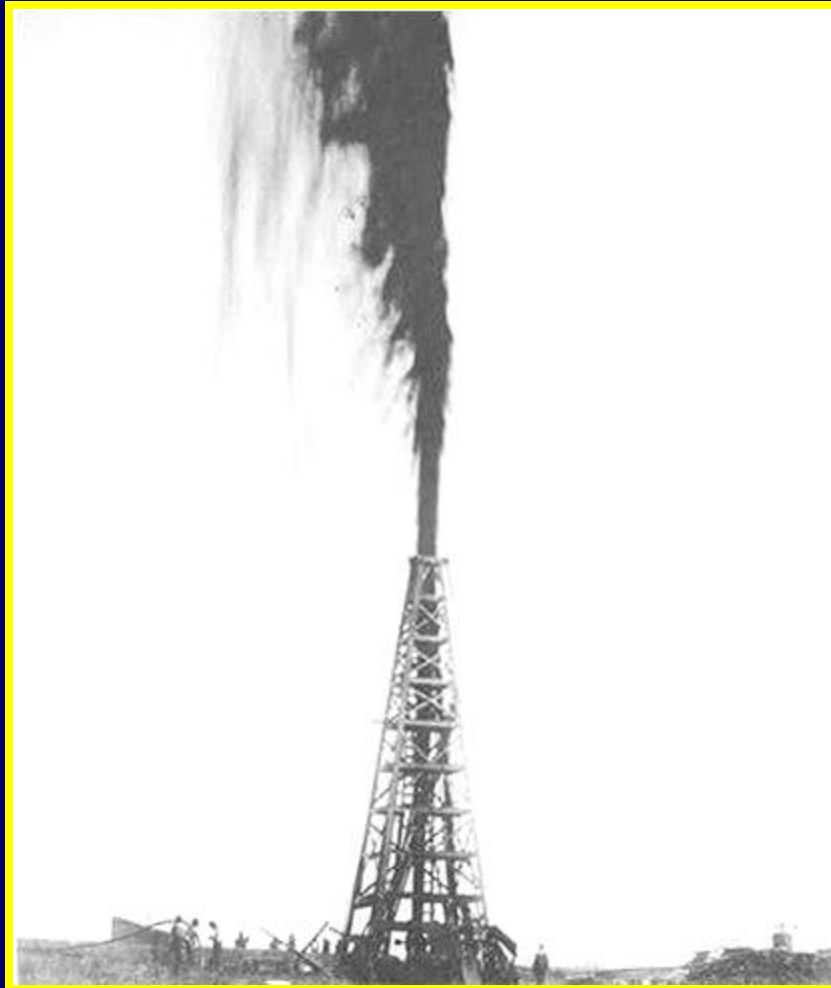
1885, oil was discovered in Sumatra in Indonesia.

1901, Spindletop Discovery Well.



Chapter Two: History of Oil and Natural Gas

introduction



Spindletop Discovery Well

Anthony Lucas drilled the “largest gusher in the history of the oil industry”

- Well drilled in 1901
- Beaumont, Texas (U.S.)
- Depth: $\pm 1,000$ feet
- Rate: 100,000 BOPD

Chapter Two: History of Oil and Natural Gas

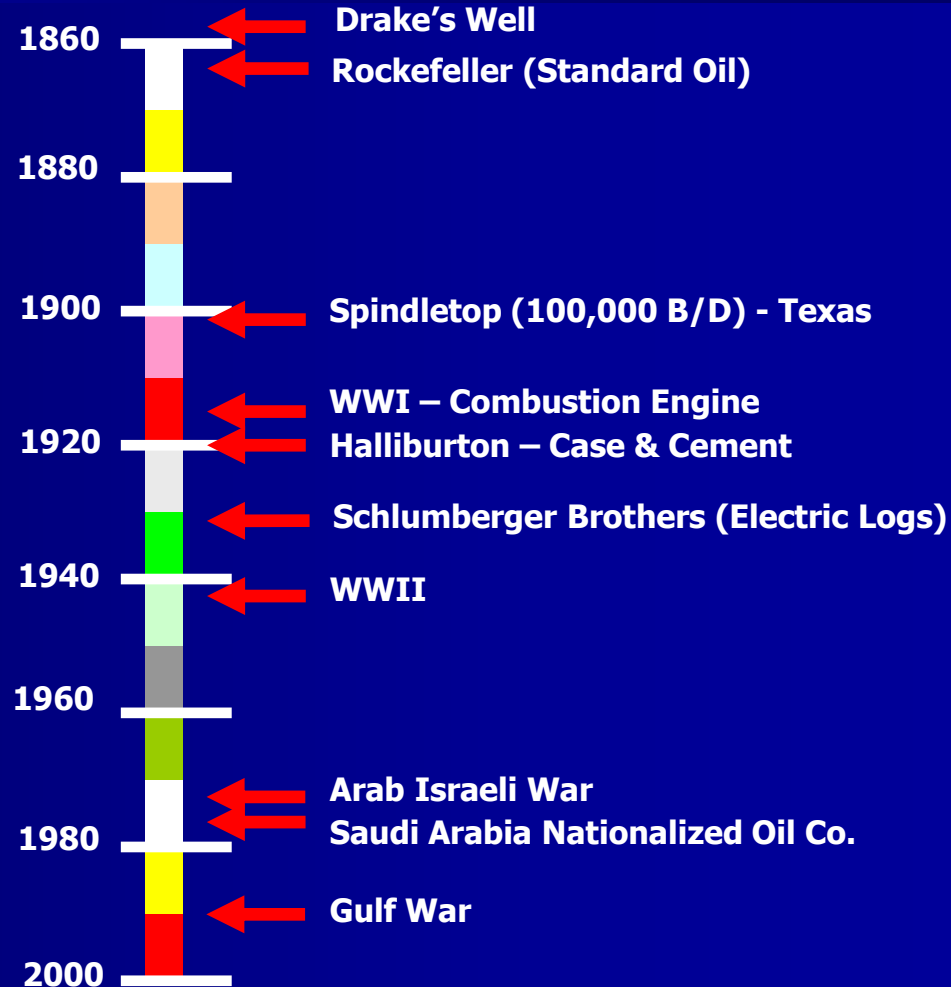
introduction

1908, oil was discovered in Iran.

1910, oil was discovered in Mexico.

1932, oil was discovered in Bahrain.

1938, oil was discovered in Kuwait and Saudi Arabia.



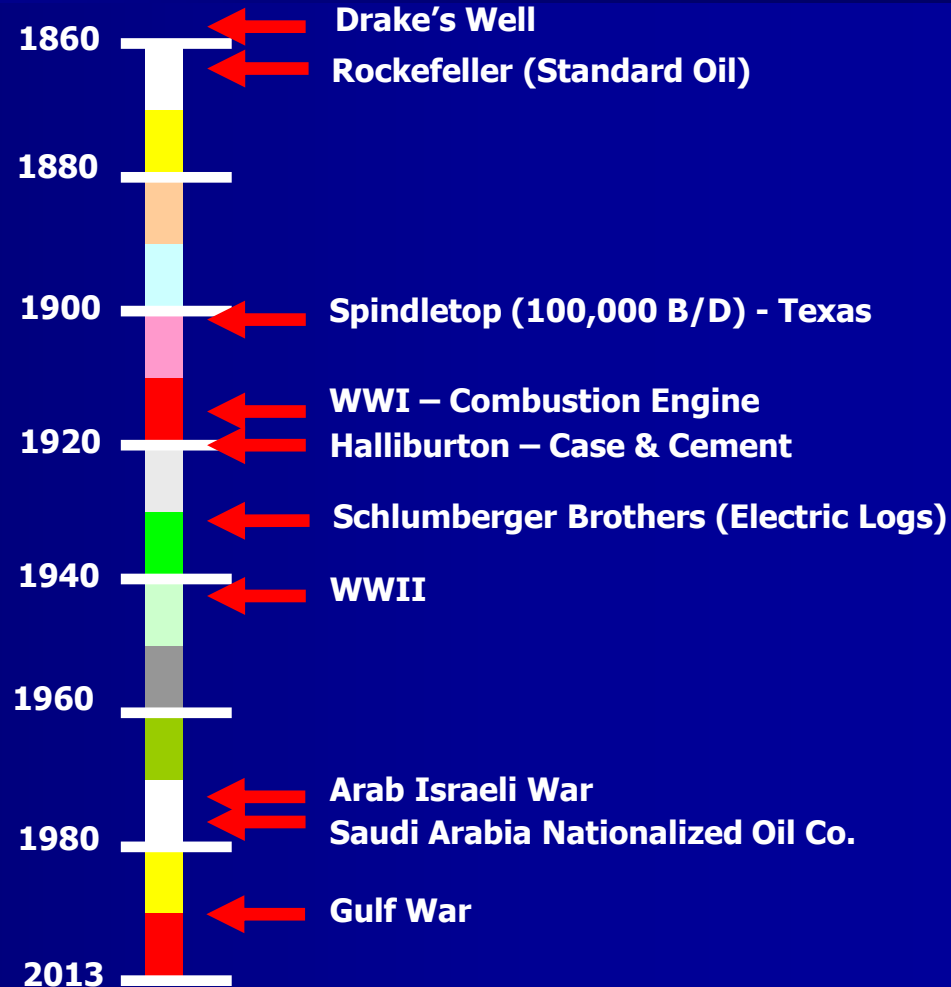
Chapter Two: History of Oil and Natural Gas

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1956, oil was discovered in Algeria and Nigeria.

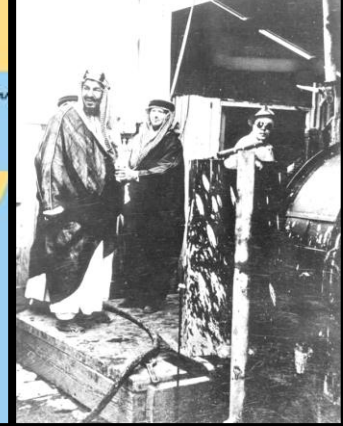
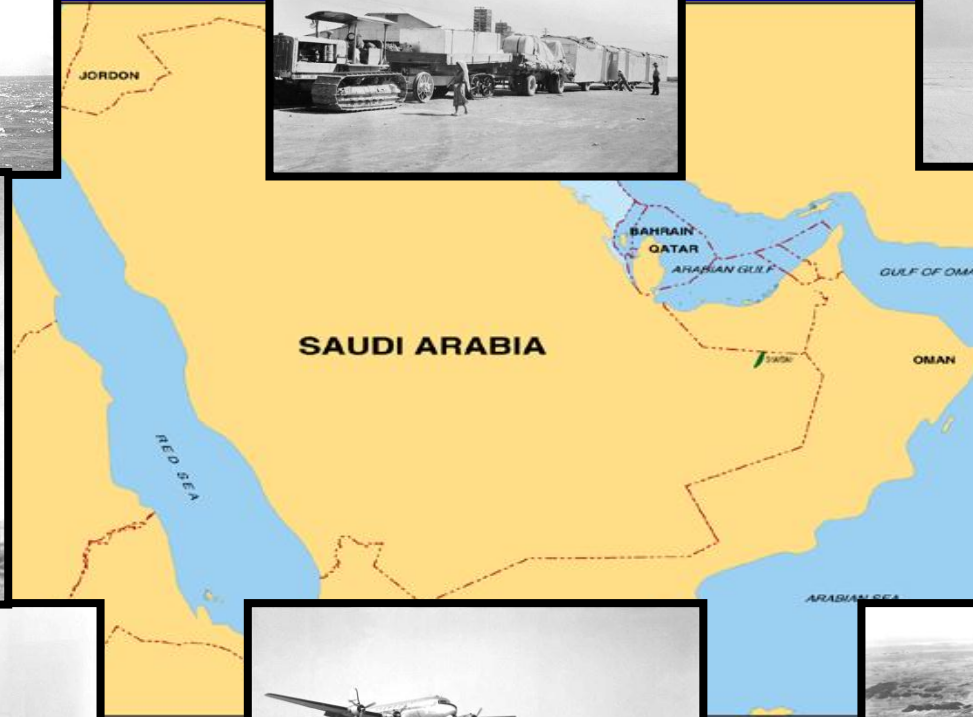
1969, oil was discovered in North Sea.

Later, oil and natural gas were discovered in several parts in the Middle East.



Chapter Two: History of Oil and Natural Gas

History of Oil and Natural Gas in Saudi Arabia

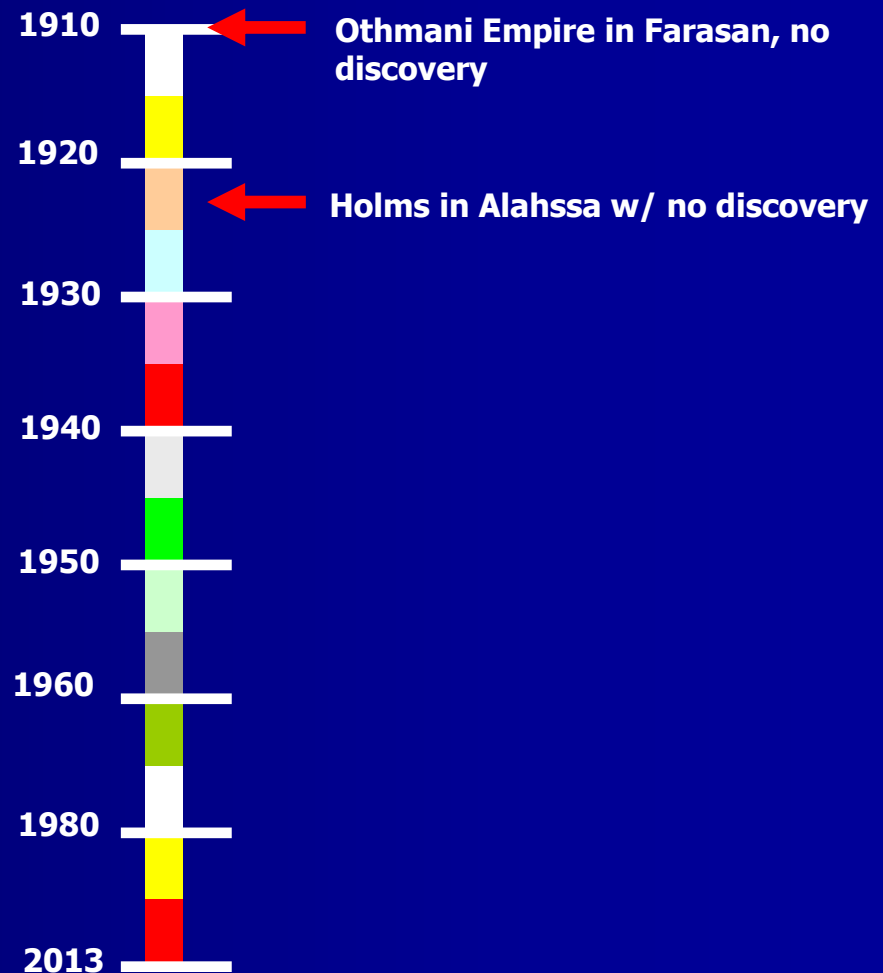


Chapter Two: History of Oil and Natural Gas

History of Oil and Natural Gas in Saudi Arabia

1910 the first concession by an Othmani Empire exploring the area of Farasan Islands in the Red Sea in the southern province of Saudi Arabia where some hydrocarbons seepage exist, with no discoveries.

1923 by "Holms" from the British investment group in the eastern province of Saudi Arabia (Al-Hassa). This concession was terminated at 1928 with no discoveries.

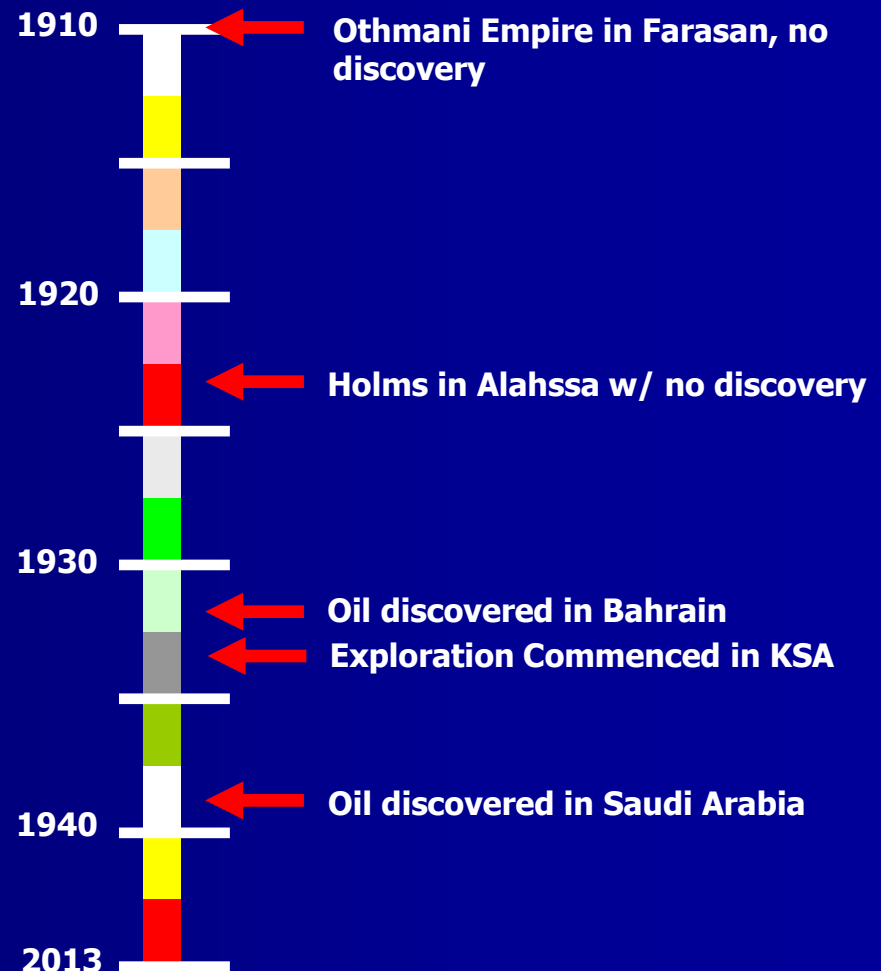


Chapter Two: History of Oil and Natural Gas

History of Oil and Natural Gas in Saudi Arabia

1933 Stimulated by the discovery of oil in Bahrain in 1932 a new exploration concession was commenced by the Standard Oil of California "SOCAL" in Dammam opposite to Bahrain Islands.

1938 The company decided to drill deeper in well no. 7 in Dammam dome where oil was discovered in commercial quantities at 4717 ft ss



Chapter Two: History of Oil and Natural Gas

History of Oil and Natural Gas in Saudi Arabia

In continue, oil and gas reservoirs have been explored in several areas onshore and offshore

These giant oil fields made Saudi Arabia as the world's most important oil producer.



Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

Energy sources are either **renewable** such as solar energy, waterfalls (hydro-energy), winds, etc. or **non-renewable** such as nuclear energy, oil, natural gas, and coal.

renewable



Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

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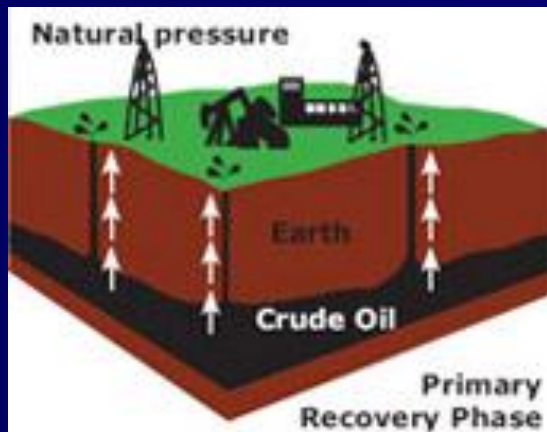


Chapter Two: History of Oil and Natural Gas

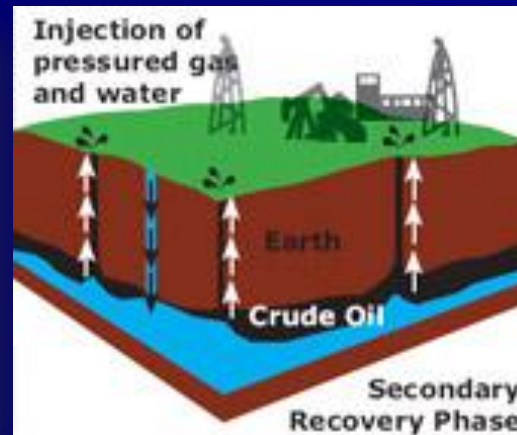
Oil and Natural Gas Reserves

Oil reserves are classified into “conventional” and “unconventional”.

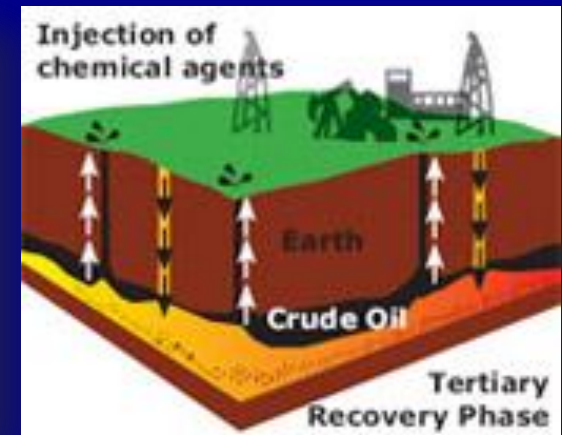
Conventional refers to the processes by which crude oil is extracted from beneath the Earth’s surface. Oil recovery can be categorized into three phases: primary, secondary or tertiary.



Uses natural pressure of the reservoir to push crude oil to the surface
Allows about 5% to 10% of the oil in the reservoir to be extracted



Injects pressurised gas and water to drive the residual crude oil and gas remaining after the primary oil recovery phase to the surface wells
Allows additional 25% to 30% of the oil in the reservoir to be extracted



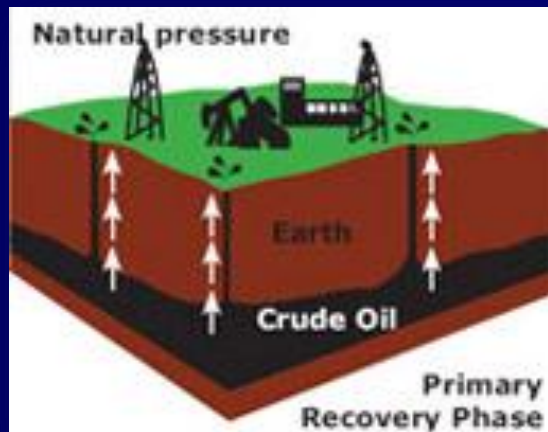
Injects different materials to improve the flow between oil, gas and rock, and to recover crude oil remaining after the primary and secondary phases. Allows additional 20% to 30% of the oil in the reservoir to be extracted .

Chapter Two: History of Oil and Natural Gas

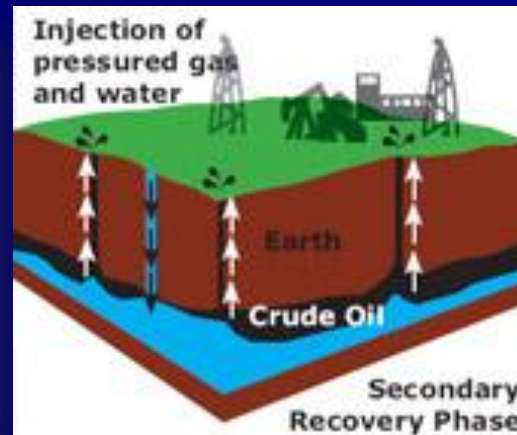
Primary, Secondary and Tertiary Recovery processes.

Oil reserves are classified into “conventional” and “unconventional”.

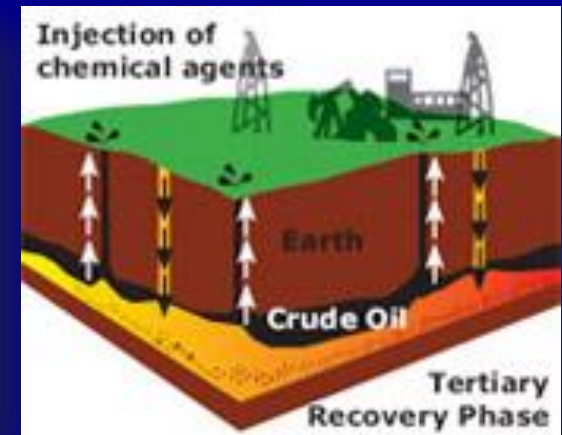
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Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

Oil reserves are classified into “**conventional**” and “**unconventional**”.

Unconventional oil comes from one of the following sources:

- i) **Extra Heavy Oil**: This type of oil is refined just like conventional petroleum except that it is thicker and has more sulfur and heavy metal contamination, necessitating more extensive refining. Venezuela's Orinoco heavy oil belt is the best-known example.



Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

Unconventional oil comes from one of the following sources:

- ii) **Tar Sand:** Tar sands are oil traps that are not deep enough below the surface to allow the generation of conventional oil. Oil can be recovered from tar sand by in-situ collection or surface mining techniques. Again, this is more expensive than producing conventional oil. Canada's Athabasca tar sand is the best-known example.



Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

Unconventional oil comes from one of the following sources:

- iii. **Oil Shale:** The oil shale layer was not hot enough to complete the oil generation.

Oil production from oil shale requires extensive recovery processing and consumes large amounts of water.



Chapter Two: History of Oil and Natural Gas

Oil and Natural Gas Reserves

Unconventional oil comes from one of the following sources:

- iv. **Synthetic Oil:** This type of oil is produced from coal or any other feedstocks. Bitumen derived from the oil sands deposits in the Alberta, Canada area has an API gravity of around 8 °API. It is 'upgraded' to an API gravity of 31 °API to 33 °API and the upgraded oil is known as synthetic crude.



Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Crude oils vary widely in appearance and viscosity from field to field. They range in color, odor, and in the properties they contain.

While all crude oils are essentially hydrocarbons, the difference in properties, especially the variations in molecular structure, mean that crude is more or less easy to produce, pipeline, and refine.



Chapter Two: History of Oil and Natural Gas

Crude Oil Types

The variations may even influence its suitability for certain products and the quality of those products.

The petroleum industry generally classifies crude oil by:

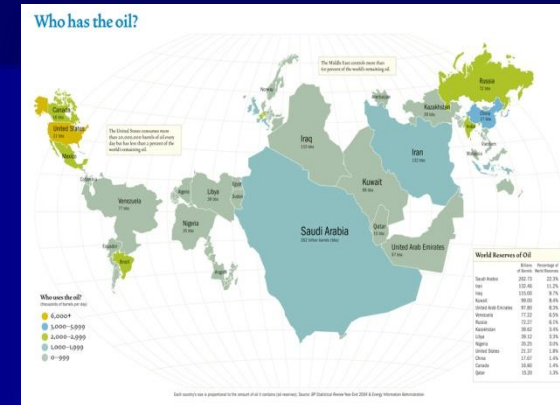
- ✓ the geographic location it is produced in (e.g. West Texas, Brent, or Oman),
- ✓ the sulfur content.
- and
- ✓ the API gravity (an oil industry measure of density),

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

✓ the geographic location it is produced in (e.g. West Texas, Brent, or Oman),

The geographic location is important because it affects transportation costs to the ports refineries.



Chapter Two: History of Oil and Natural Gas

Crude Oil Types

✓ the sulfur content.

Sweet oil commands a higher price than sour oil because it has fewer environmental problems and requires less refining to meet sulfur standards imposed on fuels in consuming countries.



Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

Crude oil may be considered light if it has low density or heavy if it has high density; Light crude oil is more desirable than heavy oil since it produces a higher yield of gasoline.



Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

The most important system of classifying crude oils into types, is the American Petroleum Institute (or API) gravities which are based on the physical property of density.

The API system compares the density of the crude oil to water.

When you compare the numerical densities of two liquids, you get a number called the **specific gravity**.

If the specific gravity is equal to 1, the two liquids have the same density

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Density = Weight per unit volume

For pure water: density = 62.4 lb/ft³

$$\text{Specific Gravity} = \frac{\rho_L}{\rho_w}$$

Example:

Density of 52.7 lb/ft³ → Specific gravity = 0.845

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

If the specific gravity is less than 1, the crude oil would be less dense than water and floats.

If the specific gravity is greater than 1, the crude is more dense than water and sinks.

The API gravity value is obtained from specific gravity (measured at 60 degrees) by the equation:

$$\text{API Gravity} = (141.5 / \text{Specific Gravity}) - 131.5$$

Example:

$$\text{Specific gravity} = 1.0 \rightarrow \text{API gravity} = 10$$

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

The higher the API gravity value, the less dense the crude; the more economically valuable it is.

If the API is 10, the specific gravity is equal to 1, and the water and oil have the same densities.

API gravities greater than 10 indicate that the crude is less dense than water and **floats**

while APIs less than 10 would indicate a crude oil that is more dense than water which **sinks**.

Most oils fall into the range of 10-70 API degrees.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

Most oils fall into the range of 10-70 API degrees.

Heavy Crude Oil: The API value **6 to 10 degrees**. Crude oil produced from offshore fields in Saudi Arabia such as Safaniya is a good example.

Medium Crude Oil: The API value **11 to 21 degrees**. Crude oil produced from offshore fields in Saudi Arabia such as Qatif is a good example.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

Most oils fall into the range of 10-70 API degrees.

Light Crude Oil : The API value **22 to 30 degrees**.

Crude oil produced from onshore fields in Saudi Arabia such as Abu Hadriyah is a good example.

Extra Light Crude Oil: The API value **31 to 39 degrees**.

Crude oil produced from onshore fields in Saudi Arabia such as Abqaiq is a good example.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

- ✓ the API gravity (an oil industry measure of density),

Most oils fall into the range of 10-70 API degrees.

Super Light Crude Oil: The API value **40 to 49 degrees**. Crude oil produced from onshore fields in Saudi Arabia such as Shaiba is a good example.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Another classifications of crude oil:

1. According to the nature of hydrocarbons they contain:

- I. **Paraffin-based Crude Oils:** These contain higher molecular weight paraffins, and little or no asphaltic (bituminous) matter. They are stable at room temperature and can produce high-grade lubricating oils.
- II. **Asphaltic Based Crude Oils:** Contain large magnitude of asphaltic matter, and little or no paraffin. Some are predominantly naphthenes so yield lubricating oil that is more sensitive to temperature changes than the paraffin-base crudes.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Another classifications of crude oil:

1. According to the nature of hydrocarbons they contain:

III. Mixed Base Crude Oils: Both paraffins and naphthenes are present in this type, as well as aromatic hydrocarbons. Most crudes in the world fit this category.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Another classifications of crude oil:

2. According to the pricing reference :

- I. **West Texas Intermediate (WTI):** a very high-quality, sweet, light oil delivered at Cushing, Oklahoma for North American oil.
- II. **Brent Blend:** comprising 15 oils from fields in the Brent and Ninian systems in the East Shetland Basin of the North Sea. Oil production from Europe, Africa and Middle Eastern oil flowing west tends to be priced off the price of this oil, which forms a benchmark.

Chapter Two: History of Oil and Natural Gas

Crude Oil Types

Another classifications of crude oil:

1. According to the pricing reference :

III. Dubi-Oman: used as benchmark for Middle East sour crude oil flowing to the Asia- Pacific region.

IV. The organization of the petroleum Exporting companies (OPEC): reference Basket, a weighted average of oil blends from various OPEC countries.

Questions

