Fundamental Of Petroleum Engineering

INTRODUCTION

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What is Petroleum Engineering?

- an engineering discipline concerned with the activities related to the production of hydrocarbons, which can be either crude oil or natural gas.
- considered as *upstream* sector of the oil and gas industry, which are the activities of finding and producing oil and gas.

What is Petroleum Engineer?

- A petroleum engineer is involved in nearly all stages of oil and gas field evaluation, development and production. The goal of a petroleum engineer is to maximise hydrocarbon recovery at a minimum cost while maintaining a strong emphasis on reducing all associated environmental problems.
- Petroleum engineers are divided into several groups:
  - Petroleum geologists find hydrocarbons by analysing subsurface structures with geological and geophysical methods.

What is Petroleum Engineer?

- Reservoir engineers work to optimize production of oil and gas via proper well placement, production levels, and enhanced oil recovery techniques.
- Drilling engineers manage the technical aspects of drilling exploratory, production and injection wells. It also include mud engineer who manage the quality of drilling fluid.
- Production engineers, including subsurface engineers, manage the interface between the reservoir and the well, including perforations, sand control, downhole flow control, and downhole monitoring equipment; evaluate artificial lift methods; and also select surface equipment that separates the produced fluids (oil, gas, and water).

Society of Petroleum Engineer

- The largest professional society for petroleum engineers and publishes much information concerning the industry.
- In UTM, SPE UTM Student Chapter – the most outstanding SPE Student Chapter in this region.
- In 2011, SPE-UTM Student Chapter met the gold standard (top 26 out of more than 200 Student Chapter).

Where Does Petroleum Engineers Work?

- Employer:
  - Government
  - Oil Company.
  - Service Company.
  - Supporting Company.
  - Academic
  - Others
- Location:
  - Office
  - Onland Oil Rig
  - Offshore Oil Rig
  - Offshore Production Platform

What Does Petroleum Mean?

- Petroleum literally means ‘rock oil’. The word comes from the Greek word ‘petra’ (meaning ‘**rock**’) and the Latin word ‘oleum’ (meaning ‘**oil**’).
- The word petrol is a shortened version of ‘petroleum’.
- Petroleum products are all the substances made from petroleum.

Crude Oil

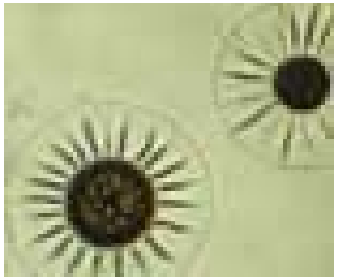
- The oil we find underground is called **crude oil**.
- Crude oil is made of a mixture of different chemicals called hydrocarbons. These were produced when tiny plants and animals decayed under layers of sand and mud.
- Crude oil doesn't always look the same – it depends where it comes from.
- Sometimes it is almost colourless, or it can be thick and black. But crude oil usually looks like thin, brown treacle.
- When it comes out of a well (especially an undersea well), the crude oil is often mixed with gases, water and sand.

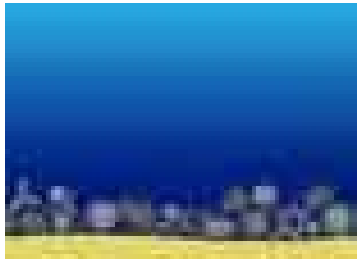
Crude Oil - Wikipedia

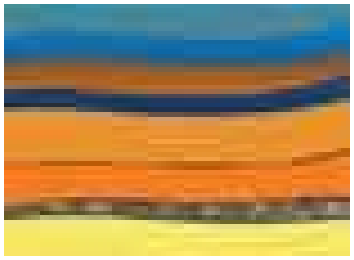
- **Petroleum** or **crude oil** is a naturally occurring, toxic, flammable liquid consisting of a complex mixture of hydrocarbons of various molecular weights, and other organic compounds, that are found in geologic formations beneath the Earth's surface. Petroleum is recovered mostly through oil drilling. It is refined and separated, most easily by boiling point, into a large number of consumer products, from gasoline and kerosene to asphalt and chemical reagents used to make plastics and pharmaceuticals.

What Made Oil?

- Tiny animals and plants that live in the sea are called plankton.
- The plankton that lived in hundreds of millions years ago made our crude oil.
- When they died they sank to the bottom and slowly got buried by sand and mud.
- Over millions of years, the dead animals and plants got buried deeper and deeper.
- The heat and pressure gradually turned the mud into rock and the dead animals and plants into oil and gas.



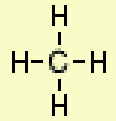
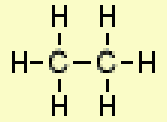
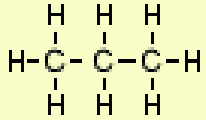




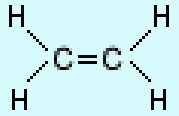
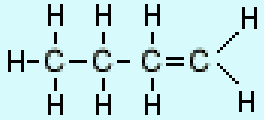
Hydrocarbon

- Crude oil is a mixture of hydrocarbons.
- They are often chains of carbon atoms with hydrogens attached.
- The longer chains have higher boiling points, so they can be separated by distillation.
- The simplest groups are the alkanes and alkenes. They all end with 'ane' and 'ene' respectively.
- The first bit of their name depends on the number of carbon atoms.

Alkanes

methane	CH_4	
ethane	C_2H_6	
propane	C_3H_8	

Alkenes

ethene	C_2H_4	
butene	C_4H_9	

meth = 1 carbon, eth = 2, prop = 3, but = 4, pent = 5, hex = 6.

Generation of Petroleum

- Petroleum generation takes place in source rocks, which may be defined as organic rich, fine grained sediments deposited under low energy, reducing conditions.
- Most commonly, petroleum source rocks containing a minimum of 0.3% to 0.5% by weight of organic matter.
- Preservation of the organic matter is the key to the development of potential source rocks.
- The environment of source rock deposition is therefore characterised by a relatively deep, unagitated (low energy) body of water with an oxygen starved bottom but abundant life at the surface.

- The non-hydrocarbon organic matter (kerogen) is the major source of oil and gas deposits.
- The generation of hydrocarbons from the source material depends primarily on the temperature to which the organic material is subjected. Hydrocarbon generation appears to be negligible at temperatures less than 150^{o}F (65^{o}C) in the subsurface and reaches a maximum within the range of 225^{o} to 350^{o}F (107^{o} and 176^{o}C), the “hydrocarbon window”. Increasing temperatures convert the heavy hydrocarbons into lighter ones and ultimately to gas. However, at temperatures above 500^{o}F (260^{o}C), the organic material is carbonized and destroyed as a source material. Consequently, if source beds become too deeply buried no hydrocarbons will be produced. (Wikipedia)

Conversion of Kerogen to Oil & Gas

- Anaerobic bacteria convert lipids (fat, oil and waxes) into a waxy substance called kerogen.
- During burial of sediments, the increase in temperature results in a progressive change in the composition of kerogen.
- Three successive stages are distinguished and referred as diagenesis, catagenesis and metagenesis.
- The main trend is a continuous increase in the carbon content of kerogen.

Diagenesis

- Diagenesis of kerogen is characterised by an important decrease of oxygen and a corresponding increase of carbon content with increasing depth.
- CO_2, H_2O and some heavy N, S, O compounds are released.
- Source rocks are considered as immature at this stage.

Catagenesis

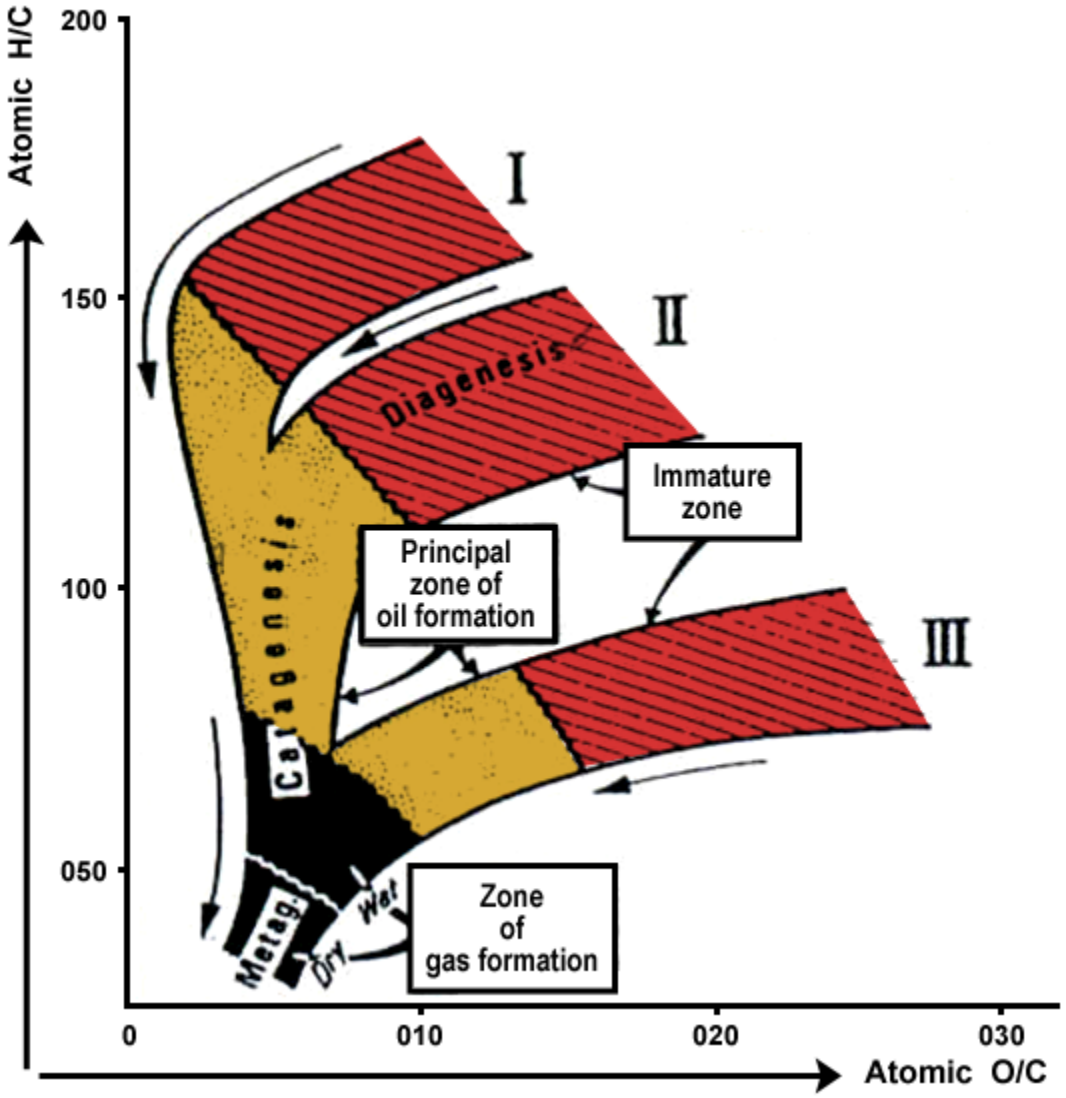
- A significant decrease in hydrogen content and in the H/C ratio takes place due to the generation and release of hydrocarbons.
- This is the main zone of oil generation and the beginning of the cracking phase which produces wet gas with a rapidly increasing proportion of methane.

Metagenesis

- Begins at temperature exceeding 175^{o}C.
- During this stage, a rearrangement of the aromatic sheets occurs.
- The stacks of aromatic layers, previously distributed at random in kerogen, now gather to form larger clusters.
- At this stage, only dry gas is generated.

The color of kerogen changes as it matures

Colour	Maturity Level	Dominant HC
Yellow	Immature	Biogenic methane
Orange	Mature	Oil
Brown	Mature	Wet gas
Black	Metamorphosed	Dry gas



General scheme of kerogen evolution presented on Van Krevelen's diagram.

Principal products of kerogen evolution

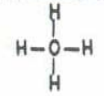
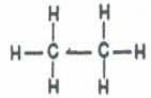
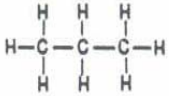
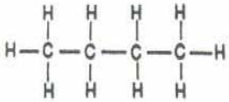
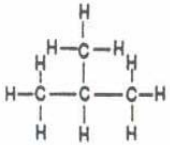
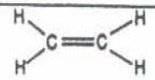
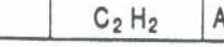
- CO_2, H_2O
- Oil
- Gas

Chemical Composition of Petroleum

- Substances present in petroleum fall into four major groups:
  - Paraffins
  - Naphthenes
  - Aromatics
  - Non-hydrocarbon
- The relative proportions of these compounds determine the physical properties (density, viscosity, pour point, etc) of petroleum.

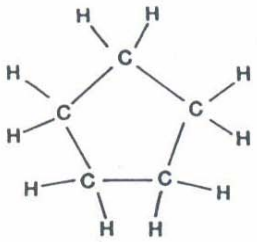
Paraffins

- These are also known as aliphatic hydrocarbons.
- They include the alkanes, which are saturated and have the general formula C_nH_{2n+2} (methane, ethane, etc) and the alkenes, which are undersaturated and have the general formula C_nH_{2n} or C_nH_{2n-n}.
- The carbon atoms are joined together to form chains.

Structure	Simple formula	Name	Properties at room temperature
	CH_4	Methane	GAS
	C_2H_6	Ethane	
	C_3H_8	Propane	
	C_4H_{10}	n–Butane	
	C_4H_{10}	i–Butane	
	C_5H_{12}	Pentane	LIQUID
	C_6H_{14}	Hexane	
	C_7H_{16}	Heptane	
	C_8H_{18}	Octane	
	C_9H_{20}	Nonane	
	$C_{10}H_{22}$	Decane	
	$C_{17}H_{36}$		
	$C_{18}H_{38}$		SOLID
	C_2H_4	Ethylene	GAS
	C_2H_2	Acetylene	GAS

Naphthenes

- These are referred to also as cycloparaffins and are characterised by their carbon atoms joined in such a way as to form a ring.
- The heavier MW fraction of petroleum often contains quite complex naphtene molecules with two or more ring joined together.

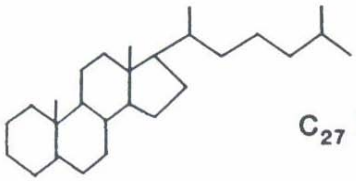


$C_5 H_{10}$ Cyclopentane

$C_6 H_{12}$ Cyclohexane

$C_9 H_{18}$ 1,1,3–Trimethylcyclohexane

$C_{10} H_{18}$ Decalin



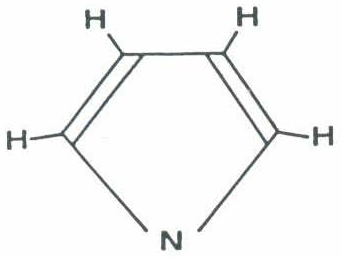
$C_{27} H_{48}$ Cholestane

Aromatics

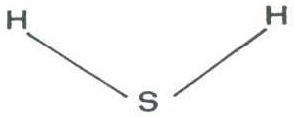
- The basic building block of these hydrocarbons is the benzene ring.
- The aromatics structure occurs especially in the high molecular weight fraction of petroleum.

Non-hydrocarbon

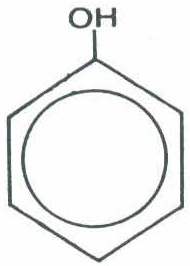
- Compounds in this group contain nitrogen, sulphur and oxygen (NSO's).
- Free nitrogen gas may be generated during the formation of petroleum.
- Sulphur organic compounds are often foul smelling. The best known is H_2S.
- Oxygen compounds include alcohols, ethers and organic acids.



Pyrrole



Hydrogen sulphide

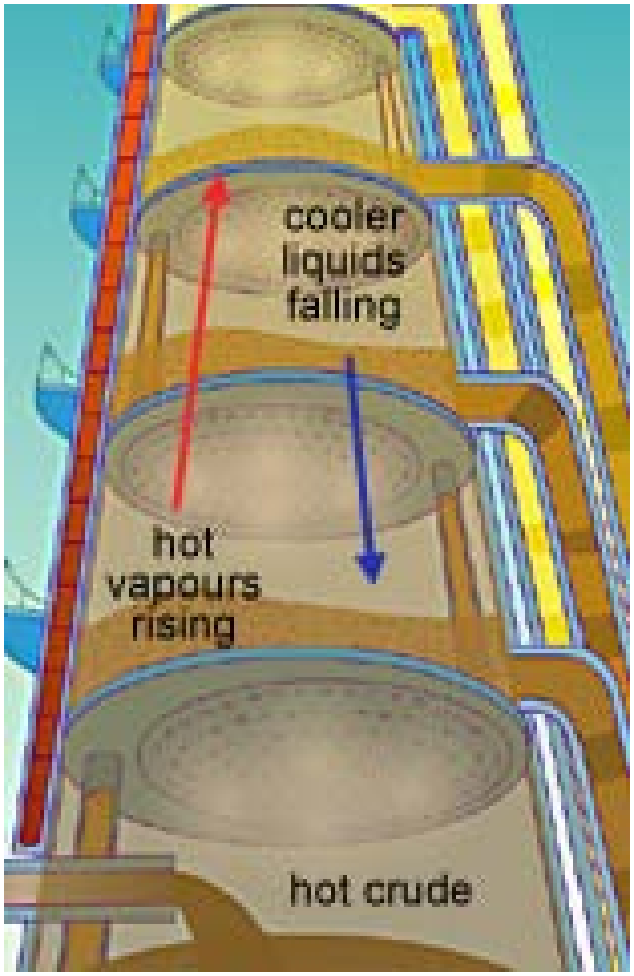


Phenol

Fractional Distillation

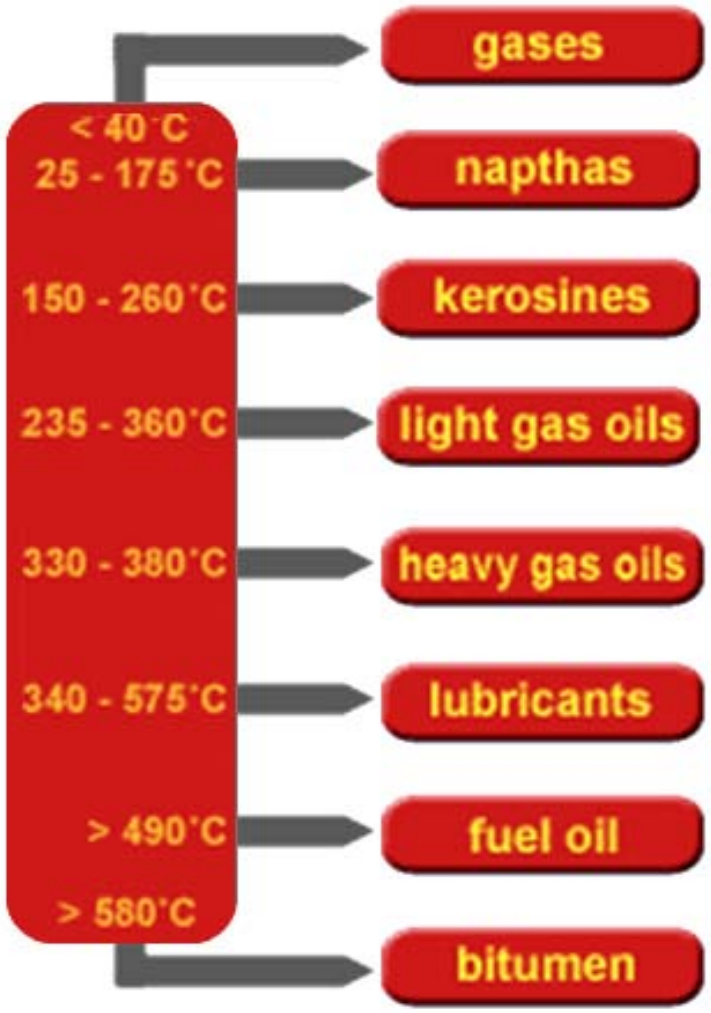
- Fractional distillation splits the crude oil into simpler mixtures called fractions. The different fractions are taken out of the still at different levels.
- This happens in a distillation tower (which we shorten to still).
- The crude oil is heated in a furnace to about 370°C and is pumped into the bottom of a distillation tower. Most of the hydrocarbons are gaseous, though the very thick ones are still a liquid even at this temperature.

- The tower is like a giant heat exchanger - it removes heat from the gases as they rise up it. The temperature falls to 20°C by the time the vapours reach the top.
- The vapours condense as they rise up the tower. The heavier ones (with higher boiling points) condense first. The thinner, runny ones get further up the tower before they condense. And the gases pass out of the top.



Where do Product come out of a Still?

- A distillation tower splits crude oil into separate fractions.
- Each fraction is a mix of hydrocarbons. Each fraction has its own range of boiling points and comes off at a different level in the tower.
- In reality, a single tower could not cover the full range of temperatures needed to split up the heavier fractions.



The table shows the names and uses of the fractions that come from the distillation process. It also shows the ranges of hydrocarbons in each fraction.

Fraction	Carbons	BP °C	Uses
Gases	1 to 4	< 40	• Fuel in refinery • Bottled and sold as LPG
Napthas	5 to 10	25 – 175	• Blended into petrols • Feedstock for making chemicals
Kerosene	10 to 16	150 – 260	• Aviation fuel
Light gas oils	14 to 50	235 – 360	• Diesel fuel production
Heavy gas oils	20 to 70	330 – 380	• Feedstock for catalytic cracker
Lubricants	> 60	340 – 575	• Grease for lubrication • Fuel additives • Feedstock for catalytic cracker
Fuel oil	> 70	> 490	• Fuel oil (power stations and ships)
Bitumen	> 80	>580	• Road and roof surfaces

The First Oil Well

- The modern oil industry dates back about 150 years.
- The world's first oil well was drilled in Titusville, Pennsylvania in 1859. It struck oil at 21 metres below ground and produced 3,000 litres of oil a day.
- Known as the Drake Well, after "Colonel" Edwin Drake, the man responsible for the well, it began an international search for petroleum, and in many ways eventually changed the way we live.

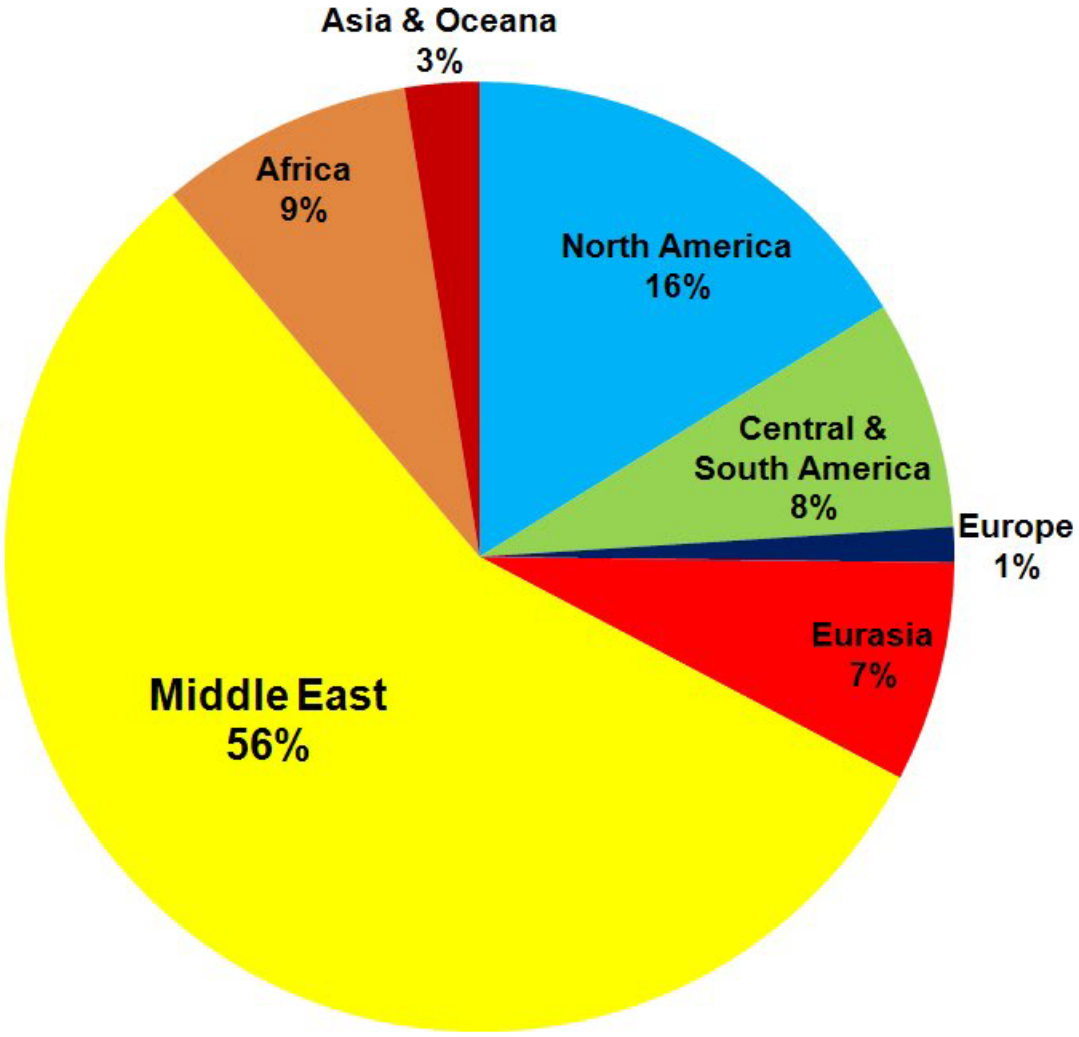
How Long Will The World's Oil Last?

- Oil took millions of years to form and the oil supplies in the ground won't last for ever.
- The oil fields already discovered hold over 1 million million barrels of oil (1,000,000,000,000).
- Although we are using oil quite quickly, the reserves go up every year. This is because more oil is discovered and new ways are found of extracting oil that couldn't be got out before.
- Even so, our oil won't last for ever. At the moment, the world uses about 26,000,000,000 barrels every year. At this rate, there should be enough oil for at least another 40 years.

How Long Will The World's Oil Last?

- It is likely that more oil will be discovered in that time.
- Oil companies are always searching for new oil fields and there are still lots more deep sea areas to explore.

World Oil Reserves by Region



Source: Wikipedia

World Proven Oil Reserves

	Country	Reserves (bbl)
	Arab League (more information) (2011)[1]	688,860,600,000
1	Saudi Arabia (more information) (2011)[2]	264,600,000,000
2	Canada (more information) (2008)	175,200,000,000 [3]
3	Iran (more information) (2006)	137,600,000,000
4	Iraq (more information) (2008)	115,000,000,000
5	Kuwait (more information) (2010)	104,000,000,000
6	United Arab Emirates (more information) (2008)	97,800,000,000
7	Venezuela (more information) (2010)	97,770,000,000
8	Russia (more information) (2009)	74,200,000,000
9	Libya (more information) (2010)	47,000,000,000
10	Nigeria (more information) (2007)	37,500,000,000
11	Kazakhstan (2009)	30,000,000,000

Source: Wikipedia

World Proven Oil Reserves (ctd)

	Country	Reserves (bbl)
27	Egypt	4,300,000,000
28	Indonesia	4,050,000,000
29	Gabon	3,700,000,000
30	Australia	1,100,000,000
31	United Kingdom	3,000,000,000
32	Yemen	3,000,000,000
33	Malaysia	2,900,000,000
34	Syria	2,500,000,000
35	Argentina	2,386,000,000
36	Colombia	1,900,000,000
37	Congo, Republic of the	1,600,000,000

Source: Wikipedia

World Oil Producer

	Country	Production (bbl/day)	Share of World %	Date of Information
—	*World*	87,500,000[3]	100%	2011
—	*Arab League*	24,171,503	29.71%	2009
1	Russia	10,540,000[4]	12.01%	2011
2	Saudi Arabia	8,800,000[5]	11.59%	2011
3	United States	7,800,000[6]	10.75%	2011
13	Norway	2,350,000	2.79%	2009
14	Nigeria	2,211,000	2.62%	2009
15	Algeria	2,125,000	2.52%	2009
16	Angola	1,948,000	2.31%	2009
17	Libya	1,790,000	2.12%	2009

Source: Wikipedia

World Oil Producer (ctd)

	Country	Production (bbl/day)	Share of World %	Date of Information
18	Kazakhstan	1,540,000	1.83%	2009
19	United Kingdom	1,502,000	1.78%	2009
20	Qatar	1,213,000	1.44%	2009
21	Indonesia	1,023,000	1.21%	2009
22	Azerbaijan	1,011,000	1.20%	2009
23	Colombia	903,000	0.97%	2011
24	India	878,700	1.04%	2009
25	Oman	816,000	0.95%	2009
26	Argentina	796,300	0.93%	2009
27	Malaysia	693,700	0.82%	2009
28	Egypt	680,500	0.81%	2009
29	Australia	589,200	0.70%	2009

Source: Wikipedia

World Oil Consumers

Rank	Country/Region	Oil - consumption (bbl/day)	Date of information
-	*World*	85,980,000	2008 est.
1	United States of America	18,690,000	2009 est.
-	European Union	13,680,000	2007 est.
2	China	8,200,000	2009 est.
3	Japan	4,363,000	2009 est.
4	India	2,980,000	2009 est.
5	Russia	2,740,000	2009 est.
6	Brazil	2,460,000	2009 est.
7	Germany	2,437,000	2009 est.
8	Saudi Arabia	2,430,000	2009 est.

Source: Wikipedia

World Oil Consumers (ctd)

Rank	Country/Region	Oil - consumption (bbl/day)	Date of information
23	Iraq	687,000	2009 est.
24	Egypt	683,000	2009 est.
25	Argentina	622,000	2009 est.
26	Belgium	608,200	2009 est.
27	Turkey	579,500	2009 est.
28	South Africa	579,000	2009 est.
29	Poland	545,400	2009 est.
30	Malaysia	536,000	2009 est.

Source: Wikipedia

World Oil Exporters

Rank	Country/Region	Oil - exports (bbl/day)	Date of information
-	*World*	63,760,000	2004
-	Arab League	21,304,469	2007 est
1	Russia	7,400,000	2010 Actual[1]
2	Saudi Arabia	5,450,000	2010 Actual[2]
3	United Arab Emirates	2,700,000	2007 est.
4	Iran	2,400,000	2010 est.
5	Kuwait	2,349,000	2007 est.
6	Nigeria	2,327,000	2007 est.
-	European Union	2,196,000	2007
7	Venezuela	2,182,000	2007 est.
8	Norway	2,150,000	2009 est.[3]

Source: Wikipedia

World Oil Exporters (ctd)

Rank	Country/Region	Oil - exports (bbl/day)	Date of information
9	Canada	2,001,000	2008 est.
10	Iraq	1,910,000	2009 est.
11	Algeria	1,891,000	2007 est.
12	United States	1,704,000	2008 est.
13	Netherlands	1,660,000	2008 est.
14	Libya	1,542,000	2007 est.
15	Angola	1,407,000	2007 est.
16	United Kingdom	1,393,000	2008 est.
17	Singapore	1,374,000	2007 est.
18	Kazakhstan	1,345,000	2009 est.
19	Mexico	1,225,000	2009 est.
29	Malaysia	511,900	2007

Source: Wikipedia

World Oil Importers

Rank	Country/Region	Oil - imports (bbl/day)	Date of information
-	*World*	63,180,000	2004
1	United States	13,470,000	2008
-	European Union	8,613,000	2007
2	Japan	5,263,000	2008
3	China	4,393,000	2008
4	Germany	2,953,000	2004
5	Netherlands	2,465,000	2004
6	Korea, South	2,410,000	2006
7	Italy	2,182,000	2004
8	India	2,098,000	2004 est.
9	France	1,890,000	2005
10	Singapore	1,830,000	2004

Source: Wikipedia

World Oil Importers (ctd)

Rank	Country/Region	Oil - imports (bbl/day)	Date of information
30	Israel	315,200	2004
31	Hong Kong	314,700	2006
32	Mexico	308,500	2004
33	Netherlands Antilles	282,500	2004
34	Finland	281,300	January–September 2007 est.
35	Pakistan	278,900	2004
36	Malaysia	278,600	2004
37	Vietnam	271,100	2007
38	Switzerland	267,000	2004
39	Aruba	235,000	2004

Source: Wikipedia

World Proven Natural Gas Reserves

Rank	Country/Region	Natural gas proven reserves (m^3)	% of total	Date of information
—	*World*	190,163,119,460,000	100%	1 January 2010 est.
1	Russia	47,570,000,000,000	25.02%	1 January 2010 est.
2	Iran	29,610,000,000,000	15.57%	1 January 2010 est.
3	Qatar	25,470,000,000,000	13.39%	1 January 2010 est.
4	Turkmenistan	7,504,000,000,000	3.95%	1 January 2010 est.
5	Saudi Arabia	7,461,000,000,000	3.92%	1 January 2010 est.
6	United States	6,928,000,000,000	3.64%	1 January 2010 est.
7	United Arab Emirates	6,071,000,000,000	3.19%	1 January 2010 est.
8	Nigeria	5,246,000,000,000	2.76%	1 January 2010 est.

Source: Wikipedia

World Proven Natural Gas Reserves (ctd)

Rank	Country/Region	Natural gas proven reserves (m^3)	% of total	Date of information
9	Venezuela	4,983,000,000,000	2.62%	1 January 2010 est.
10	Algeria	4,502,000,000,000	2.37%	1 January 2010 est.
11	Iraq	3,170,000,000,000	1.67%	1 January 2010 est.
12	Australia	3,115,000,000,000	1.64%	1 January 2010 est.
13	China	3,030,000,000,000	1.59%	1 January 2010 est.
14	Indonesia	3,001,000,000,000	1.58%	1 January 2010 est.
15	Kazakhstan	2,407,000,000,000	1.27%	1 January 2010 est.
16	Malaysia	2,350,000,000,000	1.24%	1 January 2010 est.

Source: Wikipedia

World Natural Gas Producer

Rank	Country/Region	Annual natural gas production (m^3)	Date of information
—	*World*	3,127,000,000,000	2008 est.
1	United States	593,400,000,000	2009 est.
2	Russia	583,600,000,000	2009 est.
3	Iran	200,000,000,000	2009 est.
—	European Union	181,600,000,000	2009 est.
4	Canada	161,300,000,000	2009 est.
5	Norway	103,500,000,000	2009 est.
6	Algeria	86,500,000,000	2008 est.
7	Indonesia	85,700,000,000	2009 est.
8	China	82,940,000,000	2009 est.
9	Netherlands	79,580,000,000	2009 est.

Source: Wikipedia

World Natural Gas Producer (ctd)

Rank	Country/Region	Annual natural gas production (m^3)	Date of information
10	Saudi Arabia	77,100,000,000	2009 est.
11	Qatar	76,980,000,000	2008 est.
12	Uzbekistan	67,600,000,000	2008 est.
13	Egypt	62,700,000,000	2009 est.
14	Mexico	60,350,000,000	2009 est.
15	United Kingdom	58,560,000,000	2009 est.
16	Malaysia	57,300,000,000	2008 est.

Source: Wikipedia

World Natural Gas Exporters

Rank	Country/Region	Natural gas - exports (cu m)	Date of Information
—	*World*	929,900,000,000	2007 est.
1	Russia	173,000,000,000	2007 est.
—	Arab League	144,248,000,000	2007 est.
2	Canada	107,300,000,000	2007 est.
3	Norway	85,700,000,000	2007 est.
4	Algeria	59,400,000,000	2007 est.
5	Netherlands	55,660,000,000	2007 est.
6	Turkmenistan	49,400,000,000	2007 est.
7	Qatar	39,300,000,000	2007 est.
8	Indonesia	32,600,000,000	2007 est.
9	Malaysia	31,600,000,000	2007 est.
10	United States	23,280,000,000	2007 est.

Source: Wikipedia

History of Oil in Malaysia

- First oil discovered in Sarawak Malaysia in the year 1910.
- 'Oilwell Miri No. 1' is drilled resulting from observation of oil seepages around the area.
- Located on Canada Hill, Miri.
- Start production in December 1910, and closed in 1941.
- In that time, she had produced 563,484 barrels and was still producing 10 barrles per day.
- The first oil refinery in Malaysia is built at Lutong in 1917.

Sarawak: Offshore Oilfields

- After the discovery of Miri oilfield, further search for oil onshore is carried out for 50 year without any success.
- Then effort is directed to offshore exploration resulting in the discovery of the Baram oilfield situated 14 km offshore.
- This is followed by the discovery of the West Lutong oilfield and 8 others in deeper water -– Baronia, Bakau, Betty, Bokor, Tukau, Fairley Baram, J4 dan Temana.

Sabah: Offshore Oilfields

- The search for oil in Sabah started in 1958.
- The first oilfield discovered is the Erb West in 1971, followed by the Semarang oilfield, South Furious, St. Joseph, Erb South dan Barton.
- An oil terminal is built in Labuan for exporting oil overseas.

Semenanjung Malaysia: Offshore Oilfields

- Offshore Terengganu, Esso discovered oil in 1973. Gas is discovered soon after.
- Tapis, Pulai dan Bekok are amongst the earlier oilfield discovered.

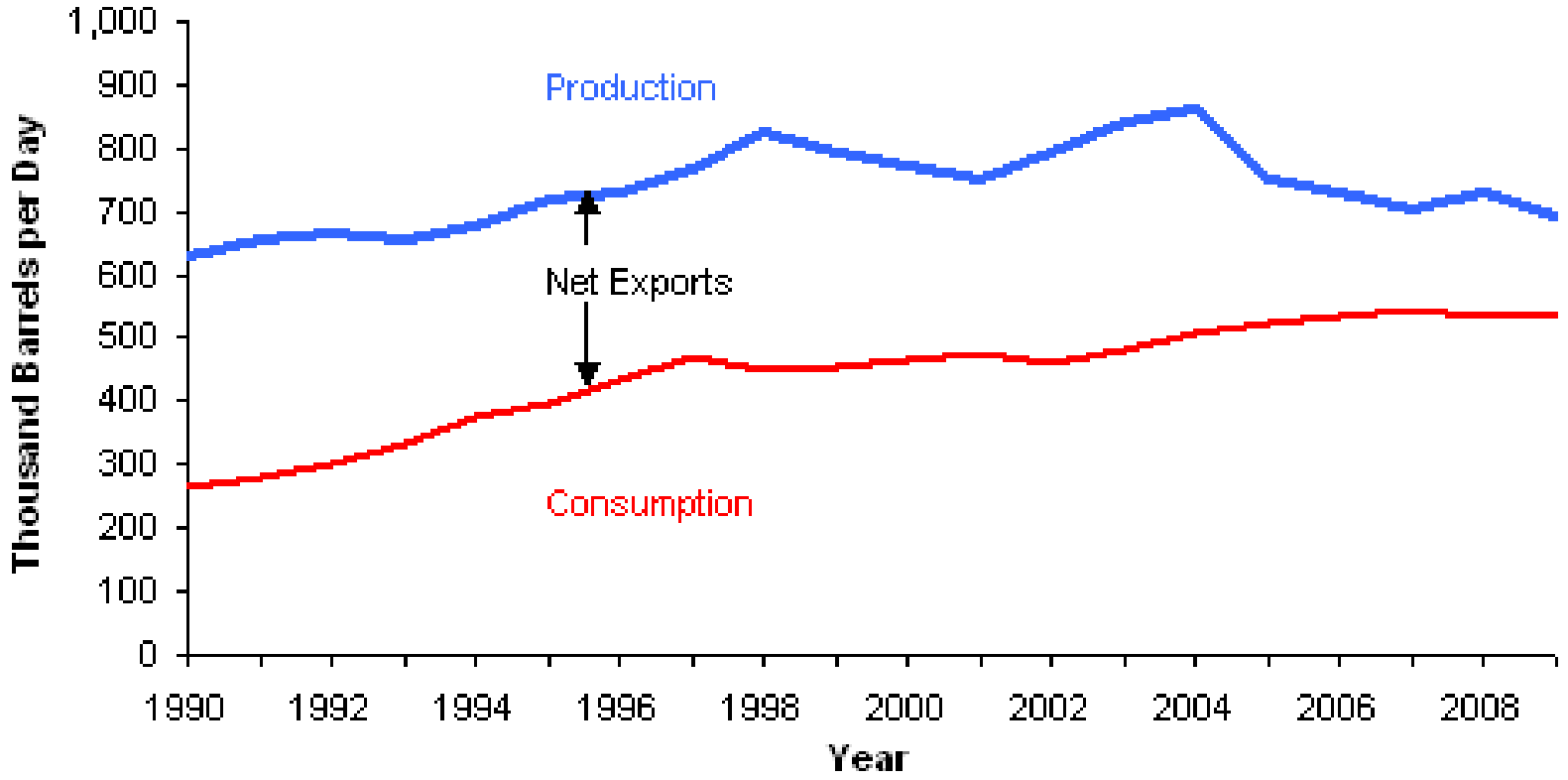
Malaysia Oil & Gas Analysis (As of Jan. 1, 2005)

- Malaysia is important to world energy markets because of its 75 trillion cubic feet of natural gas reserves and its net oil exports of over 300,000 barrels per day.
- Malaysia contains proven oil reserves of 3.0 billion barrels, down from 4.3 billion barrels in 1996.
- Despite this trend toward declining oil reserves, Malaysia 's crude oil production has risen in the last two years as a result of new offshore development.
- In 2002, crude oil production averaged 699,000 bbl/d. That figure rose to an average of 750,000 bbl/d for 2004.

- Malaysia 's oil demand has been growing at a much slower rate due to conservation of natural gas.
- As a result of the long-term trend toward declining oil reserves, Petronas, the state oil and gas company, has embarked on an international exploration and production strategy.
- Overseas operations now make up nearly one-third of Petronas revenue.
- Malaysia exports the majority of its oil to markets in Japan, Thailand, South Korea, and Singapore.

- More than half of the country's oil production comes from the Tapis field.
- Esso Production Malaysia Inc. (EPMI), an affiliate of ExxonMobil Corporation, is the largest crude oil producer in Peninsular Malaysia, accounting for nearly half of Malaysia 's crude oil production.

Malaysia's Oil Production and Consumption, 1990-2009



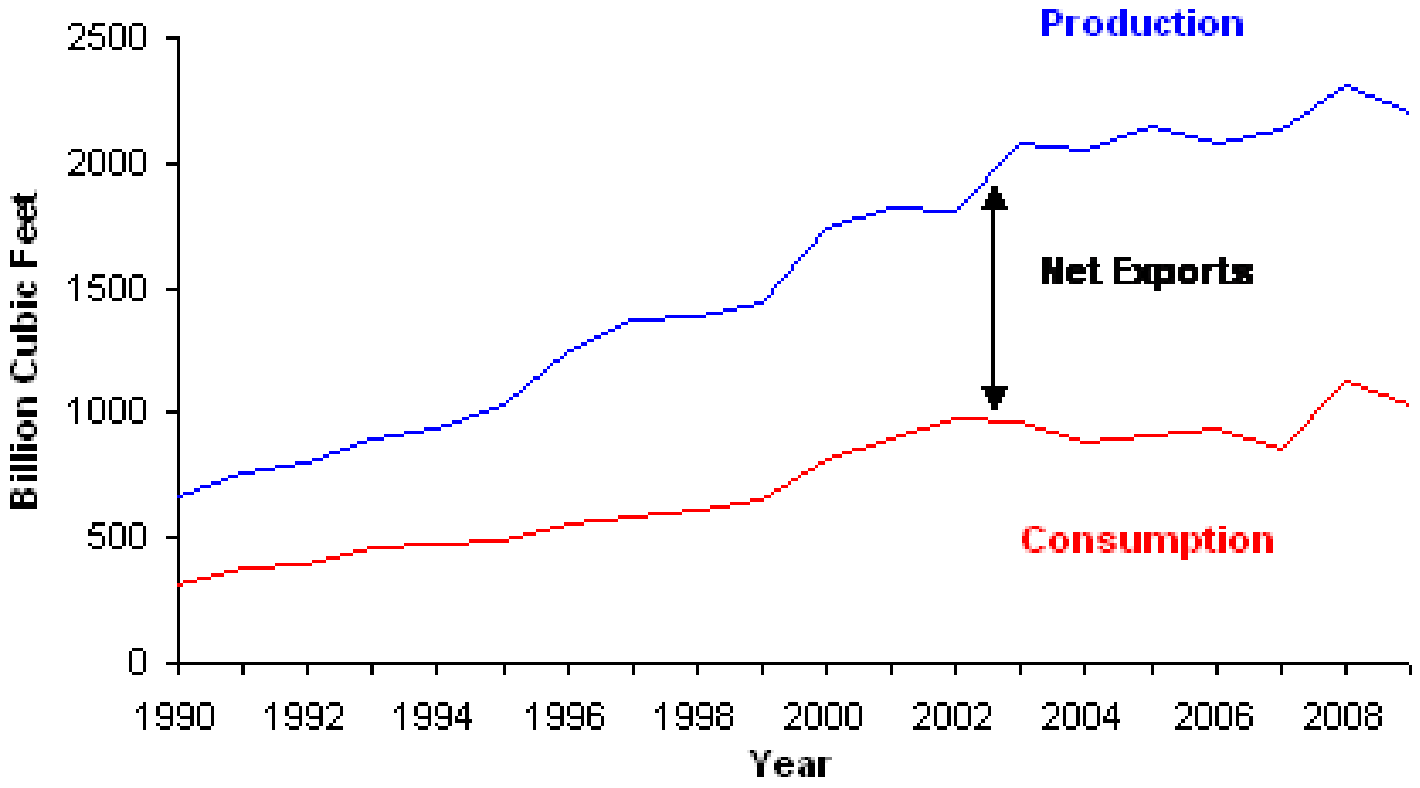
Source: EIA

Source: http://www.eia.gov

- Malaysia contains 75 trillion cubic feet (Tcf) of proven natural gas reserves.
- Natural gas production has been rising steadily in recent years, reaching 1.7 Tcf in 2002.
- Natural gas consumption in 2002 was estimated at 1.0 Tcf, with LNG exports of around 0.7 Tcf (mostly to Japan, South Korea and Taiwan).
- Malaysia accounted for approximately 14% of total world LNG exports in 2003.
- In addition to LNG, Malaysia exports 150 million cubic feet per day (Mmcf/d) to Singapore via pipeline.

- Surprisingly, Malaysia also is an importer of gas from Indonesia . Petronas signed an agreement in April 2001 with Indonesia state oil and gas company Pertamina for the import of gas from Conoco's West Natuna offshore field in Indonesian waters.

Malaysian Natural Gas Production and Consumption, 1990-2009



Source: EIA

Source: http://www.eia.gov

Refining and Downstream

- Malaysia has six refineries, with a total processing capacity of almost 600,000 bbl/d.
  - Kertih Refinery (Petronas), Terengganu, 40,000 bbl/d.
  - Melaka I Refinery (Petronas) Melaka, 100,000 bbl/d.
  - Melaka II Refinery (Petronas/Conoco Philips) Melaka, 170,000 bbl/d.
  - Port Dickson Refinery (Royal Dutch Shell), 156,000 bbl/d.
  - Esso Port Dickson Refinery (ExxonMobil), 88,000 bbl/d.
  - Lutong Refinery (Royal Dutch Shell) Sarawak, 45,000 bbl/d

Source: wikipedia.org/

Petronas

- **Petronas**, short for ***Petroliam Nasional Berhad***,[1] is a Malaysian-owned oil and gas company that was founded on August 17, 1974.
- Wholly owned by the Government, the corporation is vested with the entire oil and gas resources in Malaysia and is entrusted with the responsibility of developing and adding value to these resources.
- Since its incorporation, Petronas has grown to be an integrated international oil and gas company with business interests in 31 countries.

More information: http://en.wikipedia.org/wiki/Petronas

Production Sharing Contract

- **Production Sharing Contracts (PSC)** or **Production sharing agreements (PSAs)** are a common type of contract signed between a government and a resource extraction company (or group of companies) concerning how much of the resource (usually oil) extracted from the country each will receive.

More information: http://en.wikipedia.org/wiki/Petronas

- In PSAs the country's government awards the execution of exploration and production activities to an oil company. The oil company bears the mineral and financial risk of the initiative and explores, develops and ultimately produces the field as required. When successful, the company is permitted to use the money from produced oil to recover capital and operational expenditures, known as "cost oil". The remaining money is known as "profit oil", and is split between the government and the company, typically at a rate of about 80% for the government, 20% for the company. In some PSAs, changes in international oil prices or production rate can affect the company's share of production.

Source: wikipedia.org/