Petroleum Engineering

Prepared by
Sakibul Islam Swan
Lecturer
Department of Mechanical Engineering
University of Global Village

Basic Course Information

Course Title	**Petroleum Engineering**
Course Code	ME-463
Credits	03
CIE Marks	90
SEE Marks	60
Exam Hours	2hours (Mid Exam) 3hours (Semester Final Exam)
Level	8th Semester

ASSESSMENT PATTERN CIE- Continuous Internal Evaluation (90 Marks)

Bloom's Category Marks (out of 90)	Tests (45)	Assignments (10)	Class Test (20)	Quiz (5)	External Participation in Curricular/Co-Curricular Activities (10)
Remember	**5**		**10**	**05**	
Understand	**5**	**05**	**10**		
Apply	**10**				**10**
Analyze	**15**				
Evaluate	**10**				
Create		**05**			

SEE- Semester End Examination (60 Marks)

Bloom's Category	Test
Remember	**10**
Understand	**10**
Apply	**10**
Analyze	**10**
Evaluate	**10**
Create	**10**

Course Learning Outcomes

- **CLO-1**:This CLO emphasizes the core scientific and engineering principles that underpin all aspects of the petroleum industry

- **CLO-2**:This CLO focuses on the practical application of reservoir engineering concepts to assess and optimize hydrocarbon production

- **CLO-3** This CLO highlights the importance of well engineering in the petroleum industry, emphasizing safe and efficient well construction and maintenance.

- **CLO-4**:his CLO emphasizes the importance of strong communication skills for successful careers in the petroleum industry, enabling effective collaboration and knowledge sharing..

Course Objectives

The objectives of Petroleum Engineering course are to:

- **To locate and evaluate potential hydrocarbon reservoirs:** This involves using geological, geophysical, and other scientific methods to identify areas with promising oil and gas deposits).
- **To design and implement drilling operations:** This includes planning and executing the drilling of wells to reach hydrocarbon reservoirs, considering factors like well depth, formation pressure, and drilling fluid properties..
- **To optimize hydrocarbon production:** This involves developing and implementing strategies to maximize the recovery of oil and gas from reservoirs, such as enhanced oil recovery techniques.).
- **To ensure the safety and environmental sustainability of operations:** This includes minimizing risks to personnel and the environment throughout the entire hydrocarbon production process.

Course Summary

Serial No	Course Content	Hours
01.	Composition of Petroleum; thermal properties of petroleum, important product properties and test methods; Dehydration of Crude Oil, Desalting of Crude Oil, Crude Oil Stabilization and Sweetening, distillation of petroleum, ADU, VDU.	5
02.	blending of gasoline; fraction-impurities, treatment of gasoline, treatment of kerosene, wax and purification; Cracking, catalytic cracking, catalytic reforming, naphtha cracking, cooking, hydrogen processes, and alkylation processes isomerization processes.	5
03.	Origin of natural gas, Properties of natural gas, overview of the natural gas industries in Bangladesh. Basics, Properties, Composition, Liquefaction technologies, Production processes	15
04.	LNG carrier, LPG cylinders/tanks/vessels, Storage and handling, LPG cylinder sizing, Fire hazards, Safety legislation, Commercial and industrial uses.	15

Course Summary

Serial No	Course Content	Hours
05.	Lube Oil Base Stocks, Lube oil processing, Propane de-asphalting, solvent extraction, De-waxing, Specifications of lube oil, Lube Additives. ;	5
06.	Fundamentals of gas flow through conduits, orifice meter, Flow control and pressure regulating instruments.	5

Course Plan Mapped with CLO

Week No.	Topics	Teaching Learning Strategy	Assessment strategy	Alignment To CLO
1.	Composition of Petroleum; thermal properties of petroleum, important product properties and test methods	Lecture, Multimedia	Feedback, Q&A	CLO 1
2.	ehydration of Crude Oil, Desalting of Crude Oil, Crude Oil Stabilization and Sweetening	Lecture, Discussion Multimedia	Feedback, Q&A	CLO 1
3.	distillation of petroleum, ADU, VDU. lending of gasoline; fraction-impurities	Lecture, Multimedia	Feedback, Q&A	CLO 2
4.	treatment of gasoline, treatment of kerosene, wax and purification; Cracking, catalytic cracking, catalytic reforming	Lecture, Multimedia	Feedback, Q&A	CLO 2

Course Plan Mapped with CLO

Week No.	Topics	Teaching Learning Strategy	Assessment strategy	Alignment To CLO
5.	naphtha cracking, cooking, hydrogen processes, and alkylation processes isomerization processes	Lecture, Multimedia	Feedback, Q&A	CLO 2
6.	Origin of natural gas, Properties of natural gas, overview of the natural gas industries in Bangladesh	Lecture, Discussion Multimedia	Feedback, Q&A	CLO 2
7.	Basics, Properties, Composition, Liquefaction technologies, Production processes	Lecture, Multimedia	Feedback, Q&A	CLO 3
8.	LNG carrier, LPG cylinders/tanks/vessels, Storage and handling,	Lecture, Multimedia	Feedback, Q&A	CLO 3

Course Plan Mapped with CLO

Week No.	Topics	Teaching Learning Strategy	Assessment strategy	Alignment To CLO
9.	Fire hazards, Safety legislation, Commercial and industrial uses	Lecture, Multimedia	Feedback, Q&A	CLO 3
10.	Lube Oil Base Stocks, Lube oil processing, Propane de-asphalting	Lecture, Discussion Multimedia	Feedback, Q&A	CLO 3
11.	de-asphalting, solvent extraction, De-waxing	Lecture, Multimedia	Feedback, Q&A	CLO 4
12.	Specifications of lube oil, Lube Additives.	Lecture, Multimedia	Feedback, Q&A	CLO 4

Course Plan Mapped with CLO

Week No.	Topics	Teaching Learning Strategy	Assessment strategy	Alignment To CLO
13.	Fundamentals of gas flow through conduits, orifice meter	Lecture, Multimedia	Feedback, Q&A	CLO 4
14.	Flow control and pressure regulating instruments	Lecture, Discussion Multimedia	Feedback, Q&A	CLO 4
15.	Sweetening of natural gas, Sour gas treating, Sulfur removal processes, Solid bed sweetening processes,	Lecture, Multimedia	Feedback, Q&A	CLO 4
16.	Physical absorption and chemical absorption process	Lecture, Multimedia	Feedback, Q&A	CLO 4

❖ Week 01

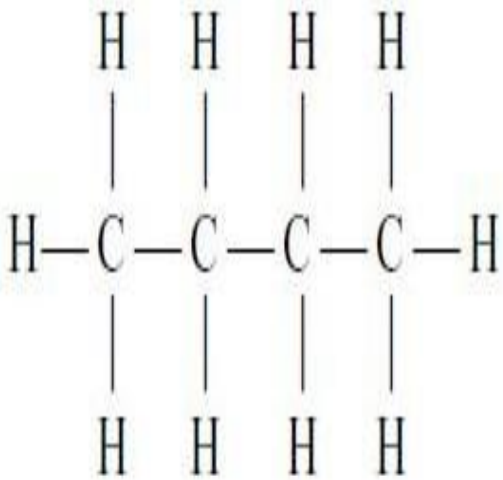
Petroleum

Petroleum, also known as crude oil, or simply oil, is a naturally occurring yellowish-black liquid mixture of mainly hydrocarbons and is found in geological formations. The name petroleum covers both naturally occurring unprocessed crude oil and petroleum products that consist of refined crude oil. A fossil fuel, petroleum is formed when large quantities of dead organisms, mostly zooplankton and algae, are buried underneath sedimentary rock and subjected to both prolonged heat and pressure.

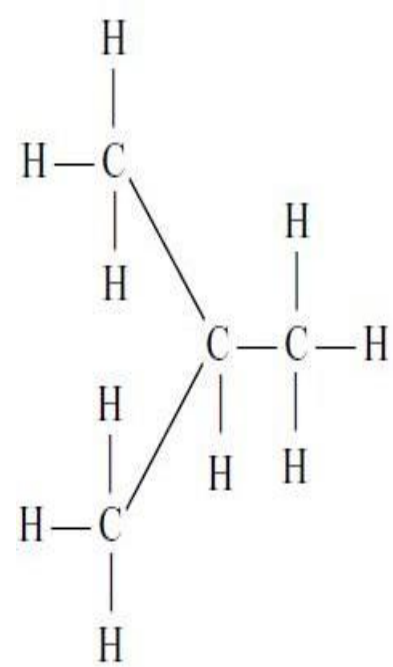
The word petroleum comes from Medieval Latin petroleum (literally 'rock oil'), which comes from Latin petra 'rock' (from Greek pétra) and oleum 'oil' (from Greek élaion).

Composition of Petroleum (Crude Oil)

Crude oil is a mixture of literally hundreds of hydrocarbon compounds ranging in size from the smallest, methane, with only one carbon atom, to large compounds containing 300 and more carbon atoms. A major portion of these compounds are paraffins (Paraffins, also known as alkanes, are saturated compounds that have the general formula C_nH_{2n+2}, where n is the number of carbon atoms) or isomers of paraffins. A typical example is butane shown below:



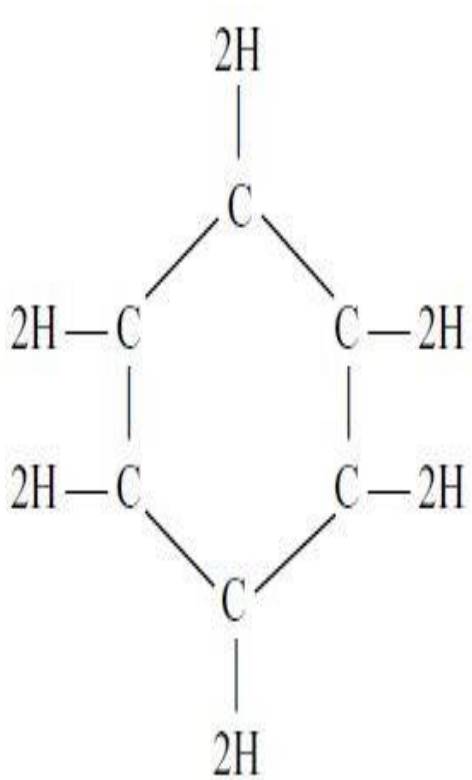
Normal butane (denoted as nC4)



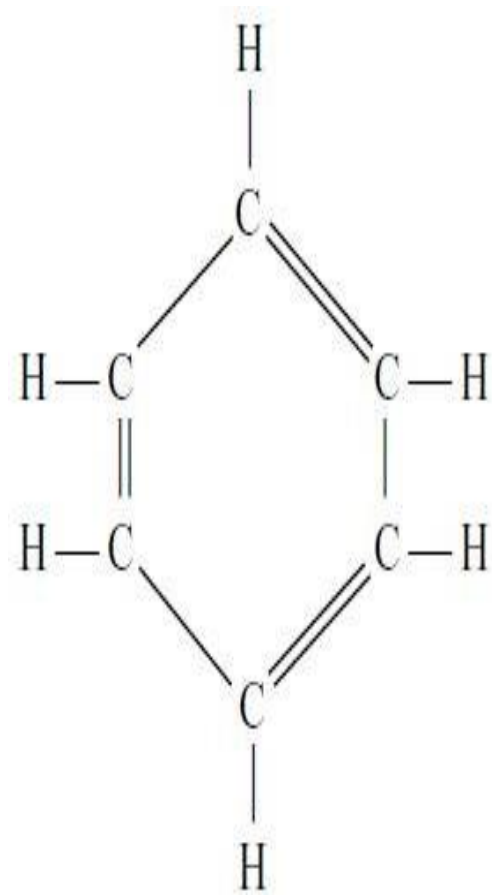
Isobutane (denoted as iC4)

Composition of Petroleum (Crude Oil)

Most of the remaining hydrocarbon compounds are either cyclic paraffins called naphthenes or deeply dehydrogenated (Dehydrogenation is the process by which hydrogen is removed from an organic compound to form a new chemical, e.g., to convert saturated into unsaturated compounds) cyclic compounds as in the aromatic family of hydrocarbons. Examples of these are shown below:



Cyclohexane (Naphthene)



Benzene (Aromatic)

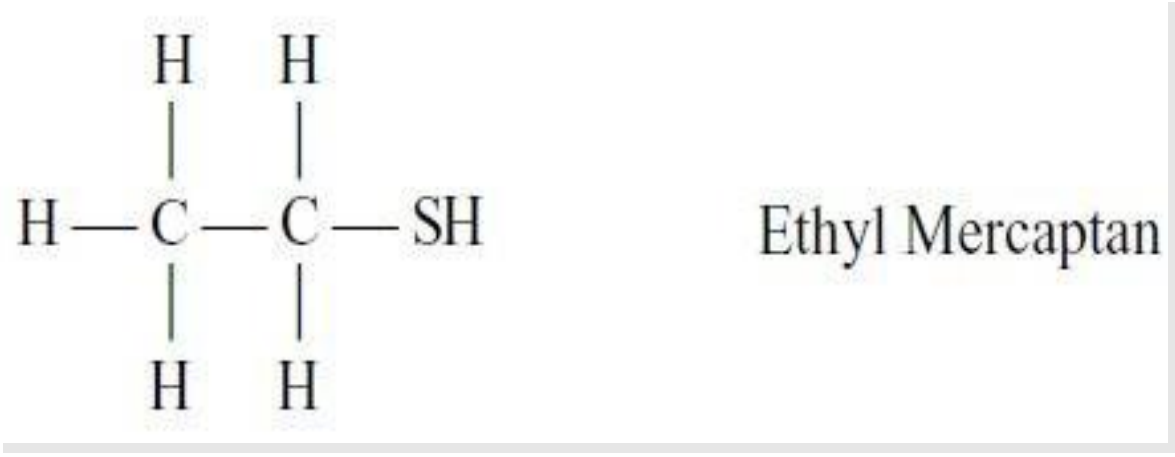
Composition of Petroleum (Crude Oil)

Only the simplest of these homologues (A homologue is a compound belonging to a series of compounds differing from each other by a repeating unit, such as a methylene bridge $-CH_2-$) can be isolated to some degree of purity on a commercial scale. Generally, in refining processes, isolation of relatively pure products is restricted to those compounds lighter than C7's. The majority of hydrocarbon compounds present in crude oil have been isolated however, but under delicate laboratory conditions.

Not all compounds contained in crude oil are hydrocarbons. There are present also as impurities, small quantities of sulfur, nitrogen and metals. By far the most important and the most common of these impurities is sulfur. This is present in the form of hydrogen sulfide and organic compounds of sulfur. These organic compounds are present through the whole boiling range of the hydrocarbons in the crude.

Composition of Petroleum (Crude Oil)

They are similar in structure to the hydrocarbon families themselves, but with the addition of one or more sulfur atoms. The simplest of these is ethyl mercaptan which has a molecular structure as follows:



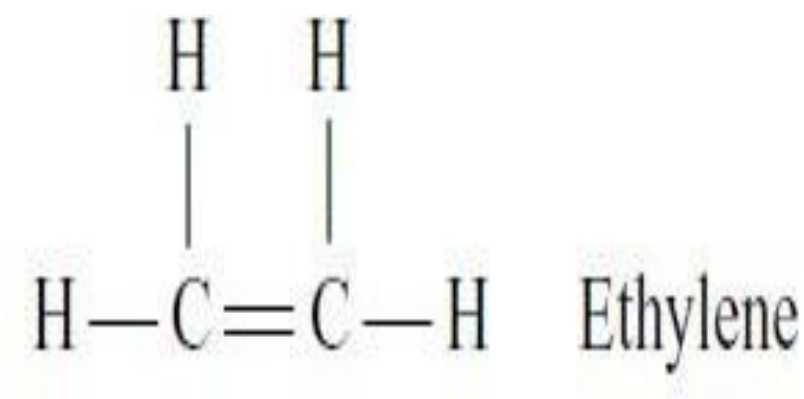
Ethyl Mercaptan

Organic chloride compounds are also present in crude oil. The most common metal impurities found in crude oils are nickel, vanadium, and sodium. These are not very volatile and are found in the residuum or fuel oil products of the crude oil. Nitrogen, the remaining impurity is usually found as dissolved gas in the crude or as amines or other nitrogen compounds in the heavier fractions.

Although the major families or homologues of hydrocarbons found in all crude oils as described earlier are the paraffins, cyclic paraffins and aromatics, there is a fourth group.

Composition of Petroleum (Crude Oil)

These are the unsaturated or olefinic hydrocarbons. They are not naturally present in any great quantity in most crude oils, but are often produced in significant quantities during the processing of the crude oil to refined products. An example of such an unsaturated compound is as follows:



Although all crude oils contain the composition described above, rarely are there two crude oils with the same characteristics. This is so because every crude oil from whatever geographical source contains different quantities of the various compounds that make up its composition. Crude oils produced in Nigeria for example would be high in cyclic paraffin content and have a relatively low specific gravity. Crude drilled in some of the fields in Venezuela on the other hand would have a very high gravity and a low content of material boiling below 350°C.

Thermal Properties of Petroleum

Heat of Combustion: The heat of combustion also called as calorific value or energy value of a substance is the energy released as heat when a compound undergoes complete combustion with oxygen under standard conditions. The chemical reaction is typically a hydrocarbon reacting with oxygen to form carbon dioxide, water and heat. It may be expressed with the quantities:

- energy/mole of fuel (J/mol)
- energy/mass of fuel
- energy/volume of fuel

The heat of combustion is traditionally measured with a bomb calorimeter. It may also be calculated as the difference between the heat of formation of the products and reactants.

Thermal Properties of Petroleum

Heat Capacity: Heat capacity is the amount of heat required to change the temperature of a given amount of matter by 1°C. The heat capacity of 1 gram of a substance is called its specific heat capacity (or specific heat), while the heat capacity of 1 mole of a substance is called its molar heat capacity.

Latent Heat of Vaporization: The enthalpy of vaporization, also known as the (latent) heat of vaporization or heat of evaporation, is the amount of energy (enthalpy) that must be added to a liquid substance to transform a quantity of that substance into a gas.

Viscosity and Viscosity Index (VI): Viscosity is a measure of a fluid's resistance to flow. Viscosity is a property which tends to decrease as the temperature increases. **Viscosity index (VI)** indicate the resistance of an oil to the changes in viscosity with temperature. Smaller the change in viscosity with temperature, higher is the viscosity index of the oil.

Thermal Properties of Petroleum

Thermal Conductivity: The thermal conductivity of a material is a measure of its ability to conduct heat. Heat transfer occurs at a lower rate in materials of low thermal conductivity than in materials of high thermal conductivity.

Thermal expansion: Thermal expansion is the tendency of matter to change its shape, area, volume, and density in response to a change in temperature, usually not including phase transitions of phase change.

❖ Week 02

History of Natural Gas

- Natural gas seeps were discovered in Iran between 6000 and 2000 BC.
- The practical use of natural gas dates back to the Chinese 2500 years ago
- Natural gas was unknown in Europe until its discovery in England in 1659. However, since manufactured gas (coal gas) was already commercially available, natural gas remained unpopular
- In 1815, natural gas was discovered in the United States during digging of a saltbrine well in Charleston, West Virginia
- The 19th century is considered as the starting point of the gas industry
- Even in the ‘20s and '30s, natural gas was only produced as an unwanted byproduct of crude oil production. Only a small amount of gas was pipelined to industrial areas for commercial use, most of it being vented to the air or flared.

History of Natural Gas

- Throughout the 19th century, natural gas was used almost exclusively as a source of light.
- Its use remained localized because of lack of transport structures, making it difficult to transport large quantities of natural gas long distances.
- After World War II that the use of natural gas grew rapidly because of the development of pipeline networks and storage systems.
- After the crude oil shortages of the seventies, natural gas has become an important source of energy in the world.
- The first natural gas pipeline longer than 200 miles was built in 1925, from Louisiana to Texas
- Natural gas now accounts for almostone-fifth of the world's primary energy consumption, surpassing coal and second only to oil.

What is Natural Gas?

- Natural gas is a mixture of gases which are rich in hydrocarbons. All these gases (methane, nitrogen, carbon dioxide etc) are naturally found in atmosphere. Natural gas reserves are deep inside the earth near other solid & liquid hydrocarbons beds like coal and crude oil.
- Natural gas is a naturally occurring mixture of gaseous hydrocarbons consisting primarily of methane in addition to various smaller amounts of other higher alkanes. Usually low levels of trace gases like carbon dioxide, nitrogen, hydrogen sulfide, and helium are also present.

What is Natural Gas?

Typical Constituents of Natural Gas (Modified after McCain, 1974)

Category	Component	Amount, %
Paraffinic HC's	Methane (CH_4)	70 - 98%
	Ethane (C_2H_6)	1 - 10%
	Propane (C_3H_8)	trace - 5%
	Butane (C_4H_{10})	trace - 2%
	Pentane (C_5H_{12})	trace - 1%
	Hexane (C_6H_{14})	trace - 0.5%
	Heptane & higher (C_7+)	none - trace
Cyclic HC's	Cyclopropane (C_3H_6)	traces
	Cyclohexane (C_6H_{12})	traces
Aromatic HC's	Benzene (C_6H_6), others	traces
Non-hydrocarbon	Nitrogen (N_2)	trace - 15%
	Carbon dioxide (CO_2)	trace - 1%
	Hydrogen sulfide (H_2S)	trace occasionally
	Helium (He)	trace - 5%
	Other sulfur and nitrogen compounds	trace occasionally
	Water (H_2O)	trace - 5%

Properties of Natural Gas

The following are the properties of Natural Gas :

- The state of matter of this gas is gaseous.
- It doesn’t have any color and is a tasteless gas.
- It is free of any kind of toxic, there is no smoke on burning and it has high calorific value.
- The gas is odorless. However, a chemical called mercaptan is added to it in small amounts to give it distinctive smell of eggs. This helps to find out any gas leaks.
- It is a combustible gas and a fossil fuel.

Properties of Natural Gas

- Its a mixture of simple hydrocarbon compounds.
- It contains primarily methane, along with small amounts of ethane, butane, pentane, and propane.
- The by-products of this gas are water vapor and carbon dioxide.
- Air is 60% heavier than natural gas.
- It has a low flammability range and a high ignition temperature.
- Generally, it is transported through pipes.
- It occurs naturally in the rocks beneath the earth’s surface, in sedimentary rocks that are porous.

Origin of Natural Gas

- Natural gas is a fossil fuel. Like other fossil fuels such as coal and oil, natural gas forms from the plants, animals, and microorganisms that lived millions of years ago.
- There are several different theories to explain how fossil fuels are formed. The most prevalent theory is that they form underground, under intense conditions. As plants, animals, and microorganisms decompose, they are gradually covered by layers of soil, sediment, and sometimes rock. Over millions of years, the organic matter is compressed. As the organic matter moves deeper into Earth's crust, it encounters higher and higher temperatures.

❖ Week 03

Origin of Natural Gas

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Origin of Natural Gas

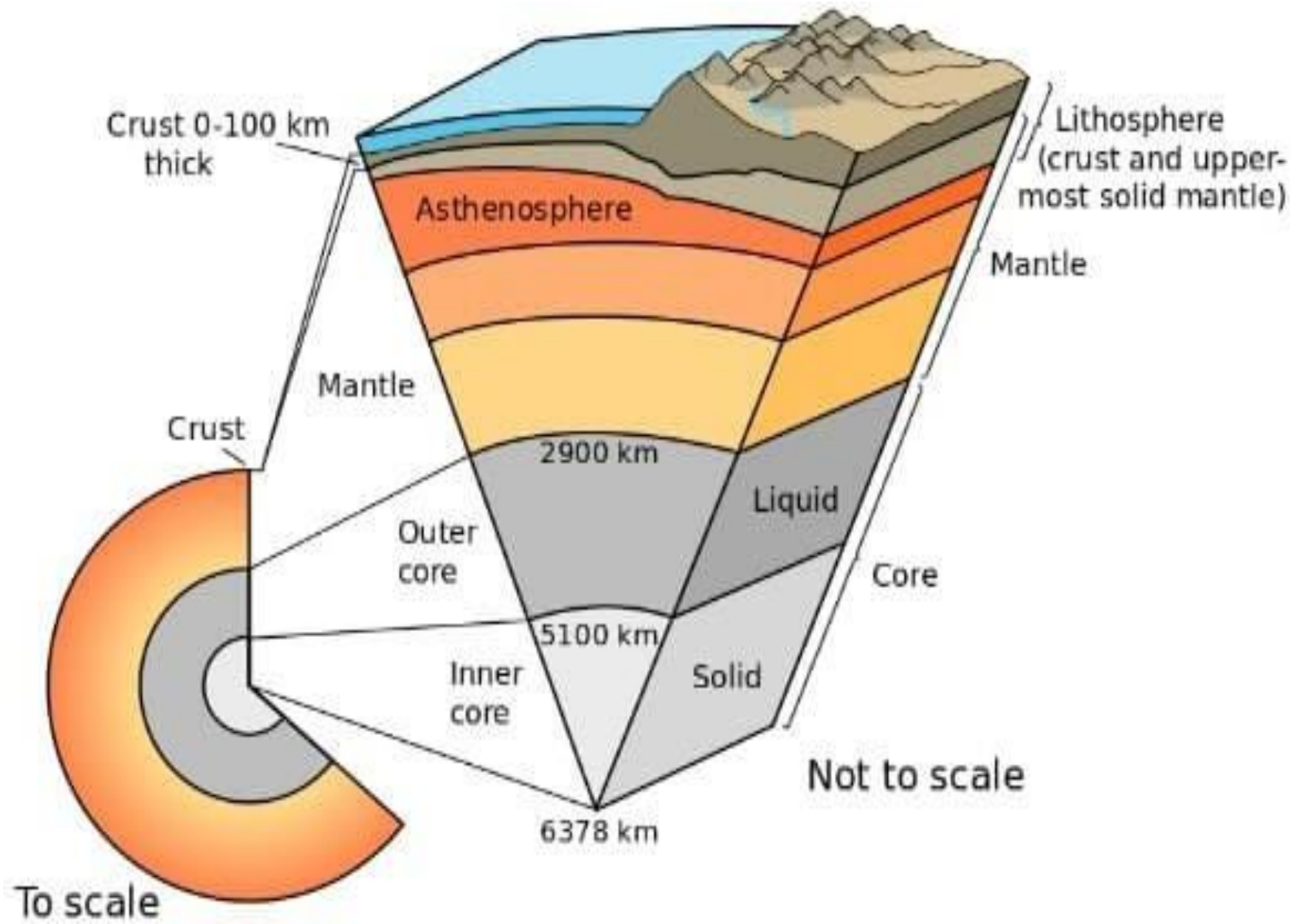
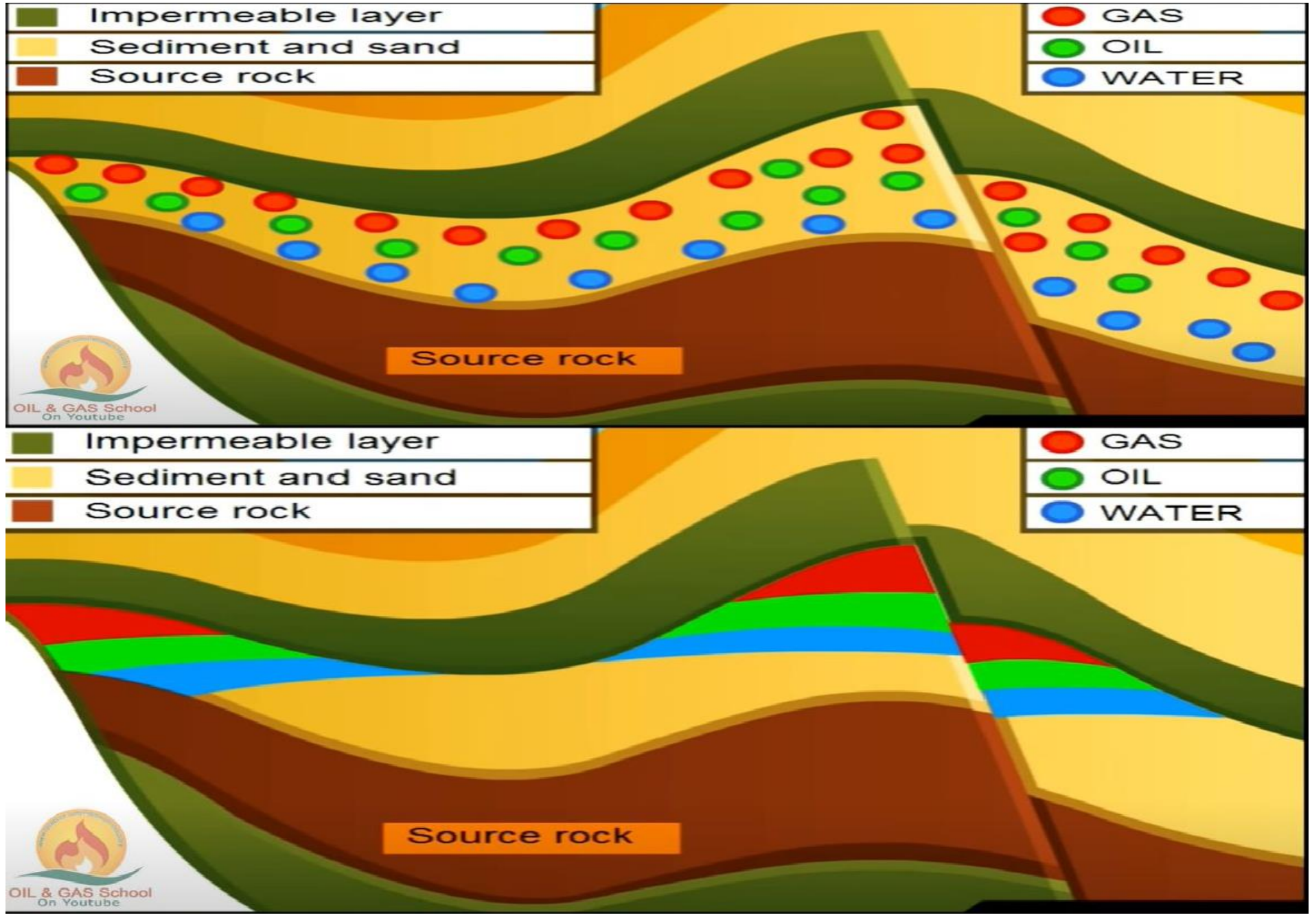


Figure: Internal Structure of the Earth

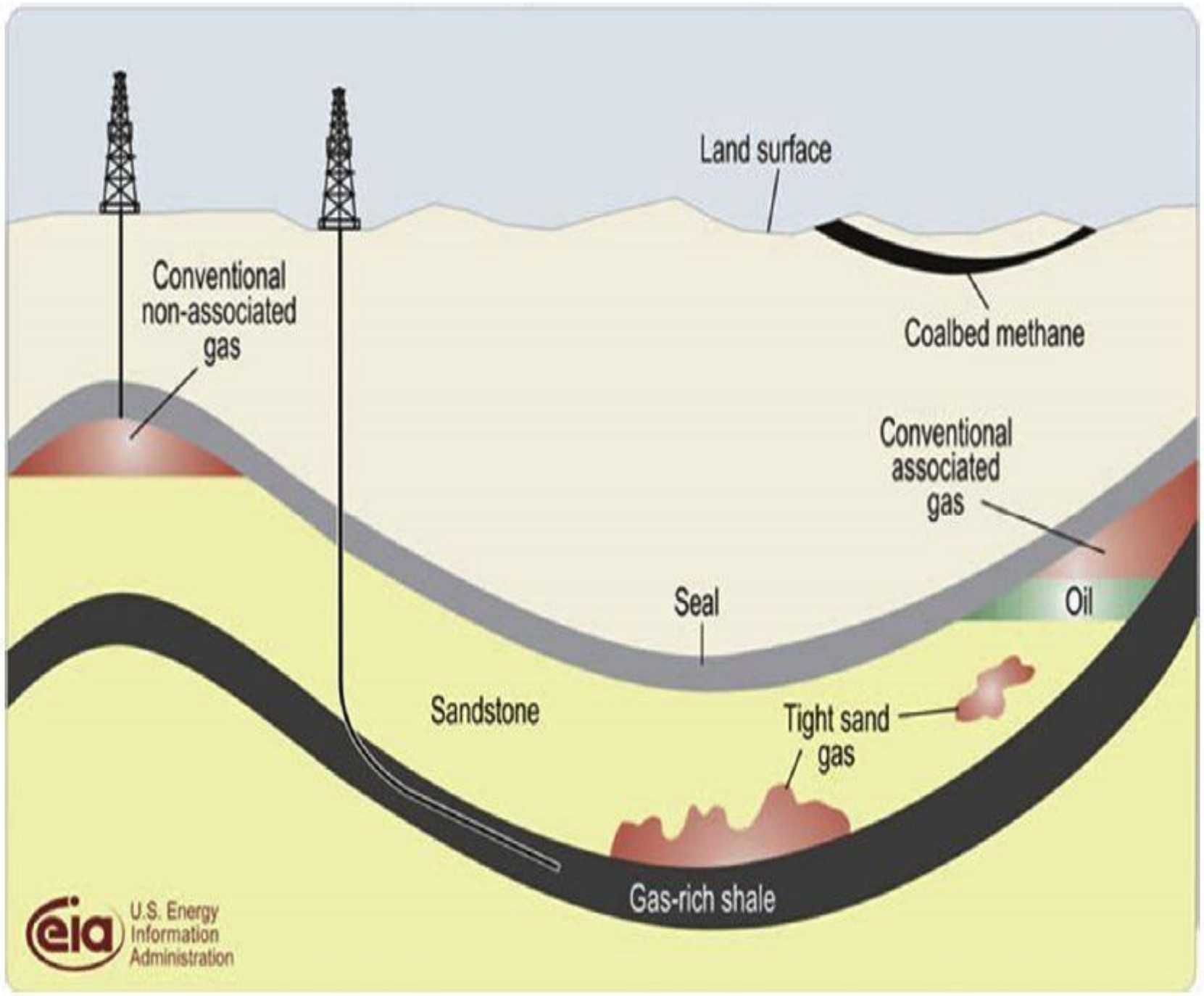
Origin of Natural Gas



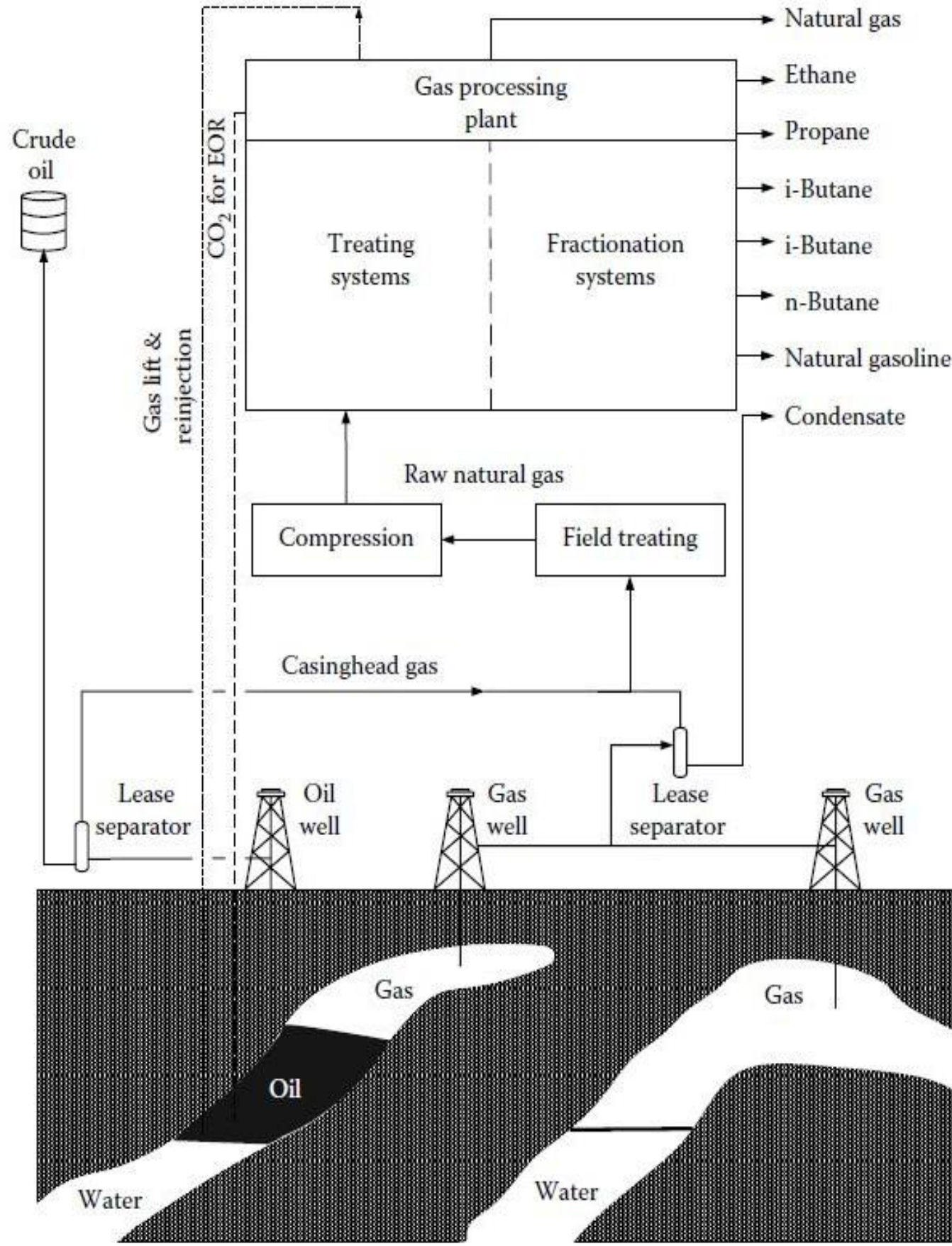
Origin of Natural Gas

- The combination of compression and high temperature causes the carbon bonds in the organic matter to break down. This molecular breakdown produces thermogenic methane-natural gas. Methane, probably the most abundant organic compound on Earth, is made of carbon and hydrogen (CH_4).
- Natural gas deposits are often found near oil deposits. Deposits of natural gas close to the Earth’s surface are usually prevented from developing by nearby oil deposits. Deeper deposits - formed at higher temperatures and under more pressure - have more natural gas than oil. The deepest deposits can be made up of pure natural gas.

Origin of Natural Gas (Resources)



Schematic geology of natural gas resources.



Schematic overview of natural gas industry. (Adapted from Cannon, 1993.)

❖ Week 04

Natural Gas Industries of Bangladesh

Petrobangla: PetroBangla (Bangladesh Oil, Gas & Mineral Corporation) is a government-owned national oil company of Bangladesh. It explores, produces, transports, manages and sells oil, natural gas and other mineral resources. It also concludes production sharing agreements with other international oil companies for exploration and development of oil and gas resources in Bangladesh.

Petrobangla companies:

1. Gas Exploration And Production Companies
2. Gas Transmission Company
3. Gas Distribution Companies
4. LNG, CNG and LPG and Mining Companies

Natural Gas Industries of Bangladesh

Gas exploration and production companies

1. Bangladesh Petroleum Exploration and Production Company Ltd (BAPEX)
2. Bangladesh Gas Fields Company Limited (BGFCL)
3. Sylhet Gas Fields Limited (SGFL)

Gas Transmission Company

Gas Transmission Company Limited (GTCL)

Natural Gas Industries of Bangladesh.

Gas Distribution Companies

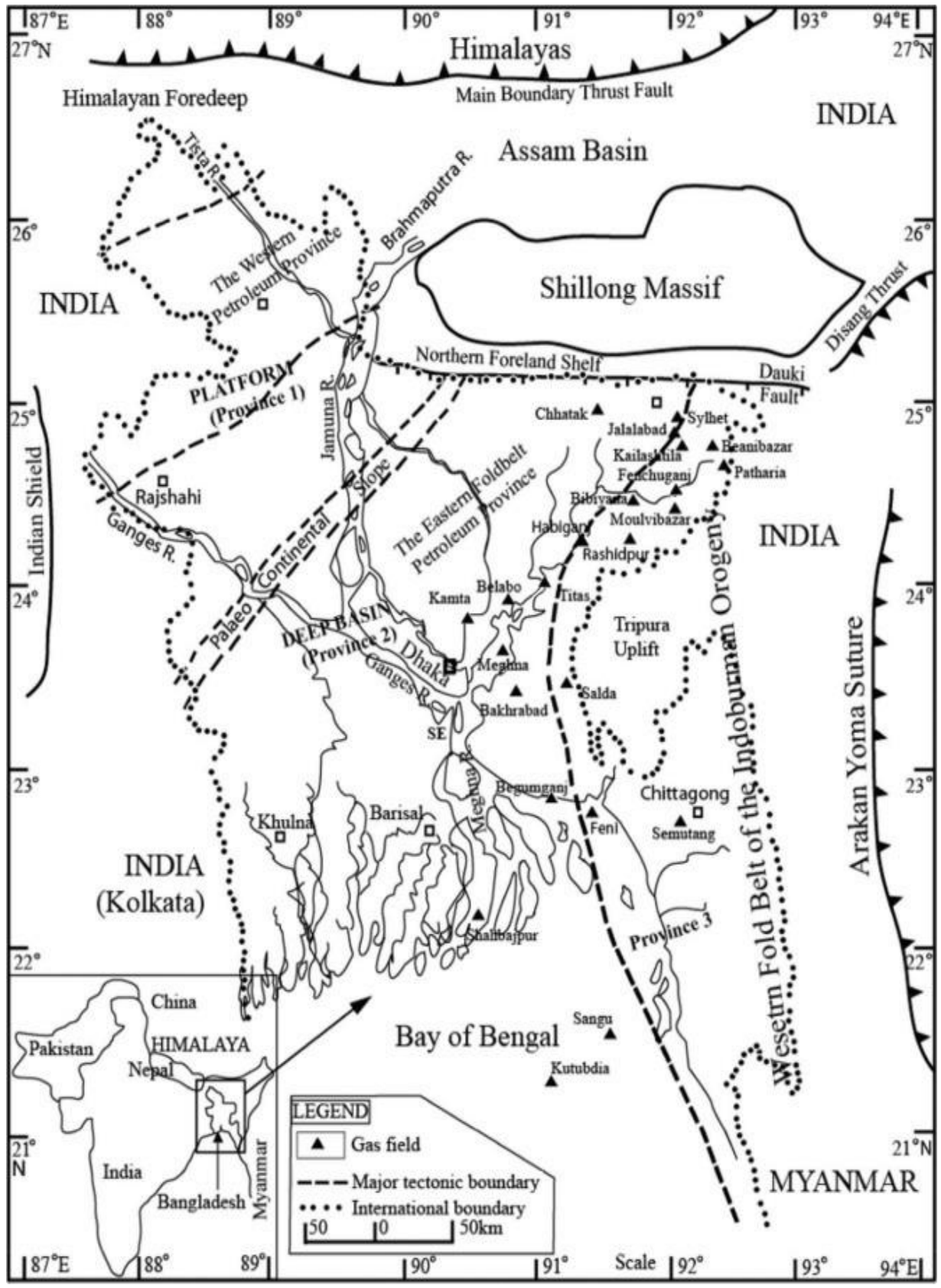
1. Titas Gas Transmission & Distribution Company Limited (TGTDCL)
2. Bakhrabad Gas Distribution Company Limited (BGDCL)
3. Jalalabad Gas Transmission and Distribution System Limited (JGTDSL)
4. Pashchimanchal Gas Company Limited (PGCL)
5. Karnaphuli Gas Distribution Company Limited (KGDCL)
6. Sundarban Gas Company Limited (SGCL)

Natural Gas Industries of Bangladesh

LNG, CNG and LPG and Mining Companies

1. Rupantarita Prakritik Gas Company Limited (RPGCL)
2. Barapukuria Coal Mining Company Limited (BCMCL)
3. Maddhapara Granite Mining Company Limited (MGMCL)

Natural Gas Fields in Bangladesh



❖ Week 06

Class Outline

- LPG
- LNG
- NGL
- CNG
- LPG or LNG Terminal
- LPG Sphere

LPG

- What is LPG (LIQUEFIED PETROLEUM GAS)?
- LPG is also known as butane (C_4H_{10}), propane (C_3H_8), or a mixture of both. It is highly flammable and produced from nonrenewable sources such as natural gas and oil production activities. It is stored in a gas bottle or cylinder, under pressure because of the high vapour pressure of both butane and propane at room temperature.
- As liquefied gas, the pressure inside the gas bottle or cylinder will remain unchanged until the last of the liquid LPG is vaporized. Meanwhile, the amount of propane content in the LPG determines the rate of vaporization. When released, LPG emits fewer hydrocarbons, oxides of nitrogen, and carbon monoxide – making it environmentally-friendly. Liquefied Petroleum Gas is rapidly gaining popularity today, as market research keeps revealing a wide range of applications.

LPG

- For example, LPG is used for heating appliances and cooking in many households in Bangladesh. However, when used at home, a gas regulator helps to detect leakages and automatically stops the flow of gas to the cooker to prevent fire outbreak and wastage. Its high-octane rating increases engine longevity, making it perfect for fueling vehicles.
- LPG is a clean, affordable and energy-efficient energy source that is readily available in Bangladesh and all over the world.

LNG

- LNG- LIQUEFIED NATURAL GAS
- LNG fuel is a natural gas that is converted to liquid form by chilling it to -161°C – a process known as liquefaction.
- LNG is comprised of 95% methane and 5% propane, nitrogen, carbon dioxide and ethane. It occupies 1/600th the volume of natural gas, making it easier to store and cost-effective to transport. Some interesting features of LNG are it is non-toxic and non-corrosive, making it environmental- friendly.
- Its odourless and colourless nature means it can only cause little or very low pollution. So, Liquefied Natural Gas can be used for operating sensitive and expensive equipment and machinery.

NGL

- ❖NGL-Natural Gas Liquids
- ❖Natural gas liquids (NGL) are components of natural gas that are separated from the gas state in the form of liquids. This separation occurs in a field facility or a gas processing plant through absorption, condensation, or other methods. There are several types of natural gas liquids and many different applications for NGL products.
- ❖Natural gas liquids are valuable as separate products, and it is profitable to remove NGL from the natural gas. The liquids are first extracted from the natural gas and later separated into different components. Natural gas liquids are hydrocarbons. As hydrocarbons, NGLs belong in the same family of molecules as do natural gas and crude oil.

❖ Week 06

CNG

- CNG-COMPRESSED NATURAL GAS
- Compressed Natural Gas is simply the gaseous form of petroleum. In relation to the name, CNG is the compressed form of natural gas. Like LNG, it is odourless, non-toxic and tasteless, making it an eco- friendly alternative fuel.
- CNG is made up of 93.05% methane, propane, carbon dioxide, nitrogen and traces of ethane. CNG is ideal for automobiles as the combustion process emits a lower percentage of greenhouse gases when compared to petrol and diesel.
- When using CNG, you're likely to get a reduction in CO emissions by 60-80%, NO_x is reduced by 50-80%, Ozone-producing Reactivity is reduced by 90-95%, Non-methane Organic Gas is reduced by 87%, and CO_2 is reduced by 20%.
- While traditional fuel releases toxic byproducts to the environment, CNG combustion contributes towards the reduction of ecological damage as it primarily releases water vapour as its byproduct.

❖LPG, LNG & CNG MAJOR DIFFERENCES

- ❖COMPOSITION: While LPG is comprised of propane and butane, LNP and CNG are mainly comprised of methane.
- ❖STORAGE: LPG is stored under high pressure. LNG is not pressurized; the contents of CNG are stored in tanks designed to release the gas more slowly.
- ❖PROCESSING: Light pressure is used to liquefy LPG; LNG is liquefied through exposure to extremely low temperatures, and CNG has a high compression ratio thanks to its octane rating.
- ❖MODE OF TRANSPORTATION: Both LPG and CNG are stored and transported in tanks or cylinders, whereas specially-designed cryogenic tanks and pipelines are used to store and transport LNG respectively.
- ❖SAFETY: Since LNG is not refrigerated, not under pressure, it is safer than LPG. CNG is safer than both LPG and LNG because it has a lighter weight than air, meaning it releases into the atmosphere when it spills.

❖LPG or LNG Terminal

❖A LPG or LNG terminal is a facility for managing the import and/or export of LPG/LNG. It comprises equipment for loading and unloading of LPG/LNG cargo to/from ocean-going tankers, for transfer across the site, liquefaction, re-gasification, processing, storage, pumping, compression, and metering of LPG/LNG. LPG/LNG as a liquid is the most efficient way to transport natural gas over long distances, usually by sea.

❖LPG Sphere

❖The reason why LPG is stored in spherical tank is liquid form gas is to be highly pressurized in order to keep it in liquid form.This is done effectively in sphere shaped tanks. As spherical shape is uniform pressure gets equally distributed. Also being no edges there are no chances of any uneven pressure area.

LPG Properties

Liquid petroleum gas (LP gas) or liquefied petroleum gas (LPG) is mixture of propane and butane. LPG is by-product from petroleum refining process.

Properties of LPG

- LPG is colourless gas.
- LPG is odourless.
- LPG is a liquid under pressure.
- The flash point of LPG is -104°C.
- LPG vapour is heavier than air.
- LPG will not ignite on its own at normal temperature.
- LPG in its liquid state is half as heavy as water
- Boiling point of LPG is low (-6°C)
- LPG is non-toxic.
- LPG is lightly anaesthetic and can cause suffocation.
- LPG is non-toxic.

For More Details about: LPG Properties
Visit this website: www.lpgstoragetank.com
Kindly click to above link.

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B-23, Mayanagari, Dapodi,Pune- 411012 Maharashtra India.
Tel: 020-30686720 / 21/ 22 Fax: 020-30686723
Email: bnhgastanks@gmail.com Web: www.bnhgastanks.com

LPG Sphere Maintenance

LPG Sphere is spherical shaped metal structure designed to store great amount of LPG gas. LPG spheres are best structure to store large volume of LPG gas using less land use. LPG Sphere is strong structure. LPG Spheres are mainly used in

- Oil and gas Refineries.
- Chemical Industry.
- Agrochemical Industry.
- Pharmaceutical Industry.

❖ Week 07

Class Outline

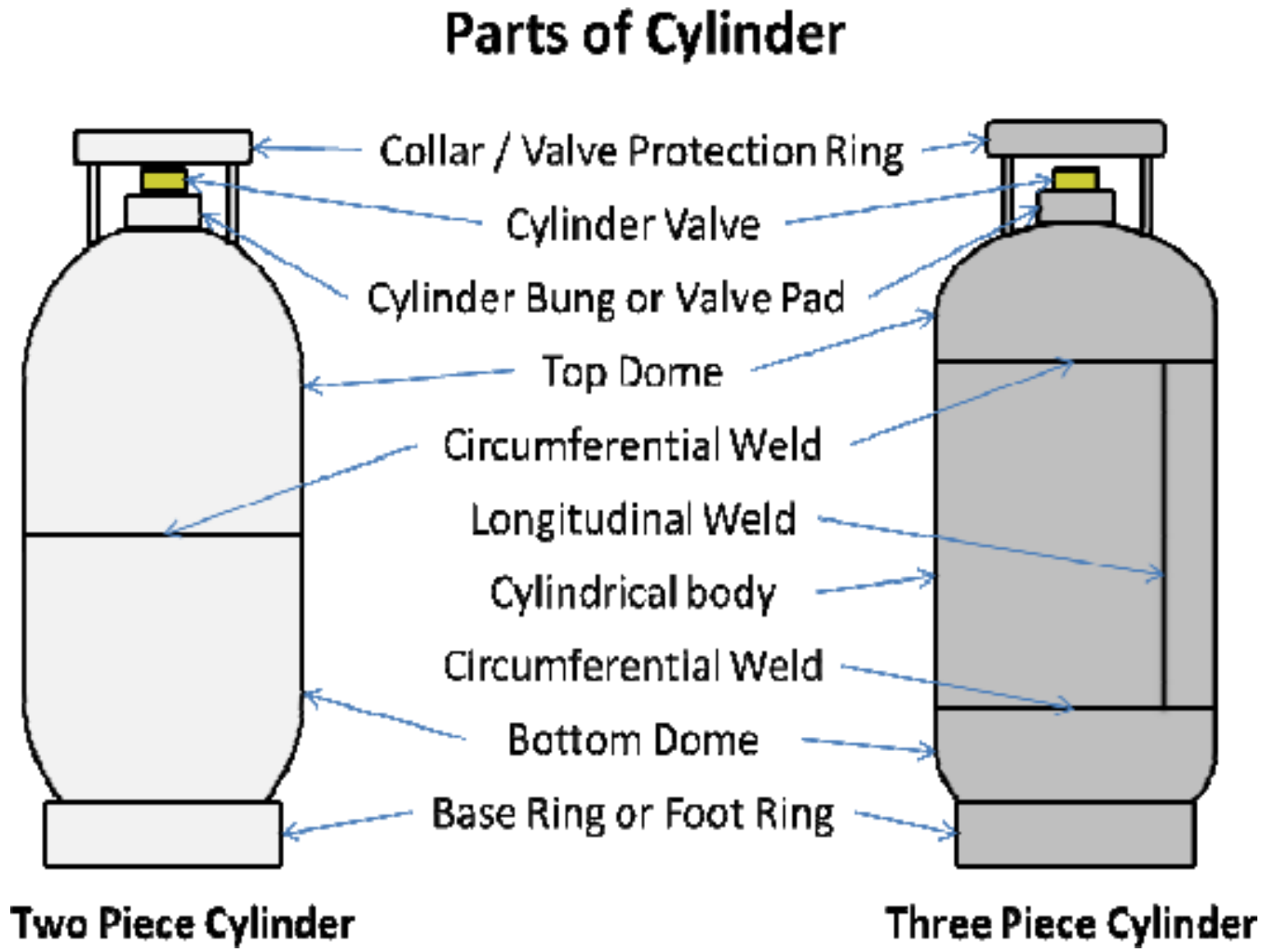
- LPG Basics
- LPG Cylinder
- LNG Carrier
- Construction of LNG Carrier
- Commercial and Industrial Use of LPG
- Fire Hazards & Safety Legislation

LPG Basics

- Liquefied Petroleum Gas, LPG (propane or butane) is a colour less liquid which readily evaporates into a gas. It is used as a fuel in heating appliances and vehicles. It is now increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons in an effort to reduce damage to the ozone layer.
- LPG is composed of the following hydrocarbons: propane, propylene, butane or butylene. LPG is stored and handled as a liquid when under pressure inside a LPG gas container. When compressed moderately at normal temperature, it becomes liquid. When pressure is withdrawn, the liquid reverts to gas. This means that it can be transported and stored as liquid and burnt as gas.
- LPG is odourless but a stench agent is added to assist in its detection in case of leakage. The odourant used in LPG is ethyl mercaptan, which owns a distinctive and unpleasant odour. Ethyl mercaptan is selected because it is non-corrosive, has low sulphur content and possesses a boiling point very near that of LPG.

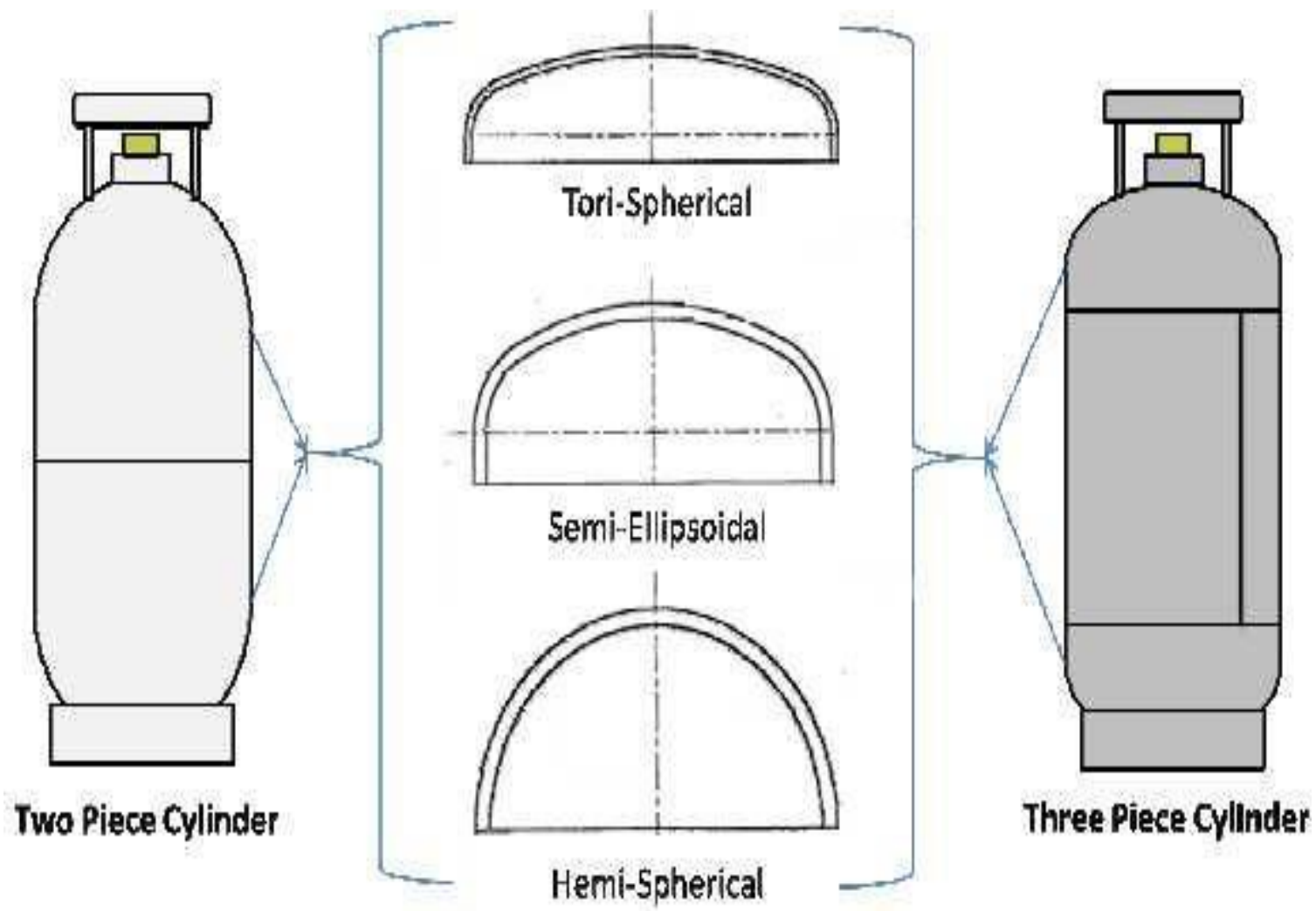
LPG Cylinder

- **Low carbon steel cylinder**
- The steel cylinders are manufactured either in two piece or three piece construction as shown in Figure. Body parts of a cylinder are explained in this Figure.



LPG Cylinder

❖In two piece construction, cylinders are fabricated by welding two domed ends directly together. A three piece cylinder is fabricated by joining two domed ends to a cylindrical body. The domed ends can be tori-Spherical, Semi ellipsoidal or Hemi-spherical in shape as shown in Figure.



LNG Carrier

- A LNG carrier is a ship that is designed for the transport of liquefied natural gas in its chilled tanks. Worldwide there were around 360 of these advanced, specialized vessels that are used specifically for the transport of liquefied natural gas in 2015. Compared to conventional vessels, LNG carriers release less greenhouse gas emissions because of their natural gas-fueled propulsion system.
- Since the gas is transported in its liquid form and because of their physical properties, they are transported either at pressures much greater than atmospheric pressures, at very low temperatures, or some combination of the two. Therefore, the ships can be classified as:

1. Fully pressurized
2. Semi-pressurized and refrigerated
3. Fully refrigerated

LNG Carrier

❖In addition, LNG carriers can be categorized based on the hazard level of the material being transported:

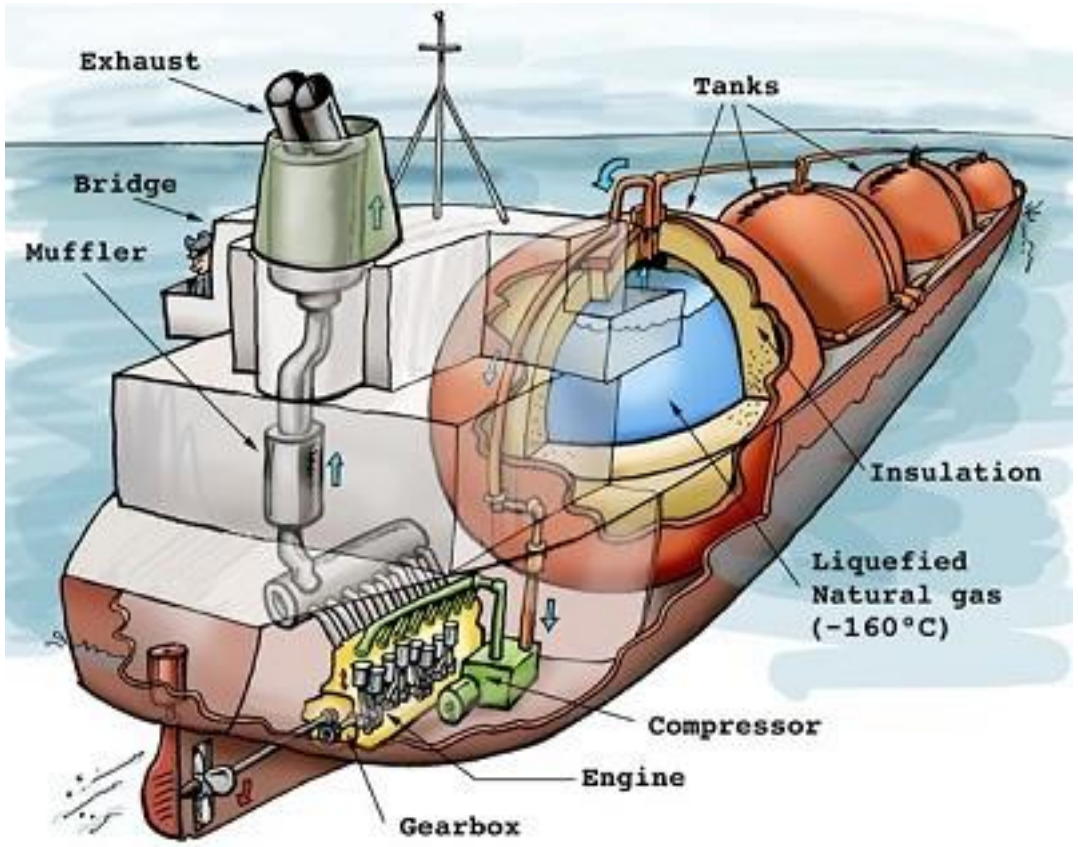
1. Type 1G: Designed to carry the most hazardous cargo
2. Type 2G and 2PG: Designed to carry cargo with a lesser degree of hazard
3. Type 3G: Designed to carry the least hazardous cargo

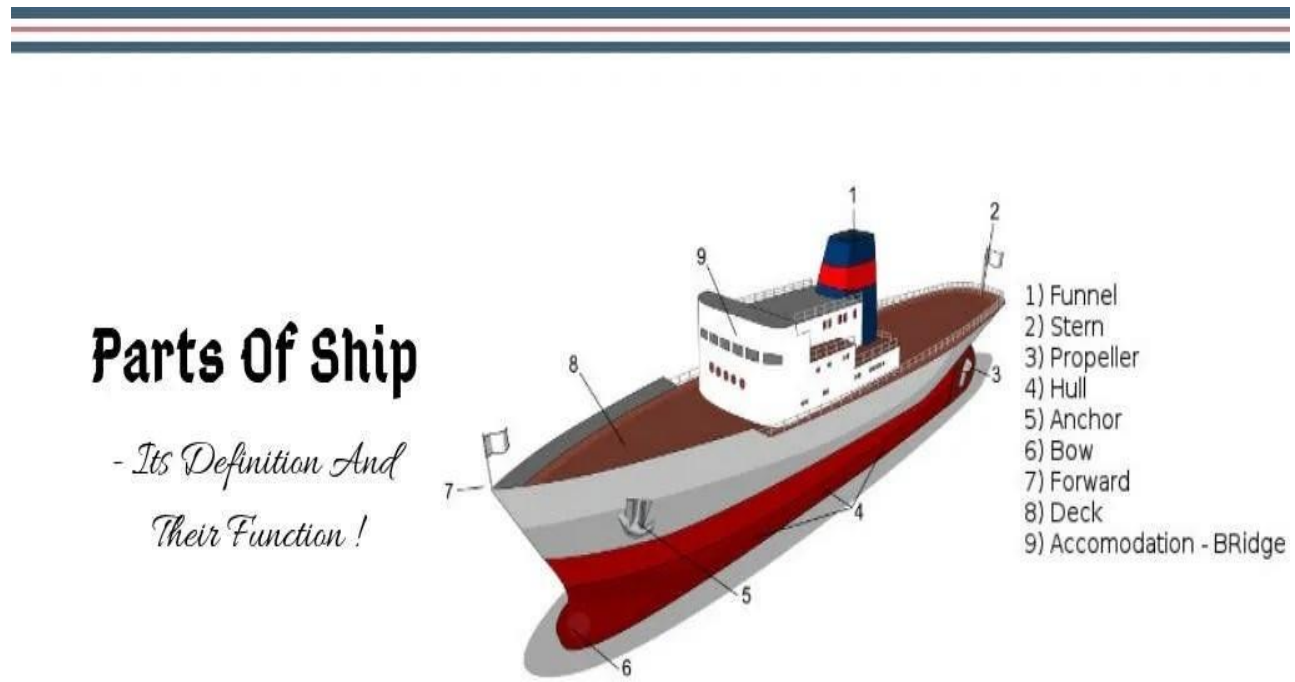
Construction of LNG Carrier

❖LNG carriers are built using a double hulled construction, with four or five large tanks to hold the liquefied gas. These tanks are generally composed of several layers of material to prevent leaks and keep the LNG at the cold temperature necessary to keep it in its liquid form. These tanks are also heavily insulated, minimizing the amount of LNG that boils off or evaporates during the transportation of the gas. Some vessels actually utilize this "boil off" to fuel the vessel itself. The tanks themselves are generally made of aluminum or 9% nickel steel.

❖ Week 09

Construction of LNG Carrier





Construction of LNG Carrier

- The materials used for the hull of the ship are designed to accommodate a wide range of temperatures. However, if the material in the hull gets too cold it will become brittle, thus it is important that the tanks (at temperatures of -160˚C) are insulated sufficiently to protect the hull from the harmful effects of these temperatures. The double hulled construction helps with this, as the insulated tanks are located within the inner hull. There is a space between the inner and outer hull to reduce the transfer of heat and protect cargo tanks in the event of some emergency. The cargo tanks are separated from each other and other components of the ship by dry compartments.

- In addition to these ships being advanced in the way that they hold the LNG, they are also equipped with advanced gas and fire detection and suppression systems to ensure that even a small leak would trigger a response. This makes a catastrophic fire on a LNG carrier extraordinarily unlikely.

Commercial and Industrial Use of LPG

❖**Commercial Uses of LPG**

❖Liquified Petroleum Gas (LPG) is a flammable gas made of petroleum. LPG can be used as fuel gas for most cooking equipment, heating appliances, and also vehicles. An industrial LPG cylinder differs from a domestic LPG cylinder in terms of its quantity and the rate of usage. When the rate of use is high, all industrial users will be given larger vessels. This is done so that they do not run out of gas fast.

❖Commercial LPG cylinders are strong and can serve the best to all consumers in the commercial market. LPG can also be used for various commercial purposes, from industries to your large chains of restaurants. The commercial uses of LPG are:

❖**Refrigerant**: LPG as a refrigerant - It serves as the best contender to replace CFC’s for domestic refrigerators as well as car air conditioners.

Commercial and Industrial Use of LPG

- **Fuel**: Commercial LPG is used as fuel for vehicles as it burns much better than petrol and diesel. It can be used as an ignition fuel as it is energy efficient and leaves less damage to the environment.
- **Agriculture**: Commercial LPG can be used in the field for agriculture for many drying processes.
- **Industry**: In industries, LPG can be used for solution heating processes. The paper and food processing industries use commercial LPG heavily.
- **Heating**: Commercial LPG is used for centralized heating solutions in industrial spaces.
- **Other**: LPG is also used to produce electrical energy by running turbines. Commercial LPG can be used as a chemical feedstock.

Commercial and Industrial Use of LPG

- **Industrial Use of LPG**
- **Ceramic -** LPG is one of the best choices of energy in this particular industry. Ceramics made of clay require a high heating value in order to dry and become hard and solid. Easily controllable, LPG provides clean combustion and is therefore advantageous in the maintenance process. Burners and kilns have to be maintained less often causing less downtime, with the consequence of saving costs and increasing productivity. As a choice energy, LPG is widely used in pottery, roofing, ceramic tiles and sanitary ware.
- **Food Processing** - LPG is widely used in many food processing systems because of its clean burning properties. Bakeries and the manufacturers of biscuits, chips and chocolate are inclined to choose LPG as their preferred energy option as their products will not be exposed to the risk of contamination. In addition, this energy is also used in slaughterhouse for the cleaning of facilities and sterilization, pork butchery in the process of cooking, drying and smoking as well as in the dairy industry for pasteurization.

Commercial and Industrial Use of LPG

- **Metal Processing -** Metallurgy uses heat treatments to meet the demand for highly specialized metals. Heat treatment consists in modifying the original structure of the metal or alloy in order to obtain mechanical specifications. This is done while using a precise thermal cycle that includes heating, maintaining a high temperature and cooling. Some heat treatments need a controlled atmospheric environment and the production of such an environment is possible in furnaces where LPG is used since combustion products have no contact with the furnace wall (thus avoiding any oxidation processes). Using LPG in this process allows the industry to manufacture products of a higher quality thanks to its flexible usage and low maintenance costs. LPG can also be used in applications involving surface treatment such as paint drying and galvanization.

Commercial and Industrial Use of LPG

❖**Textile -** The textile industry requires a number of energy-consuming processes for which LPG is found to be a suitable fuel. These processes are:

✓Heating of the bath (cleaning, bleaching, dyeing)

✓Drying, thread singeing and polymerisation

✓Ironing

❖**Printing -** The manufacture of pulp, paper and cardboard consumes a considerable amount of energy. If fuel oil is to be commonly used in manufacturing pulp, it is possible for LPG to find many applications in paper, cardboard manufacturing processes and printing. In colour printing, the paper has to go several times through the rotary press as it requires a fast ink drying process. It is therefore always better to use the decentralised heating solution rather than the centralised steam solution in these processes as it offers more advantages: modular heating, easy regulation of gas output, cleanliness and environmental care.

❖ Week 10

Commercial and Industrial Use of LPG

- **Chemicals Production -** Although chemical engineering is the biggest user of steam boilers, LPG- powered heat-exchangers are recommended in a number of different stages of the process.
- Forklift Trucks - Good for meeting air quality regulations in the workplace and technical demands for a modern handling (rapidity, power, flexibility, economy), LPG is nowadays the best response for the fuelling of thermal-engine trucks. Lead-free and soot-free, LPG has a very low rate of carbon monoxide emissions and is therefore the chosen energy for a pollution-free environmen.

Fire hazards & Safety legislation

- 4 Potential Hazards From An LPG
- 1 FIRE FROM LEAKAGE
- Fire from accidental leakage from the gas tubes or explosion due to accumulated gas from the leakage is one of the leading causes of fire accidents.

- What causes leakage of LPG?
- Tubes with holes or worn-out tubes connecting LPG and the stove
- Poor maintenance of stove
- Not switching off the cylinder or stove when not in use.

Fire hazards & Safety legislation

- To prevent fires from LPG leakage, you must use tubes that are recommended by the service provider. Also, you should check for the date of expiry and replace old tubes as and when necessary. Even if you are leaving your house for a short duration, shut off the cylinder to prevent accidental leakage.

- Poor maintenance of the stove also causes gas leakage. Keep the stovetop clean of greases and dirt accumulation. Even if you suspect a small leakage, get it checked by the authorized person immediately. Store the phone numbers of the emergency contact numbers issued by your gas agency. This may come handy in case of leakages.

Fire hazards & Safety legislation

❖2 CARELESS USAGE OR POOR HANDLING

❖There is a potential fire hazard if the LPG is not stored in a proper way. Not storing an LPG in an upright position or storing combustible elements close to LPG or storing below the ground level could cause fires. Here are a few points to consider:

❖Do not store combustible materials near LPG, eg: wood, cloth, paper, etc.

❖Store the LPG in an upright position on the ground level.

❖Do not store two gas cylinders in the same place.

❖If you suspect gas leakage, contact the emergency numbers provided by your agent. Never check the gas leakage with naked flames.

Fire hazards & Safety legislation

❖3 UNATTENDED COOKING

❖House fires are often caused by food catching fire. These accidental fires could lead to a big disaster as we use LPG in our kitchens. Do not leave cooking unattended even for a short duration.

❖4 SUFFOCATION DUE TO INHALATION

❖Though this is not a fire hazard, suffocation due to inhalation of LPG could be fatal. Prolonged inhalation of LPG could damage the lungs and could cause death due to suffocation. If there is a prolonged inhalation of LPG, it is advisable to seek medical help immediately. Not only inhalation, if there is an eye contact with LPG, rinse it thoroughly with water and seek medical assistance. To prevent accidental inhalation of LPG, it is advisable to use electronic gas leak sensors in your kitchen. These devices are available in online shops.

❖ Week 11

Class Outline

- Lubricating Oil
- Functions of Lube Oil
- Lube Oil Processing
- Lubricant Additives

Lubricating Oil

- Lubricating oil, sometimes simply called lubricant/lube, is a class of oils used to reduce the friction, heat, and wear between mechanical components that are in contact with each other. Lubricating oil is used in motorized vehicles, where it is known specifically as motor oil or transmission fluid.
- There are two basic categories of lubricating oil: mineral and synthetic.
- Mineral oils are lubricating oils refined from naturally occurring crude oil. Synthetic oils are lubricating oils that are manufactured. Mineral lubricating oils are currently the most commonly used type because of the low cost of extracting the oils from crude oil. Additionally, mineral oils can be manufactured to have a varying viscosity, therefore making them useful in a wide range of applications.

Lubricating Oil

❖Lubricating oils of different viscosities can be blended together, and it is this ability to blend them that makes some oils so useful. For example, common motor oil - shown in Figure - is generally a blend of low viscosity oil to allow for easy starting at cool temperatures and a high viscosity oil for better performance at normal running temperatures.

Use in Vehicles

- The use of lubricating oils in vehicles is vital to their operation. When an engine is properly lubricated, it needs to put less work into moving pistons as the pistons glide easily. In the long run, this means that the car is able to operate while using less fuel and run at a lower temperature. Overall, the proper use of lubricating oil in a car improves efficiency and reduces the amount of wear and tear on moving engine parts.

Recycling

- ❖Since lubricating oils are such a valuable resource, there have been many efforts to recycle used oils. Used lubricating oil is recycled at "re-refineries", where water is removed from the oil in a process of dehydration.
- ❖Impurities within the used oil - such as industrial fuel - are separated out and the oil is captured using vacuum distillation. This leaves behind a heavy waste that contains oil additives and byproducts.
- ❖The extracted lubricating oil then undergoes a series of refining processes to remove other impurities.
- ❖Once refined, the oil is separated into three different viscosities for a variety of uses.

Functions of Lube Oil

❖Lubricants have a wide range of functions that include controlling the following:

✓Friction (lubricants reduce heat generation and energy consumption)

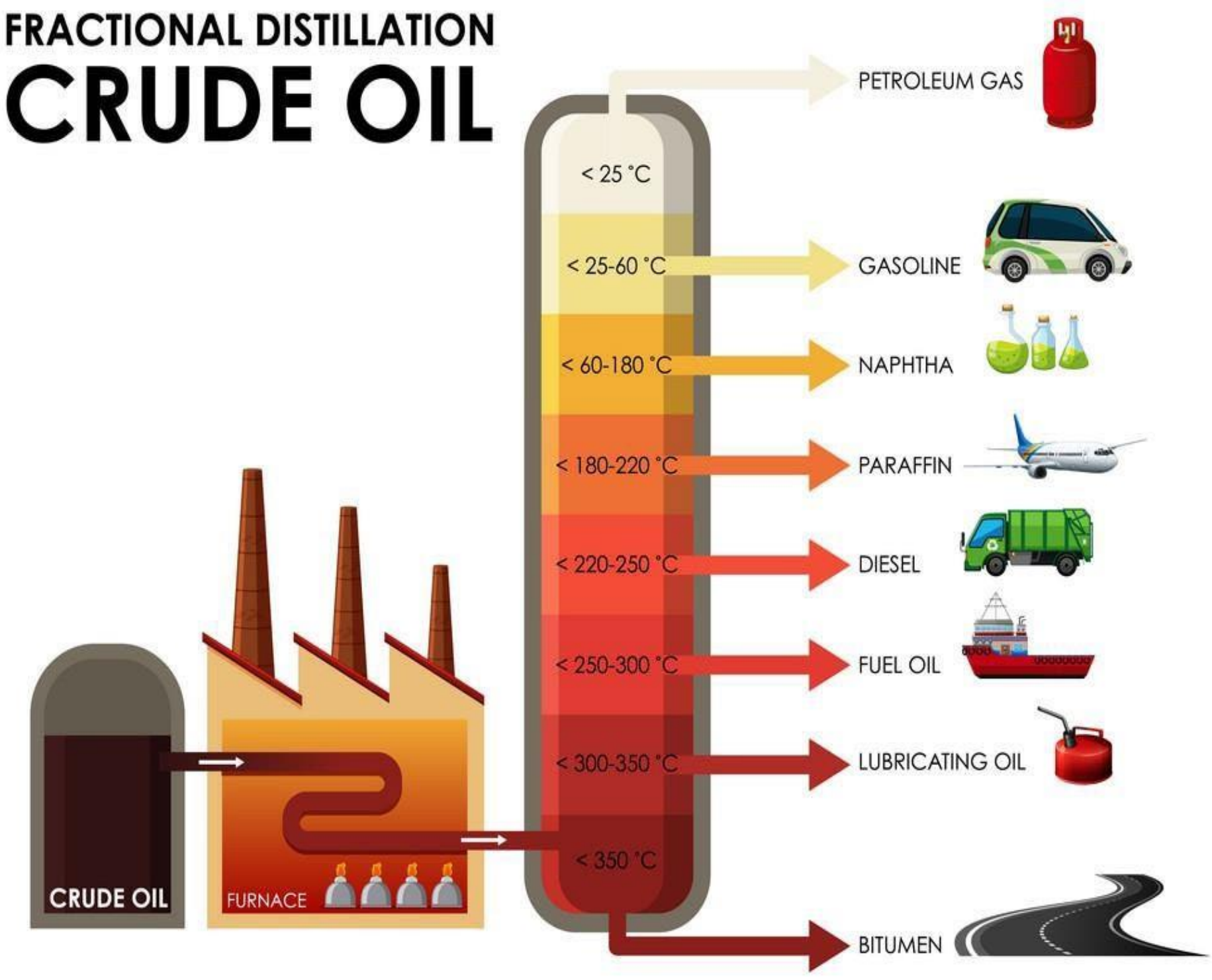
✓Wear (lubricants can reduce mechanical and corrosive wear)

✓Corrosion (quality lubricants protect surfaces from corrosive substances)

✓Contamination (lubricants transport particles and other contaminants to filters and separators)

✓Temperature (lubricants can absorb and transfer heat)

Lube Oil Processing

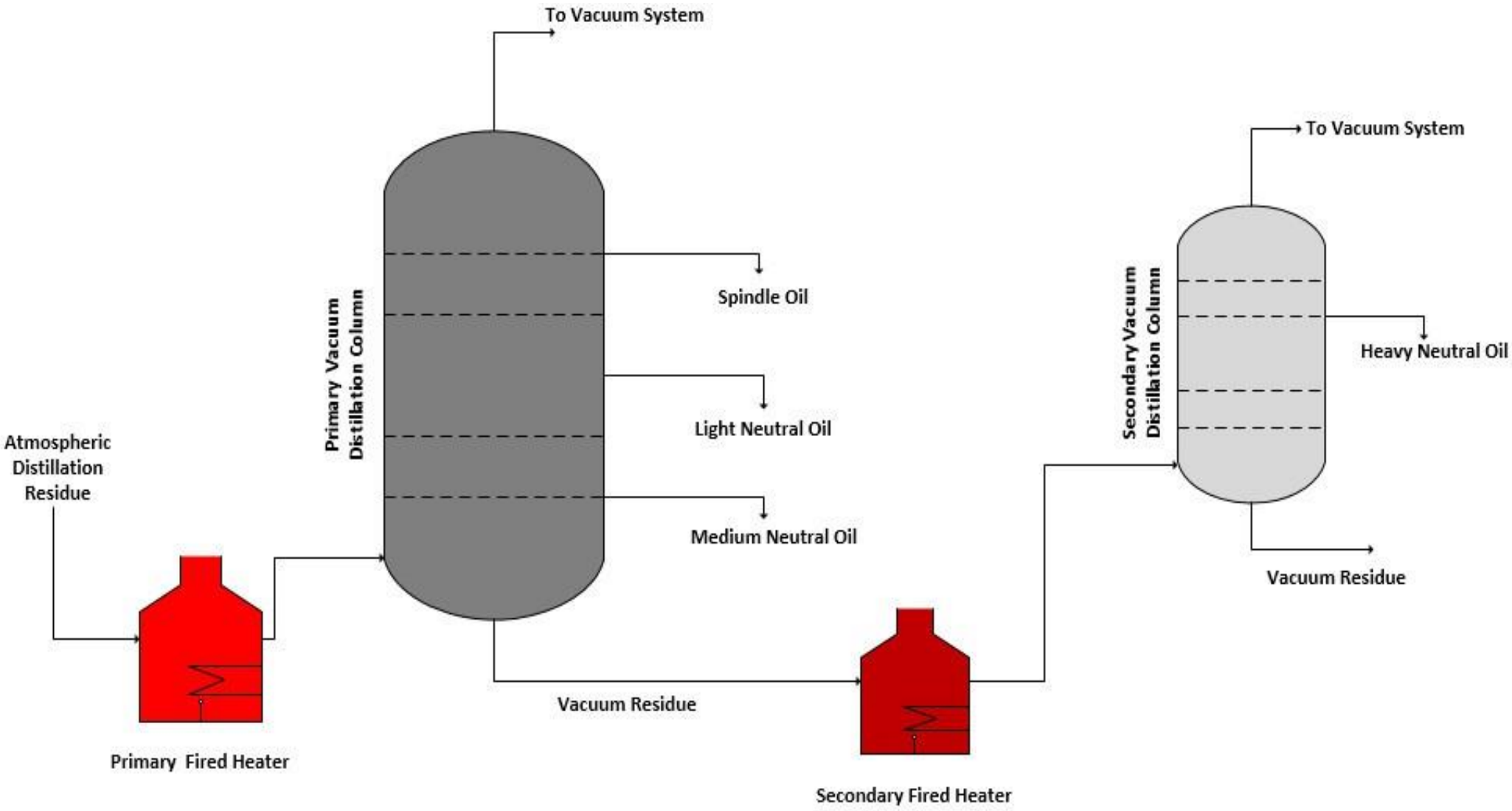


Lube Oil Processing

- The first step in the lubricant production process is vacuum distillation of atmospheric residue obtained like bottom product in the atmospheric distillation processes.
- For vacuum distillation units dedicated to producing lubricating fractions the fractionating need a better control than in the units dedicated to produce other fuels.
- A typical arrangement for vacuum distillation unit to produce lubricating fractions is presented in Figure

  1. A secondary vacuum distillation column is necessary when it is desired to separate the heavy neutral oil stream from vacuum residue.

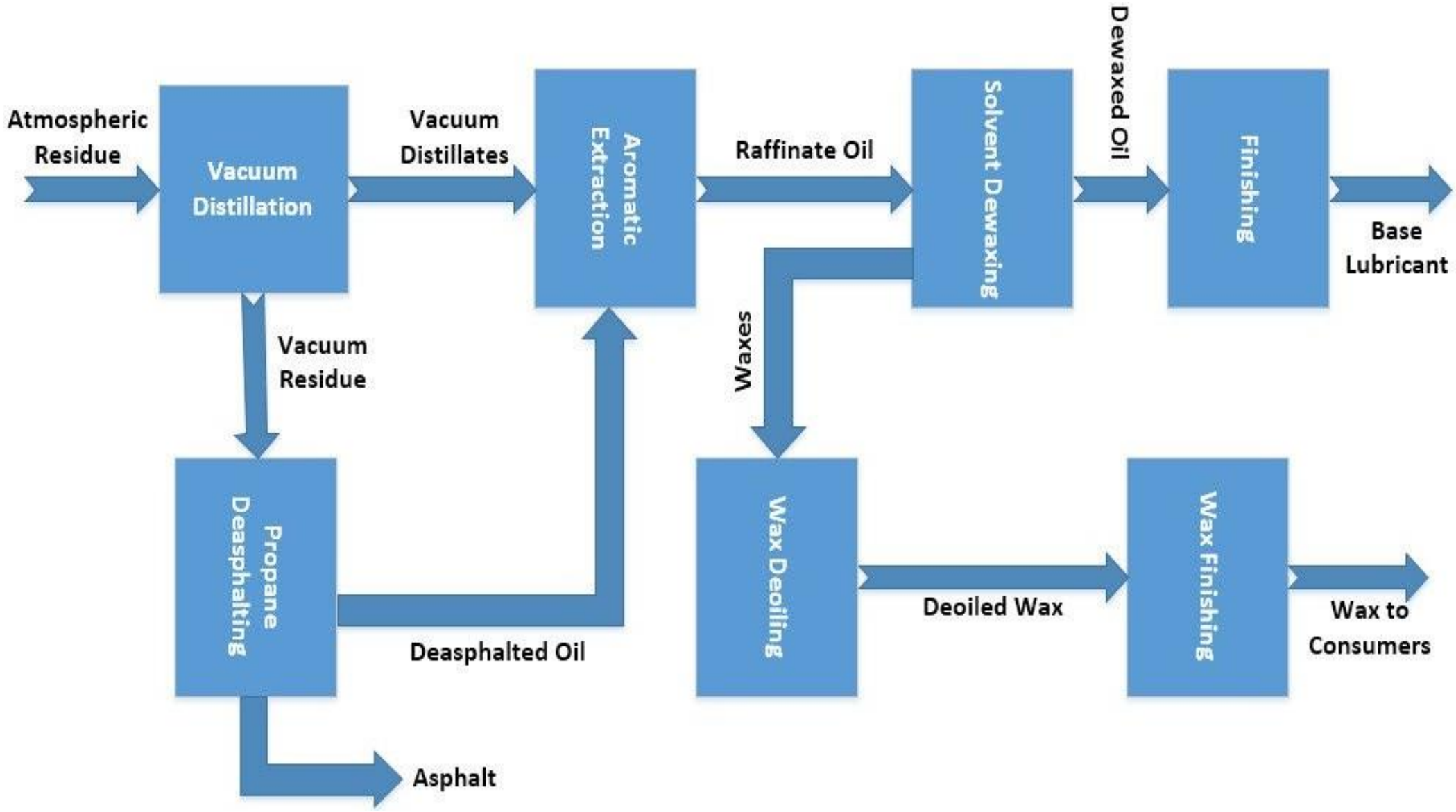
Lube Oil Processing



Lube Oil Processing

- In lubricating production units based on the solvent route the following steps are basically physical separation processes with the objective to remove from the process streams the components which can affect the desired properties of base oils, mainly the viscosity index and chemical stability.
- Figure 2 shows a block diagram corresponding to the process steps to produce base lubricating oils through solvent extraction route.
- Like aforementioned in the vacuum distillation step, the fractionating quality obtained between the cuts is critical for these streams reach the quality requirements like flash point and viscosity. After vacuum distillation step the side cuts are pumped to aromatic extraction unit and the vacuum residue is sent to propane deasphalting unit.

Lube Oil Processing



Lube Oil Processing

- The Propane deasphalting process seeks to remove from vacuum residue the heavier fractions which can be applied as lubricating oil. The Propane deasphalting units dedicated to produce lubricating oils by applying pure propane like solvent because this solvent has higher selectivity to remove resins and asphaltenes from oil.
- In the aromatic extraction step, the process streams are put in contact with solvents selective to remove aromatics compounds, mainly polyaromatics. The main objective of removing these compounds is the fact that they have low viscosity index and low chemical stability, this is strongly undesired in lubricating oils. As the nitrogen and sulfur compounds are normally present in the polyaromatic structures, in this step the major part of sulfur and nitrogen content of the process stream is removed. The solvents normally applied in the aromatics extraction process are phenol, furfural, and N-methyl pyrrolidone.

❖ Week 12

Lubricant Additives

- Lubricant additives are chemical components that need to blend well with the base oil to function as a single fluid.
- The primary function of Lubricant additives is to improve the properties of the base stock under different operating conditions and the high performance requirements of any machinery. The additive content in lubricating oils ranges from just a few parts per million to several percentage points. Depending on the function that the additives develop they may be classed as:
- Substances intended to improve the intrinsic characteristics of the base oils (viscosity index modifiers and pour point improvers).
- Lubricant protective substances (antioxidants).
- Substances giving new properties and protecting the metal surfaces of engines (detergents, dispersants, friction modifiers, anti-wear/Extreme Pressure (EP) additives, rust and corrosion inhibitors).