

# Lecture 1

## Petrochemicals Engineering

*Dr.Duaa Alwarid*

## ❖ Syllabus

### ■ Introduction

Origin , Composition , Sources , Physical and chemical properties of natural gas

### ■ Basic concepts , Flow diagram and units of Natural gas processing .

### ■ Phase Separation

Gravity , Multistage , Centrifugal and Twister supersonic separators .

### ■ Condensate Stabilization

Flash vaporization , Stabilization by fractionation .

### ■ Acid gas Sweetening by Amine and Other Processes .

### ■ Natural Gas Dehydration by Glycol and Solid desiccant dehydration processes .

### ■ Products Recovery

Liquefied natural gas ( LNG ), Hydrogen and sulfur .



## ❖ References

- Campbell, J.M., "Gas Conditioning and Processing," 3rd Ed. Campbell, (1992).
- Saeid Mokhatab S. & William A. Poe, "Natural Gas Transmission and Processing" (2006).
- Abdel Aal H.K. , Mohamed Aggour and Fahim M. K.," Petroleum and Gas Field Processing", (2003).
- Arthur J. Kidnay and William R. Parrish "Fundamentals of Natural Gas Processing" (2006).



# Definitions

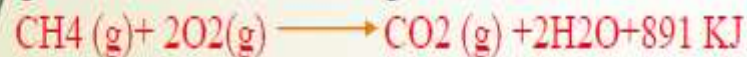
- ❖ **Natural gas** is the gas obtained from natural underground reservoirs either as free gas or gas associated with crude oil. It generally contains large amounts of methane ( $\text{CH}_4$ ) along with decreasing amounts of other hydrocarbons. Impurities such as  $\text{H}_2\text{S}$ ,  $\text{N}_2$ , and  $\text{CO}_2$  are often found with the gas. It also generally comes saturated with water vapor.
- ❖ **Pipeline Gas** is the gas which has the quality to be used as a domestic or industrial fuel. It meets the specifications set by a pipeline transmission company, and/or distributing company.
- ❖ **Sour Gas**: Gas that contains more than 1 grain of  $\text{H}_2\text{S}$ /100 SCF
- ❖ **Sweet Gas**: Gas in which the  $\text{H}_2\text{S}$  content is less than 1 grain /100 SCF.
- ❖ **Wet Gas**: Gas that contains more than 0.1 US gallons of condensates per 1000 CF of gas.
- ❖ **Dry Gas**: Gas that contains less than 0.1 US gallons of condensates per 1000 CF of gas.
- ❖ **Rich Gas**: Gas containing more than 5 to 7 US gallons of compounds heavier than ethane ( $\text{C}_3+$ ) per 1000 CF of the gas.
- ❖ **Lean Gas**: Gas containing 1 US gallons or less of compounds heavier than ethane ( $\text{C}_3+$ ) per 1000 CF of the gas.
- ❖ **Pentanes**: The pentane and heavier fraction of hydrocarbon liquid.
- ❖ **Condensates**: The hydrocarbon liquid fraction obtained from a gas stream containing essentially pentanes.



# Natural gas

**Natural gas** is a complex mixture of hydrocarbons, ranges C1(methane) up to C7 and C8 with some with a minor amount of non-hydrocarbon gas like Carbon dioxide, Hydrogen sulfide water vapor and trace amount of nitrogen and some rare gases like Helium and others. This hydrocarbon gases are combustible by nature and produce energy.


- So, this is a natural gas comes under the sub-category of petroleum, it follows the same theory of the oil leak like organic materials underneath the surface gone through the geological time scale heating under the pressure and converted to gas.
- Ignites when the air- and -gas mixture is between 5 to 15 percent natural gas.



- ❖ Measured in energy content: Btu
- ❖ 1 standard cubic feet : 500-1550 Btu, depends on the composition.
- ❖ 1MMBtu= 1 million Btu = 10 therm

Methane	Hydrocarbon
Ethane	
Propane	
i-Butane	
n- Butane	
i-Pentane	
i-Pentane	
n-Pentane	
Hexane	
Heptane and Heavier	
Carbon dioxide+H2O	Non-hydrocarbon
Hydrogen sulfide	
Nitrogen +Helium	





# Natural gas

## The properties/ features :

A- colorless

B- odorless ( doesn't smell to have the deduction capacity of this gas, some are captions like added in the natural gas to deduct it is leakage or it presence).

C- combustible

D- clean fuel

# Natural gas resources

↓  
Conventional and Unconventional energy

## A- Conventional natural gas :

- ▶ Fossil Energy


A- natural gas

B- oil

C- Coal

} The natural gas presence in all three fossil fuel energy sources under the conventional natural gas geological setting and rock type rather than to the gas it self.





## B- Unconventional natural gas

Is called unconventional natural gas not because they are different in compositions but may be different in geological setting, how the natural gas trapped in the reservoir and in the coal stream and how long it was there.

- ▶ Shale gas
- ▶ Tight Gas
- ▶ Gas hydrate
- ▶ Coal bed methane ( CBM)
- ▶ Others





## Unconventional natural gas

- ❖ **Tight gas** : relatively impermeable rock, limestone or sand stone ( $< 1$  md ), trapped similar in the shale gas.
- ❖ **Shale gas**: gas trapped in fine-grained sedimentary rock-shale and extract the natural gas from these sources certain kind of fractured need to be created.
- ❖ **Coal-bed methane (CBM)**: gas trapped in coal seams, adsorbed in the solid matrix of the coal.
- ❖ **Gas hydrate**: where the gas molecules are in the form of crystalline, similar structures that the water molecules stabilized by small gas molecules. The gas molecules ( methane or very light hydrocarbon) trapped by water molecules.
- ❖ Organic material on geological time scale gradually becomes coal, oil, or natural gas.



## Unconventional natural gas

### Total unconventional gas production in 2014 by producing country

Country	CBM (bcm)	Shale Gas (bcm)	Tight Gas (bcm)	Total (bcm)
U.S.	37,10	378,77	127,71	543,58
Canada	7,18	5,94	72,93	86,04
China	14,10	1,32	17,22	32,64
Russia	0,50	-	20,77	21,27
Australia	7,65	0,00	0,00	7,65
Argentina	-	0,31	2,21	2,51
Germany	0,90	-	0,41	1,31
Egypt	-	-	1,02	1,02
United Kingdom	0,06	-	0,60	0,66
Mexico	-	-	0,61	0,61
Poland	0,27	0,00	0,34	0,61
India	0,53	-	0,01	0,53
<b>Sum</b>	<b>68,28</b>	<b>386,33</b>	<b>243,82</b>	<b>698,42</b>





Thank you