Unconventional Hydrocarbon Resources (VIII Sem)

Q.1. What are the difference between conventional and unconventional hydrocarbon resource?

Answer. Conventional oil or gas comes from formations that are "normal" or straightforward to extract product from. Extracting fossil fuels from these geological formations can be done with standard methods that can be used to economically remove the fuel from the deposit. Conventional resources tend to be easier and less expensive to produce simply because they require no specialized technologies and can utilize common methods. Because of this simplicity and relative cheapness, conventional oil and gas are generally some of the first targets of industry activity.

Unconventional oil or gas resources are much more difficult to extract. Some of these resources are trapped in reservoirs with poor permeability and porosity, meaning that it is extremely difficult or impossible for oil or natural gas to flow through the pores and into a standard well. To be able to produce from these difficult reservoirs, specialized techniques and tools are used. For example, the extraction of shale oil, tight gas, and shale gas must include a hydraulic fracturing step in order to create cracks for the oil or gas to flow through. In the oil sands, in situ deposits must utilize steam assisted gravity drainage to be able to extract thick bitumen from underground deposits. All of these methods are more costly than those used to produce fossil fuels from a traditional reservoir, but this stimulation allows for the production of oil and gas from resources that were previously not economic to extract from. These resources become reserves when they can be utilized economically.

Q.2. Write down the classification of unconventional hydrocarbon resource and its distribution?

Answer. Classification of unconventional resources

The unconventional resources are classified into: shale gas, shale oil, tight gas, tight oil, coal seam gas/coal-bed methane and hydrates. Most of them will be covered in this article from a geologic perspective.

Distribution of the main unconventional resources

The distribution of the worldwide unconventional gas resources (after Rogner 1996 , taken from Kawata and Fujita 2001)				
Region	Coalbed Methane	Shale Gas	Tight-Sand Gas	Total
	(Tcf)	(Tcf)	(Tcf)	(Tcf)
North America	3,017	3,840	1,371	8,228
Latin America	39	2,116	1,293	3,448
Western Europe	157	509	353	1,019
Central and Eastern Europe	118	39	78	235
Former Soviet Union	3,957	627	901	5,485
Middle East and North Africa	0	2,547	823	3,370
Sub-Saharan Africa	39	274	784	1,097
Centrally planned Asia and China	1,215	3,526	353	5,094
Pacific (Organization for Economic Cooperation and Development)	470	2,312	705	3,487
Other Asia Pacific	0	313	549	862
South Asia	39	0	196	235
World	9,051	16,103	7,406	32,560

Q.3. Write a short note on coal bed methane.

Answer. Formation of coal process- Coal was formed from the remains of vegetation that grew about 400 million years ago. Therefore, it’s called fossil fuel. Formation of peat Peat is a soggy, dense material which is formed by accumulation of layers of sediments over the remains of dead plants and trees that sank to the bottom of the swampy areas, over long periods of time. The changes in the earth's surface caused deposits of sands, clay and other minerals to accumulate and bury the peat underneath. Then, sandstone and other sedimentary rocks were formed, and the pressure caused by their weight squeezed water out from the peat. This depth associated with heat, gradually changed the material into coal. Scientists claim that 3 to 7 feet of compacted plant matter is required to form 1 foot of bituminous coal Formation of coal bed methane Biogenic methane is produced by anaerobic bacteria in the early stages of coalification.Thermogenic methane is mainly produced during coalification at temperatures ranging from 120 – 150 °C. However, some contrasting features exist between CBM reservoirs and conventional gas reservoirs. These features include: Gas CompositionGas produced from coal beds may be initially higher in methane content than the gas produced from conventional reservoirs. Methane is less adsorbed than ethane and other heavier saturated hydrocarbons. Consequently, they may not be as readily adsorbed at the onset of production. The mechanism by which hydrocarbon gases are stored in the coal reservoir contrasts the mechanism of gas storage in conventional reservoirs. However, methane is held to the solid surface of coal by adsorption forces instead of occupying void spaces -as in the case of free gas- between sand grains (only 1-2%).

Country	Billion Tons
Russia	4,860
China	4,000
U.S.	2,570
Australia	600
Canada	323
Germany	247
United Kingdom	190
Poland	139
India	81
South Africa	72
Others	229

Q.4. Explain the formation of shale gas?

Answer. Formation of shale-gas

Natural gas is not different from what you currently use to heat your home, cook with, or use to generate electricity, which is naturally trapped in its original source rock; the organic-rich shale that formed from the sedimentary deposition of mud, silt, clay, and organic matter on the floors of shallow seas..

Geological characteristics of shale-gas

Organic Material

They are rich in organic material (0.5% to 25%).

Thermal Maturity

Thermal Maturity is an indicator of how much pressure and temperature the rock has been subjected to.

The shale is usually more mature, has higher gas ratio and matured in the thermogenic gas window, where high heat and pressure have converted petroleum to natural gas.

Pore Space

The pore spaces here not the main core characteristics but the effective permeability in shale gas which ismuch less than 0.1 (md)

Distribution of shale-gas

Here is a map of major shale gas basis all over the world from the EIA report World Shale Gas Resources: An Initial Assessment of 14 Regions outside the United States.

Q.5. Explain Fischer tropsch Process for coal to synthetic petrol production.

Answer. The Fischer–Tropsch process (or Fischer–Tropsch Synthesis or F-T) is a set of chemical reactions that changes a mixture of carbon monoxide gas and hydrogen gas into liquid hydrocarbons (like gasoline or kerosene). People care about the F-T process for many different reasons, for example, it might be a way to make fuel for cars and trucks that doesn't pollute as much as fossil fuels.

Other reactions relevant to F-T

Many steps are required to make the gases needed for the F-T process. For example, all chemicals entering the reactor must have all sulfur removed. For factories that start out with methane and want to make a liquid hydrocarbon (like kerosene), another important reaction is "steam reforming", which turns the methane into CO (carbon monoxide) and H_2 (hydrogen gas). This is the chemical equation for how steam reforming works.

$$H_2O + CH_4 \rightarrow CO + 3\ H_2$$

The reaction above describes one molecule of H_2O (steam) plus one molecule of CH_4 (methane) converts into one molecule of CO (carbon monoxide) and three molecules of H_2 (hydrogen gas).

Fischer-Tropsch catalysts

A catalyst is a substance added to change the rate of a chemical reaction, generally to make it faster. Many different catalysts can be used for the Fischer–Tropsch process. The most common catalysts are the metals cobalt, iron, and ruthenium. These metals are all transition metals. The metal nickel can also be used, but generally with unwanted results. A nickel catalyst in the reaction usually produces a lot of methane, which is undesirable.

Cobalt seems to be the most active catalyst (it has the greatest and fastest effect on the process). When the input is a natural gas, cobalt catalysts are very good for the Fischer-Tropsch process. Iron catalysts are better when the input gas is of lower quality (less pure) such as coal or biomass

Most metals used for this process (like cobalt, nickel, and ruthenium) remain in their metal form when added to the process. However, iron catalysts behave very differently. Often, iron catalysts change form and chemical phase, like converting into various oxides and carbides during the reaction. It is important to control all of the iron reactions during the process, or else the process may not work correctly.

Gasification

Some F-T factories use coal, biomass or other solid compounds as a starting point. Before these factories can begin the F-T process, they must turn the solids into gases such as CO, H_2, and alkanes. Changing solid chemical compounds into gas is called gasification. The gas collected from coal gasification often has a CO/H_2 ratio of ~0.7 instead of the optimal ratio of ~2. This ratio can be adjusted from 0.7 to 2.0 using the water-gas shift reaction. Gasification is a dirty and expensive process. Coal-based Fischer–Tropsch factories start out with coal, gasify the coal, and then use the resulting gas as feed stock for the Fischer-Tropsch process. These factories can produce large volumes of CO_2 in this way. One of the main reasons for this approach is the large amounts of energy required for a coal-based gasification process.

Fischer-Tropsch catalysts are famous for being extremely sensitive to the addition of sulfur. Even a tiny amount of sulfur can have an undesirable impact on the reaction. Cobalt catalysis is more sensitive to sulfur than iron.