Health, Safety and Environmental Management in Petroleum and offshore Engineering

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Module No. # 02

Lecture No. # 03

Oil hydrocarbon in marine environment

Today, in this lecture, we will discuss about the physical and the chemical characteristics of oil hydrocarbons in marine environment. This is part of module-2 of the HSE course which you have been hearing.

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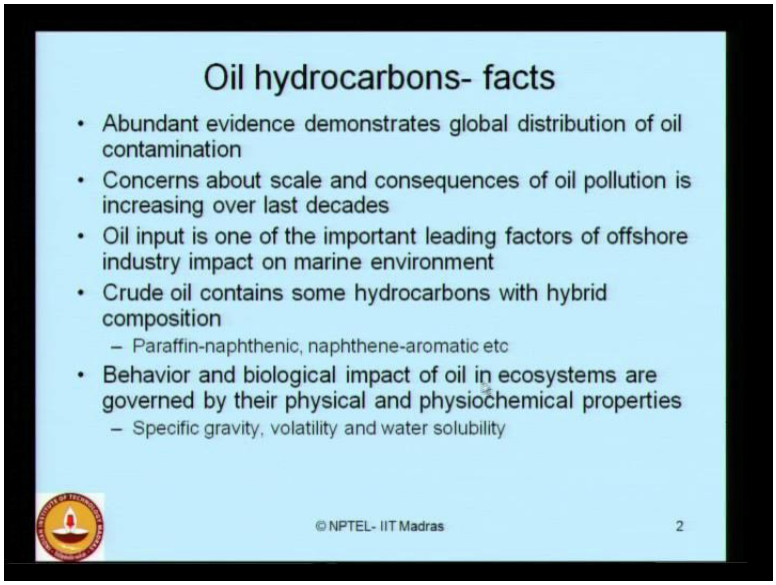

Let us look some facts of oil hydrocarbons before we understand how do they influence in the marine environment. Abundant evidence are available in the literature, which demonstrates global distribution of oil contamination. Concerns about the scale and consequences of oil pollution is increasing over the last decades in the research front as well. Oil input is considered as one of the most important leading factors of offshore industry that influences marine environment significantly. If you look at the characteristics of oil hydrocarbons, crude oil contains some hydrocarbons with hybrid

composition, for example, paraffin-naphthenic, naphthene-aromatic etcetera. These are complex compounds which are considered as hybrid composition present in the crude oil.

The behavior and biological impact of oil in ecosystems are generally governed by their physical and physiochemical characteristics, for example, specific gravity, volatility, water solubility or some of the indices of these properties which affect significantly the biological impact on ecosystems in ocean environment.

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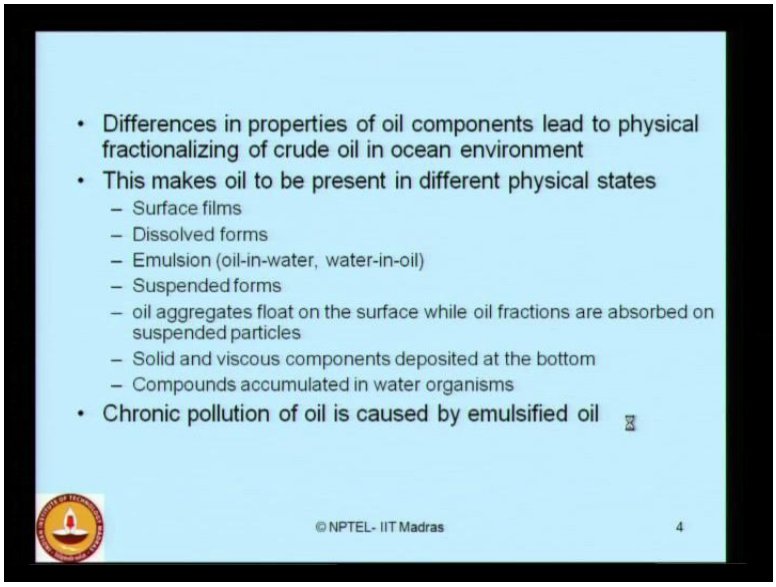

Let us look more facts about crude oil. Differences in properties of oil components lead to physical fractionalizing of crude in ocean environment. This makes crude oil to be present in almost different physical states. Ladies and gentlemen, the main difficulty in identifying the presence of crude oil in ocean environment is that they are available in different physical states. So, there are different kinds of tests generally being carried out, to identify the significant presence of the crude oil in the sea water. They are available in different physical states, for example, there are can be thin surface films which can be form on the top layer of the sea water.

You can also find crude oil somewhere in the dissolved form. Somewhere it is available in the emulsion form either oil in water or water in oil. Sometimes you will see the crude oil components can be seen in suspended forms as well in the sea water. The oil aggregates float on the surface while oil fractions are absorbed on the suspended

particles. They improve the specific gravity of the suspended particles and allow the particles to settle down on the sea bed. Solid and viscous components are usually deposited at the bottom. So, compounds accumulated in water organisms. You can see crude oil as a component hydrocarbon is present in sea water in following different physical states. The differences in properties of oil component lead to physical fractionalizing of crude oil in ocean environment. They are available in different states. This causes a chronic pollution of oil by emulsified oil content.

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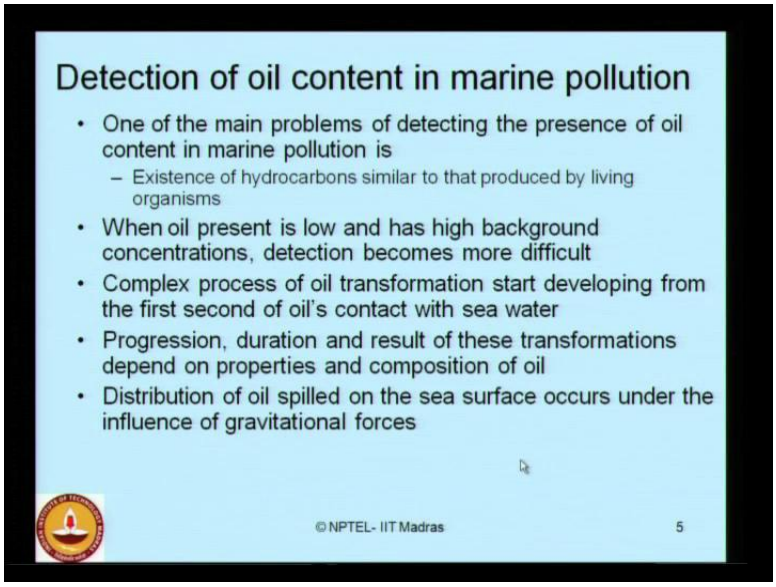

Now, the questions comes here is, how will you detect the oil content present in a marine pollution? One of the main problems of detecting the presence of oil in the marine pollution is that existence of hydrocarbons similar to that produced by living organisms. There are many living organisms in the marine environment which produces also hydrocarbon which are of similar characteristics of that of the oil. Therefore, it is difficult to identify exactly whether these hydrocarbons are produced by the living organisms or they are actually content of the oil spill in the sea water. When oil is present is low and has high background concentration then the detection becomes further more difficult actually.

So, the complex process of oil transformation, start developing from the first second of oil's contact with sea water. The moment oil spills start in the sea water from the first second of its contact, the complex process of oil transformation start taking place. Then

the progression, the duration and result of these transformations actually depend on properties and composition of the crude oil. Distribution of oil spilled on the sea surface occurs under the influence of gravitational forces.

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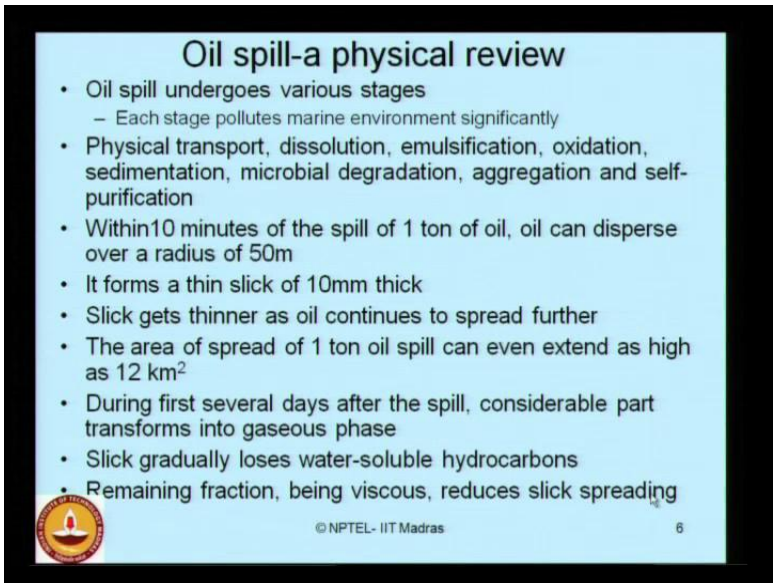

Let us look at the physical review of an oil spill. What are the difference processes has involved in an oil spill? Oil spill actually undergoes various stages. It is unfortunate to know that each stage it pollutes the marine environment significantly. There are different stages at which the oil spill takes place physical transport, dissolution, emulsification, oxidation, sedimentation, microbial degradation, aggregation and self-purification. Within 10 minutes of a spill of 1 ton of oil, oil has a capacity to get disperse over a radius of over 50 meters, that is the characteristic of a typical oil hydrocarbon which can get mixed in sea water. When it starts spilling first it forms, what we call as a thin slick of 10mm layer. This what, we call as a physical transport.

The slick gets thinner as oil continues to spread further. The area of spread of 1 ton oil spill can even extend to as high as about 12 square kilometer; that is standard data which has been seen the literature. During first several days after this spill, considerable part of the oil transforms into gaseous phase. The slick gradually losses water soluble hydrocarbons. Remaining fraction becomes viscous, and therefore it reduces spreading of the slick further.

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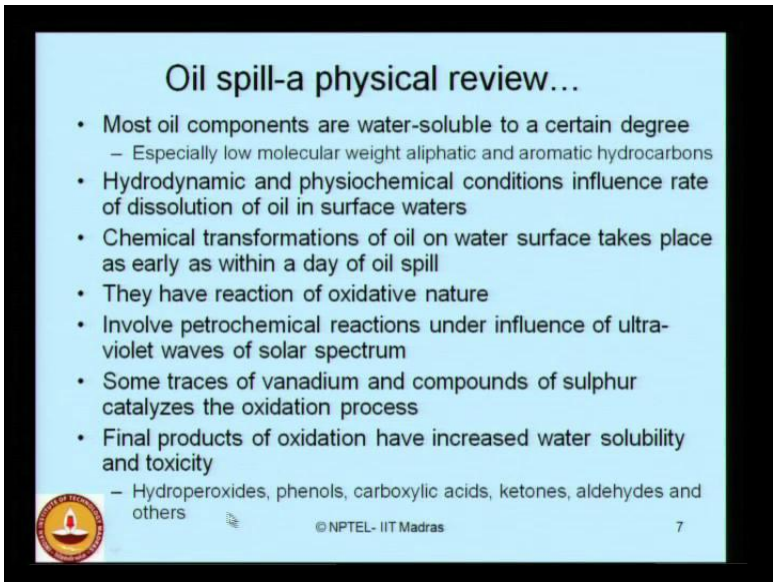

Most of the oil components are water soluble to a certain degree. Especially low molecular weight aliphatic and aromatic hydrocarbons are water soluble to a higher order. Hydrodynamic and physiochemical conditions influence rate of dissolution of oil in surface waters substantially. The chemical transformations of oil on water surface takes place as early as within a day of the oil spill. They have reaction of oxidative nature. It involves petrochemical reactions under influence of ultra-violet rays of solar spectrum. Some traces of vanadium and compounds of sulphur catalyzes the oxidation process in total. The final products of oxidation have increased water solubility and higher toxicity, for example, hydroperoxides, phenols, carboxylic acids, ketones, aldehydes and others have high degree of toxicity as well as they have high water solubility. It means that when an oils spill happens in a sea environment there increased water solubility makes them to get mixed up with the sea water much faster as well as the improved toxicity causes endanger to a specimens in the marine environment.

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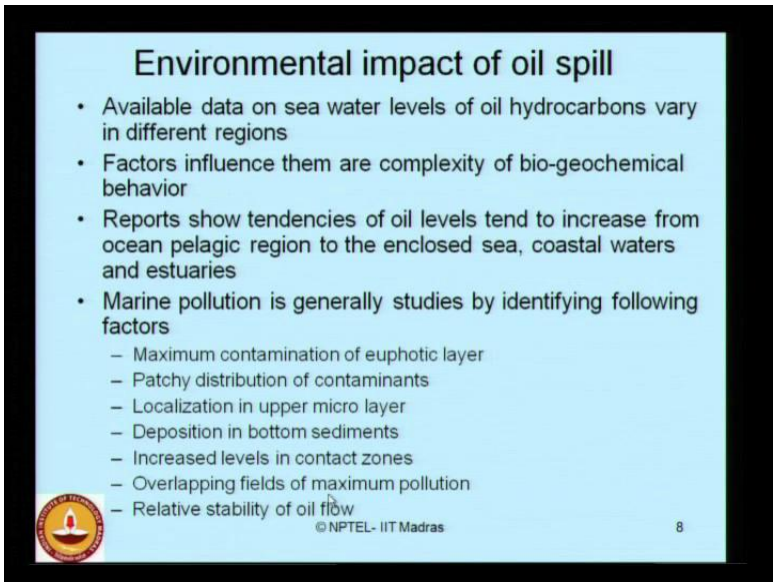

Now, let us look very briefly the environmental impact of oil spill in marine environment. The available data and the literature on sea water levels of hydrocarbons vary in different regions. The study shows that the sea water studies on oil hydrocarbon contents vary from different regions as well. The factors influences in them are complexity of bio-geochemical behavior of the oil. Reports show tendencies of oil levels tend to increase from ocean pelagic region to the enclosed sea, coastal waters further and estuaries. Marine pollution is generally studied by identifying the following factors - maximum contamination of euphotic layer, patchy distribution of contaminants, localization in upper micro layers, deposition in bottom sediments, increased levels in contact zones, overlapping fields of maximum pollution and relative stability of oil flow. These are some of the important factors by which can identify the presence of oil in marine pollution.

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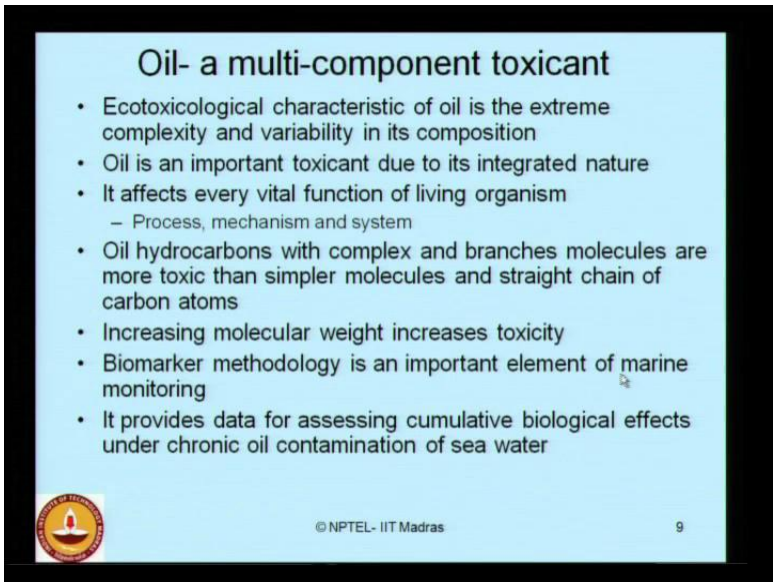

Now, oil is seen as a multi-component toxicant actually. The ecotoxicological characteristic of oil is of extreme complexity and the composition is very high degree of variability. Oil is an important toxicant due to its integrated nature. It affects every vital functions of living organism. The process, the mechanism and the system as a whole is very badly affected by the presence of oil of a multi-component toxicity in nature. Oil hydrocarbons with complex and branches molecules are more toxic than simpler molecules and straight chain of carbon atoms. Increasing molecular weight increases toxicity of the oil content.

Biomarker methodology is one of the important elements of marine monitoring, which provides data for assessing the cumulative biological effects under chronic oil contamination of sea water. The methodology is named as a biomarker technique which is now practiced as one of the important method of marine monitoring.

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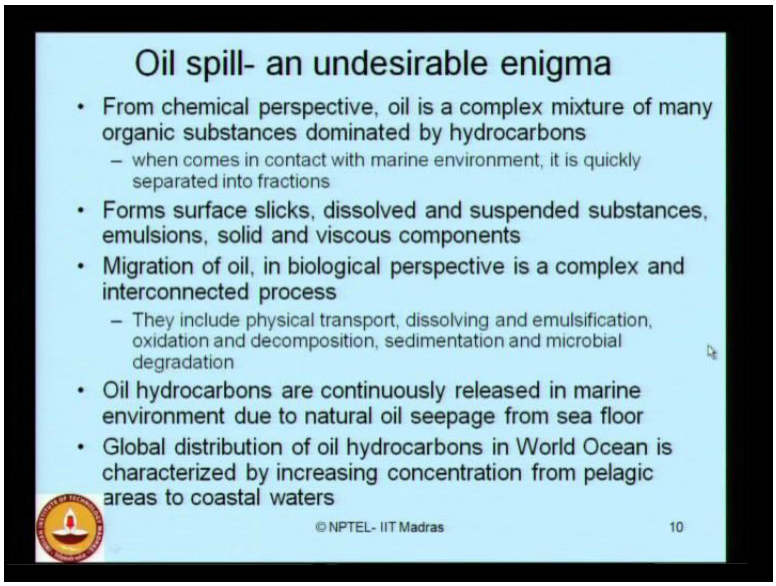

Oil spill is an undesirable enigma which happens in marine pollution. From chemical prospective, oil is considered as a complex mixture of many organic substances which is dominated by presence of hydrocarbons. When they come in contact with marine environment, it quickly spreads because they can get separated into fractions much faster. It forms a surface slicks first then get dissolved, some of them are remain as suspended substances; some of them become emulsions; some solid and viscous components gets settle down in the sea floor. So, oil gets mixed up in sea in different physical states: surface slicks, dissolved components, suspended substances, settled components, emulsions etcetera.

And the migration of oil in a biological prospective is a complex and interconnected process. It includes physical transport, dissolving and emulsification, oxidation, decomposition, sedimentation and microbial degradation as well. Oil hydrocarbons are continuously released in marine environment due to natural oil seepage from the sea floor.

Ladies and gentlemen, please do not think that oil spill is manmade disaster. In case of accidents oil spill do occur which as occurred in the past in the recent past as well to be very specific, but still hydrocarbon release in marine environment is a continuous process actually. Because it is due natural oil seepage from the sea floor also, but obviously, as you feel so oil spill intentionally spread on specific segment of marine

environment is really catastrophic. Therefore we should avoid such oil spills, but if they occur due to accidents which are unavoidable then we should see how this can the spread can be controlled.

So, that is what the mechanism people adopt to basically protect the marine environment from oil spill spreading. Oil spill is an undesirable enigma no doubt on that, but how will you prevent its further spreading is very important. The global distribution of oil hydrocarbons in World Ocean is actually characterized by increasing concentration from pelagic area towards coastal waters. In my last lecture I clearly highlighted about the severe migration of fisheries from a specific segment of coastal water because of contamination of water because of the presence of oil hydrocarbons. You can see also here, the global distribution is happening from the pelagic areas towards coastal waters which are undesirable, because this is a segment which contributes 90 percent of marine organisms.

Thank you