Health, Safety and Environmental Management in Offshore and Petroleum Engineering

Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module – 03
Accident modeling, risk assessment and management
Lecture – 17
Safety measures in design and operation-I

Welcome friends to the 17th lecture in module 3, where we are going to focus on different safety measures and practices in design and operation.

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This is one lecture covering in module 3 where we are focusing on accident modeling, risk assessment and management. We already said that safety and risk are very important item in terms of offshore engineering is concerned. In fact, in oil and gas production industries risk associated with this process is very high. Therefore, though we have admissible level of risk involved by international agencies; however, risk assessment and subsequently managing the risk becomes very vital, so that the economic perspective of risk is handled very carefully.

Obviously, if you want to do a very good risk management then in that case your hazard identification, hazard analysis and the management should be extremely good. On the whole people may think in other way that if you follow safety procedures properly the risk can be reduced, please understand risk is actually is an outcome of undesirable events which are unexpected. They come purely accidental therefore, risk analysis will talk about perceiving these ideas in more or less a possible reality or the probable reality and check whether if these events become real, what would be their consequences in the overall structure of oil and gas industries in terms of economy, in terms of loss, etcetera when you talk about risk management then I will argue and accept your argument to some extent saying risk management is successful, where healthy safety practices are in place.

So, what could be those healthy safety practices, safety measures both in design level and in operation level, so that we can do a better risk management is what we will see in couple of lectures. Now, as we all understand and agree safety measures can be done both in design stage and operational stage.

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Safety measures can be practiced both in design and operational stages. One of the major events which is undesirable in oil and gas industry is fire and explosion because this has

got or results in because this results in highest consequence. Therefore, prevention of fire and explosion is one of the major focuses. We already know in oil and gas industries we deal with flammable chemicals, flammable materials which are also highly hazardous. The flammable characteristics of the material can be altered in such a manner it may not result in combustion explosion which may otherwise happen when you allow them to exit in the environment.

So, there are certain terms and certain practices what we will try to do to understand certain terminologies involved in this. Let us say, what we understand by holding purge it is nothing, but the procedure of maintaining inert gas or a liquid in a close system. It is actually a procedure maintaining inert gas or liquid in a system. Let us say in a closed system where that is very important during maintenance or repair. So, why do you do that?

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It is actually used to replace. It is used to replace the normal combustible content something called hot cutting, cutting the oxy acetylene torch or by other means into any pipeline or a vessel that contains combustible gas that is what you call as hot cutting. Hot tap is actually a procedure of cutting into a pipeline containing a combustible gas or liquid by use of a special machine. So, use a special machine for cutting into a pipeline

containing combustible gas or liquid interestingly this machine will be attached with special fittings which have been previously welded to it, on the loaded pipeline. The tapping machine and the fittings are constructed such that the required size of the opening may be cut in the loaded pipeline.

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So, it is actually employed to cut a required size of opening in the loaded pipeline that is why it is called hot tap? Once the operation is over, the machine can be safely removed without any appreciable loss of combustibles inert gas. Inert gas has special characteristics, it is a gas which is non combustible and incapable of supporting combustion, how that can happen because this contains lesser than 2 percent of oxygen concentration and the combustible constituents are lower by or lower than 50 percent of explosive limit.

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Next could be inert purging; inert purging is act of changing the contents of pipeline or a vessel by using inert substance, actually a process of changing the contents of a pipeline or a vessel by using a inert substance. Actually, it displaces the original content present in the pipeline or the vessel. Interestingly inert purging should not be done with flammable mixtures. Purging is the process of removing the content of the pipe or container and replacing it with another gas or liquid is a process of removing the contents of a pipeline or a vessel and replacing it with another gas or liquid.

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Purge gas, the gas which is used to displace the contents of containers called a purge gas. Generally, pure gas is used, it is only because to avoid any flammable mixture. Therefore it is very important to estimate the quantity of purge gas which is required to displace the contents of the vessel. It enables or it ensures a minimum contact with the contents and flammable mixture, so that any possible combustion can be minimized or controlled. We already studied in the earlier lectures about purge; into service purge, out of service and etcetera. Let us look at them more in detail now for understanding purposes.

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Let us say I want to do purge into service. This is an operation of replacing an air or inert gas replacing air or inert gas present in a closed system by a combustible gas vapor or liquid it is called purge, into service purge, out of service. This is an operation of replacing the normal combustible content present in a closed system or of a closed system by inert gas liquid or vapor pyrophoric a substance or a mixture that can ignite spontaneously, slug a quantity of inert gas, inter post between the combustible gases, let say in a pipeline.

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We have a combustible gas and this becomes a slug, a slug actually is quantity of inert gas inter post between the combustible gas during purging slug does not fill the entire length of the pipeline of the pipeline it moves through the pipe as a separate mass which separates or avoids mixing of the gas ventilation .

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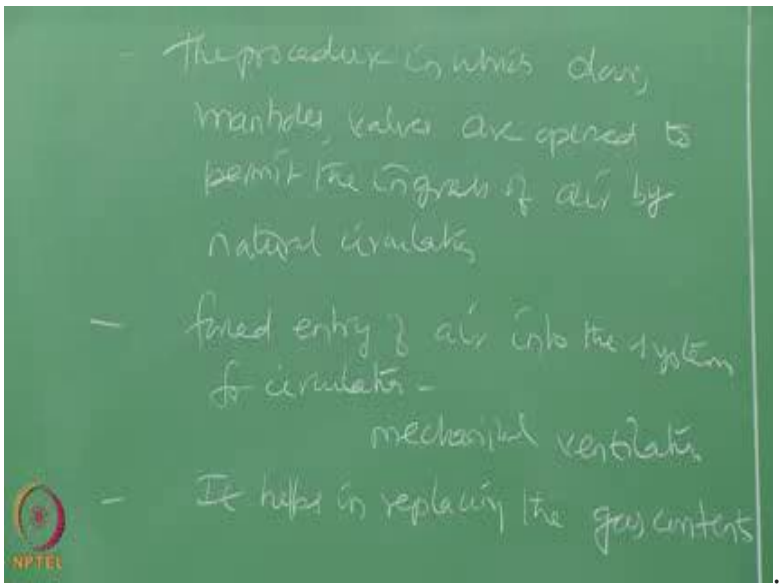

The procedure in which doors manholes valves are opened to permit the ingress are opened to permit the ingress of air by natural circulation, where there is no proper ventilation; one can also go for forced entry of air into the system for circulation. This is called mechanical ventilation the advantage of ventilation is it helps in the replacing the gas contents. So, friends we have seen that purging is one of the important operations in safety practices which is very well adopted in process industries in downstream sectors especially in oil and gas industries. Purging actually helps us to put the vessel back to service or to take out the vessel from service. We have also seen the quantity required, what kind of pressure purging you should do? In the earlier lectures let us quickly see what are the factors that affect purging?

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The foremost factor is essentially purging is an operation of replacing one gas by another in an enclosed space or chamber. There are two actions taking place here, two actions take place during purging; one is the displacement, two is the dilution. You can also call this as mixing in a purge that is affected entirely by displacement gas or air that is originally present in the container is pushed out of the escapements.

So, when you do purging by displacement ensures pushing the gas or air out of the container through exit's or vents. So, that little or no mixing of the purge gas with the

original contents happen, no mixing of the purge gas with the original. So, when you do it by displacement operation then this should be ensured therefore, friend's quantity of purge gas required for an operation or pushing by displacement is approximately equal to the gas which is to be replaced.

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So, quantity of purge gas required by displacement operation is approximately equal to the quantity of air or gas present in the container or sometimes even slightly more certain conditions are important in this case. Size of the chamber or the vessel shape of the chamber and the nature of gases what is used for purging and what should be displaced. Therefore, these factors will govern the mixture of the purge gas with the original contents while getting displaced. So, this may lead to the next step which is dilution or mixture.

If you are not able to achieve purging 100 percent by displacement which will be governed by these factors, then a second issue will come in purging operation which will result in either dilution or mixture. So, purging by dilution can be supported in some situations by pressurizing and depressurizing the facility. So, if you really want to then do effective purging by dilution or mixture then one need to do this operation by pressurizing and depressurizing by many cycles which you already saw in the previous

lectures . So, friends purging by dilution is considered to be one of the safest method of operation and safety practices of course, one can also do purging by displacement.

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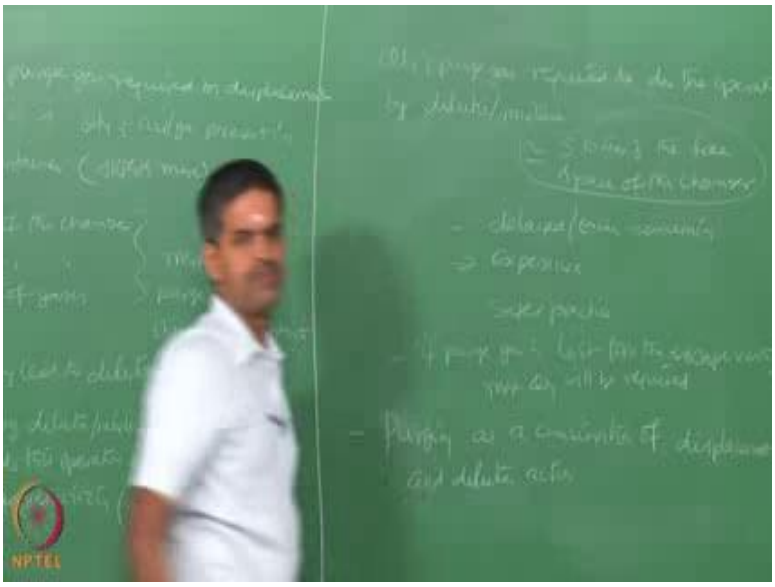

So, if you want to do purging by dilution quantity of purge gas required to do the operation by dilution which is safe compared to displacement is approximately equal to five times of that of free space of the chamber one can therefore, say purging by dilution of mixture can be a delay and time consuming operation. It is expensive because the quantity of purge gas required to do this operation effectively is 5 times of the empty space of the container; however, it is safer compared to that of the displaced content increase demand of the purge gas will be seen when increased amount of purge gas is required or it is lost from the escapements.

So, if purge gas is lost from the escapements or through the escapements then more quantity will be required I mean which is obvious. So, here the quantity required is very large therefore, expensive, but it is very easy amongst all the purging operations carried out. Generally, purging is a combination of displacement dilution action; generally people prefer purging as a combination of displacement and dilution action in actual practice. It is rather impossible to avoid mixing of the purge gas with the air or the gas that is present inside the container.

In general, one can only assure ensure lesser mixing of this or more dilution. So, lesser mixing or more dilution of purge gas with the gas present in the container will determine the efficiency of purging. Therefore, proceeds with mixing or dilution generally it is applied to tankers or holds which should be accompanied with inert purge medium to avoid flammable mixtures that is very important. If you do this operation then one should go for inert purge medium to avoid flammable mixtures, which makes the process bit more expensive. If you ask me a question, can we do purging without inert gas? Then purging without the use of inert medium should be limited only to pipelines.

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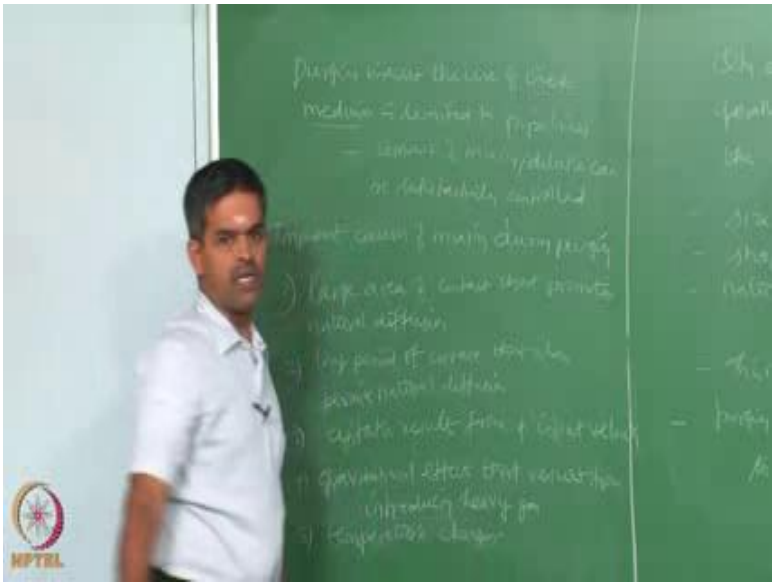

In general, purging without the use of inert medium is limited to pipelines, whereas in the case of closed container large vessels it should be definitely in the presence of inert medium is because of the reason the amount of mixing can be controlled satisfactorily by other methods. In this case, amount of mixing and dilution can be satisfactorily controlled whereas, when you attempt to do this without inert medium in large vessels or container controlling the dilution process will becomes extremely difficult and dangerous. Therefore, one of the good safety practices which is advocated in downstream sector and oil gas industries that one can do purging by a combined operation of displacement and dilution in the presence of inert medium, so that you can avoid the flammable mixtures in the whole process.

Let us see, what are the important causes of mixing during the purging large area of contact that promotes natural diffusion, long period of contact that permit's natural diffusion also agitation which can result from high input velocity, gravitational effects that result from introducing heavy gas for purging or light gas vice versa. Next could be temperature changes and differentiates which can cause convection currents, convection currents as a violation of safety. Now, if one fail to understand the important parameters which are listed below.

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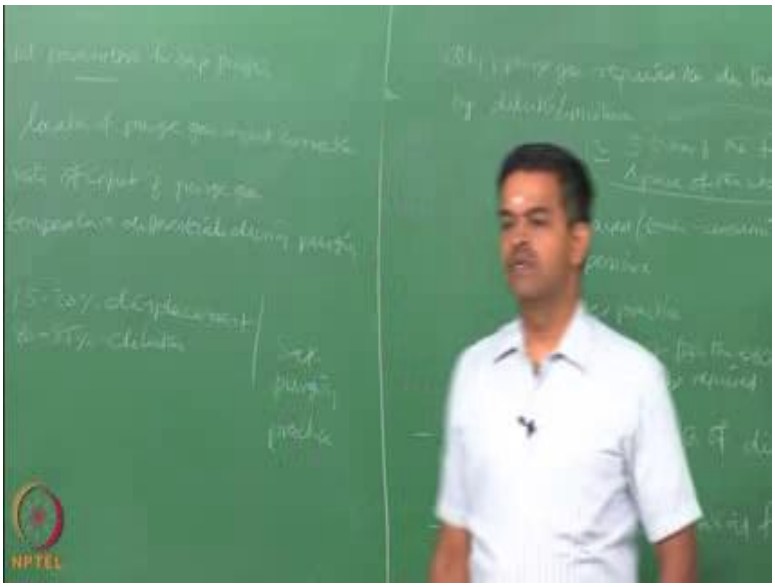

So, vital parameters for let say safe purging, the location of purge gas input connection, rate of input of purge gas temperature differentials during purging are very important to realize to have an effective purging operation which is also safe. So, one should generally go for 15 to 20 percent displacement technique and about 80 to 85 percent dilutions that is a good practice. There are few more parameters which will affect the purging operation and few more thumb rules which are going to be a good safety practice, which can be followed in different types of purging operation which we will discuss in the subsequent lecture.

So, friends in this lecture we are trying to understand, list out a very few important safety practices which can be useful in downstream sector especially, in process industries in oil

and gas sector. So, purging is the one of the safe and very important operation which is being done in oil gas industries essentially, in any process industry to clean up the area or to clean up the vessel or to reduce the flammable characteristics of the liquid or the gas present in a container which is very, very important as well as offshore industry or oil and gas sector is considered.

Thank you very much.