Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 03
Accident modelling, risk assessment and management
Lecture – 18
Safety measures in design and operation –II

Welcome friends to the 18th lecture in module-3.

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In the online course on Health Safety Environmental Management practises, we are talking about in this lecture, continue discuss about safety measures in design and operation this is eighteenth lecture. In module 3 and as we know module three is focusing on Accident Modelling Risk Assessment and Management. In the last lecture we discussed about some important safety measures in operation, we said that purging is one important mechanism or by safety operation which is very a very common practise in oil and gas industries essentially which deals with hazardous materials we are now continue to look at the factors which affect the efficient way of purging in that list. Let us talk about the time of contact the duration of contact of surfaces of purge gas in the original gas an important element. So, the duration of contact of purge gas and the

original gas is an important parameter for better efficiency it should be minimum as far as possible.

For example, if the purge gas input rate is too low that case it will result in excessive mixing by natural diffusion.

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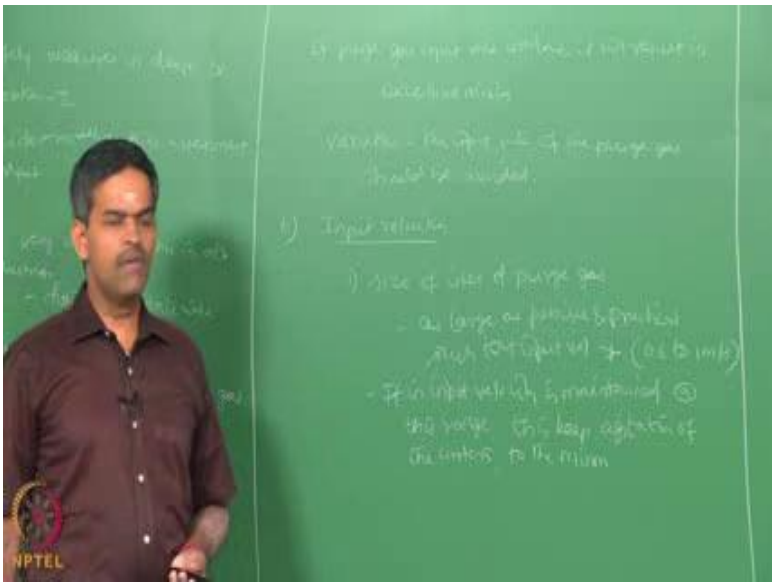

So, interruptions and variations of the purge gas input rate should be avoided. So, variations in the input rate of the purge gas should be avoided as far as possible the other factor, which is also important in efficient purging operations which is safe is input velocities. Velocity of purge gas at the entrance plays a very vital role in general the factors which will lead to this could be size of the inlet of the purge gas that is a very important parameter it should be as large as possible, it should be as large as possible and practical such that the input velocity should not exceed a specific value should not be more than let us say a range of 0.6 to 1 meter per second.

So, what is the advantage of maintaining the input velocity at this specific range? If the input velocities are maintained at this range then this keeps the agitation or starring of the chamber contents of the minimum. So, this keeps agitation of the contents to the minimum alternatively. If the input connection or the diameter is too small to the rate of the input it may result in higher velocity. If the input velocity is higher and the output vent is larger than the purge gas may stream are arc across the inlet outlet limiting both displacement and dilution for example.

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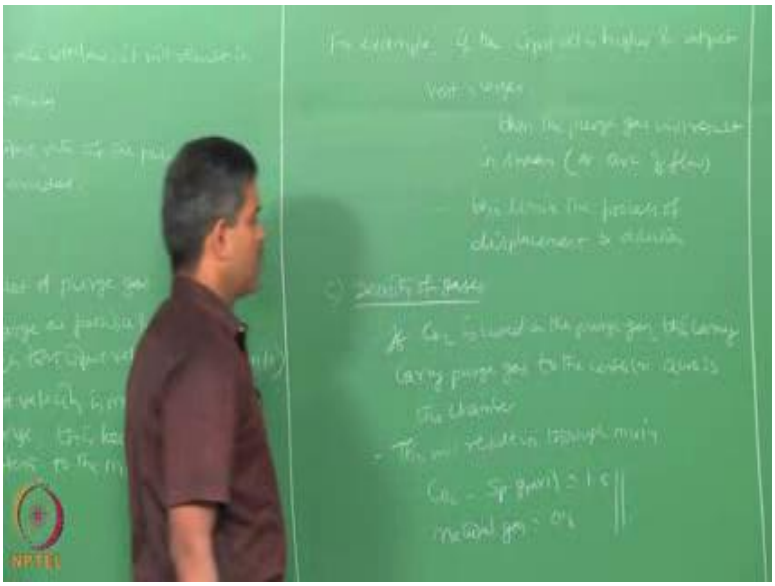

If the input velocity is very high and output vent is very large, then the purge gas will result in a stream of flow or what we call arc of flow from the inlet outlet. What is the disadvantage of this if this happens this limits the process of displacement and dilutes the next factor which is also important for efficient purging is the density of the gases.

The relative densities of the purge gas and air being purged as a very import in effect on the mechanics of purging action; for example, if you use carbon dioxide a specific gravity of approximately 1.5 this will carry the purge gas up to the centre and across the chamber. So, let say if carbon dioxide is used as the purge gas this shell carry purge gas approximately to the centre across the chamber.

So, this will result in thorough mixing which will improve the efficiency of purging operation this is large enough when compared to that of a natural gas whose specific gravity is about 0.6 was carbon dioxide has specific gravity approximately 1.5 where as natural gas has specific gravity approximately 0.6. So, the density of gases in terms of the purge gas and the air of the gas container in the vessel play a very important role in checking or assessing the efficiency of the purging operation. So, if you have a combination of this order this will create inner gases to stratify and remain in layer at the bottom on the chamber filled with a natural gas.

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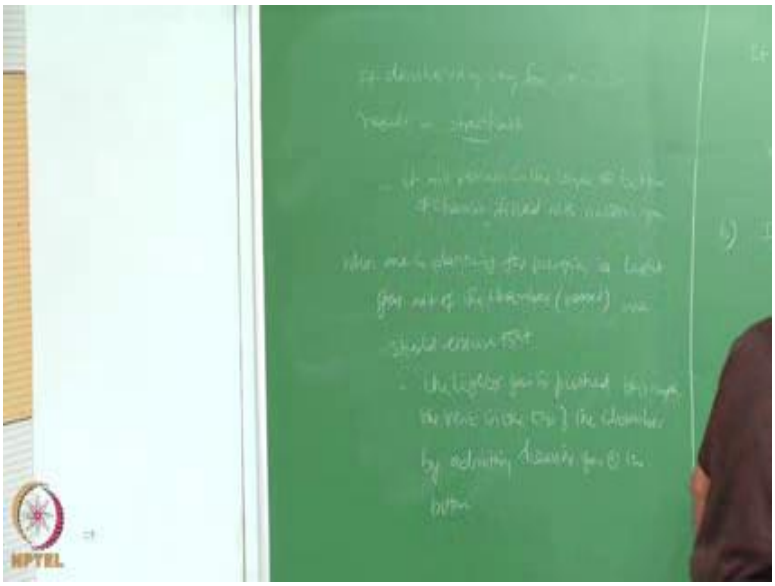

So, one can say if density is very very far this will result in stratification what is stratification it will form a layer. So, it will remain in the layer it will remain in the layer at bottom of the chamber which will be filled with natural gas. Therefore, when purging a light gas out of the chamber one must say or one must check to push the lighter gas out through the vents in the top of the chamber. So, when you when one is planning for purging a light gas out of the chamber or a vessel or a container then, one should assess or one should ensure that one should ensure that the lighter gas is pushed through the vent in the top of the chamber by admitting heavier gas at the bottom alternatively.

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When putting back the equipment in service in that case heavier inert gas is to be replaced by lighter ones. Then the lighter gas should be introduced at the top of the chamber on top of the chamber while the heavier gas is vented from the bottom when purging facilities is out of the service have contained gases with higher specific gravity. Then vapours can be effectively replaced with the minimum mixing by introducing inert gas at the top of the chamber and displace the vapour through the bottom vents.

When purging facility into service that and after replacement of air by an inert gas heavy vapours a liquid should be admitted in the base of the vessel while purge gas should be displaced upwards through the vents, it means the purging cycle and operation is decided based on the density of purging gas and the gas inside the chamber. So, while placing the vessel in operation or placing the vessel out of service one should be very carefully operating the kind of purge gas with the higher or lower density in comparison to the gas inside the chamber. So, that the lighter one is exit out and the heavier one is pushed from the bottom or vice versa interestingly heavier gases like butane propane or benzyl vapours can be first displaced downwards natural gas is displaced upwards because it is lighter out of the top vents in inert gas which is subsequently replaced by air.

Therefore, friends the importance of density difference in purging operation demands approximately about 50 percent of inert gas is to replace by air in the large chamber. So, approximately about 50 percent of the inert gas is to be replaced by air in the large chamber. If you look at nitrogen is a purge gas which has specific gravity approximately 0.97.

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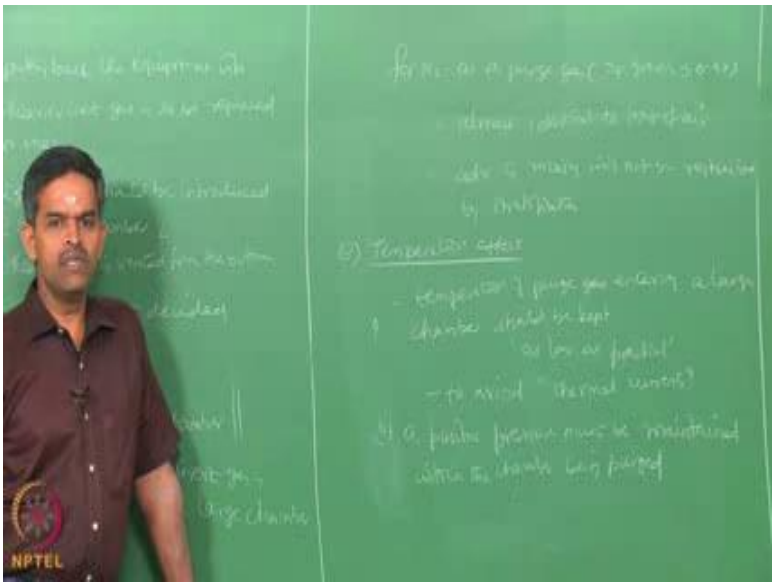

For nitrogen as a purge gas whose specific gravity is approximately point nine seven this is considered to be almost identical of air. So, that mixing is not restrained by stratification the advantages mixing will not be restrained by stratification while the natural gas is being replaced the next could be temperature effects it is always advisable to keep the temperature of the purge gas entering a large chamber as low as practical. So, temperature of purge gas entering a large chamber should be kept as low as possible or practical to avoid what we call thermal currents.

A positive pressure must be maintained within the chamber being purged that is another condition. Therefore, friends whenever there is a sudden drop in atmospheric temperature which can occur during purging of a vessel it is necessary to reduce a rate of release of the purged gas that is very important.

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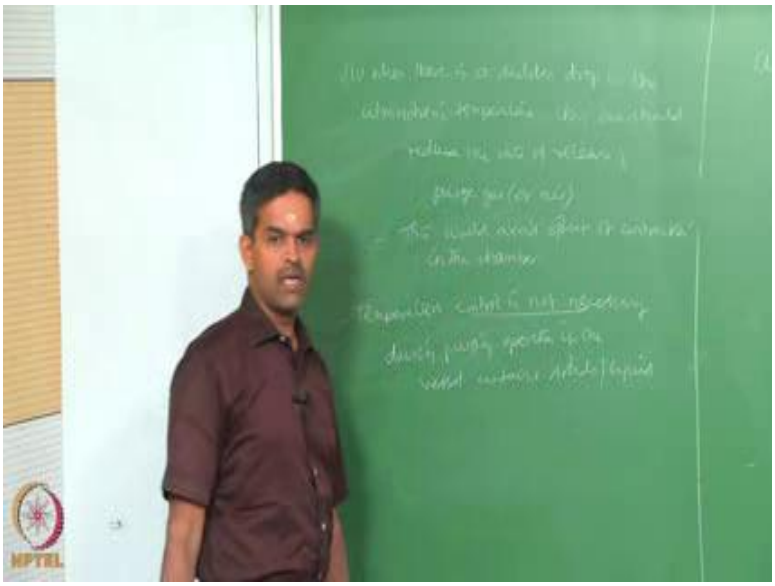

When there is a sudden drop in the atmospheric temperature which may cause thermal currents then one should reduce the rate of release purge gas or air whatever may be why this is done because to offset the contraction of the contents present in the chamber. So, this would avoid offset of contraction what we call in the chamber please understand that it is not necessary to control the temperature when the chamber is being purged, when the chamber contains solid or liquid. So, temperature control is not necessary, during purging operation if the vessel contains solids or liquids this control is essential only when the vessel contains the gas because the temperature difference or the thermal gradient will result in what we call thermal currents.

Now, let us see what are the special precautions one should take as a safety practise while purging with respective temperature.

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The special precaution should be taken, if the container or the pipe or the facilities contains naphthalene at all deposits if the container or the pipe or the vessel contains naphthalene deposits or far deposits oil solvent and other volatile material present is also a problem. So, one should go for a special precaution when you are purging a vessel or a pipe containing these kinds of a hazardous chemicals like naphthalene deposits far deposits oil solvent and other volatile material. Because they can give of combustible vapours because they can produce of combustible vapours even under margin increase in temperature. So, one has got to be very careful and do this very high level of safety precaution either before or during the purging these deposits like naphthalene etcetera should be heated to such a degree that there could be no further volatilization possible during the purging operation.

So, one important safety measure when you are purging vessels or pipes having these kinds of deposits is to heat the container such that no further vaporization is possible. So, this is what we call as.

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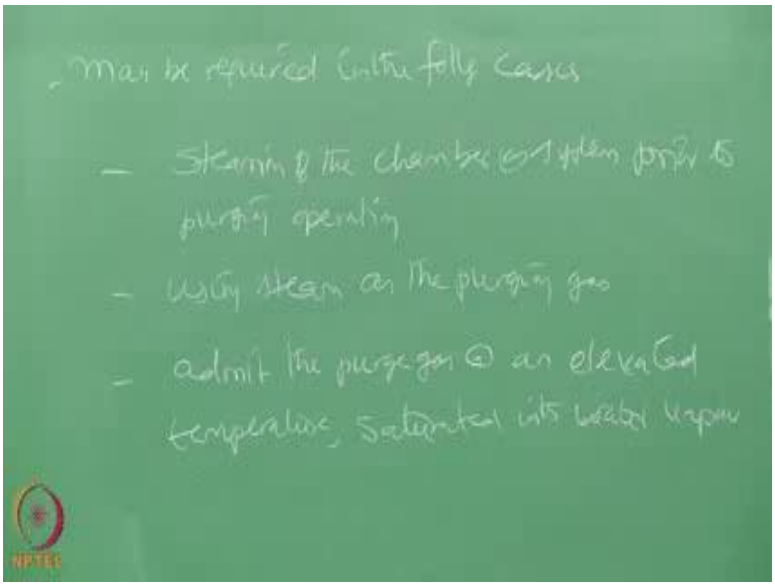

This is called as topping distillation of deposits this can be required in the following cases one streaming of the chamber or system prior to gas and purging. So, that you avoid further vaporization that is what we call as topping distillation of deposits you can also alternatively use steam as the purging gas that can be advantage and this will not allow any further vaporization. The third method by which a safety measure can be adopted is admit the purge gas at an elevated temperature saturated with water vapour now the question comes, what are those factors which can be considered to obtain high mechanical efficiency during purging.

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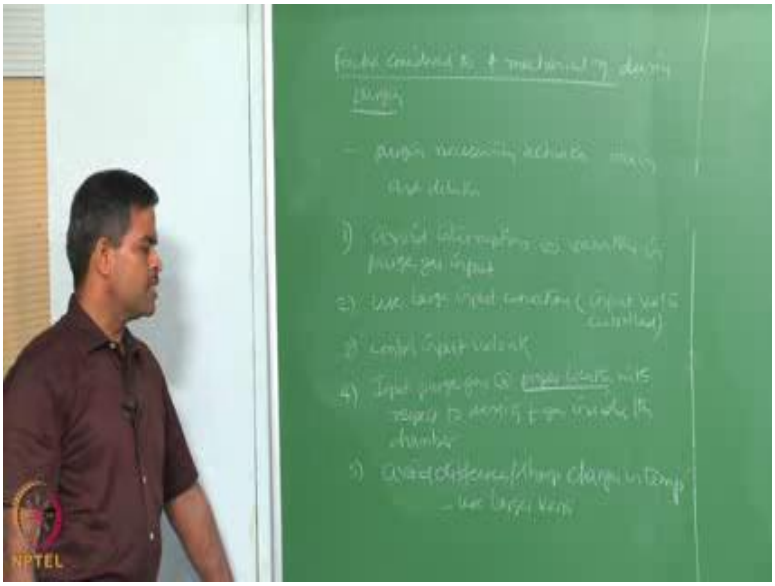

Factors considered to improve mechanical efficiency during purging we all know that purging necessarily activates mixing and dilution to make it efficient one can follow the following procedures avoid interruptions avoid interruptions or variations in purge gas input.

So, the purge gas input should be more or less continuous and constant second could be used large input connections. So, that the input velocity is more or less controlled that is the third point. So, control input velocity forth could be introduced purging gas at a proper location with respect to gas density because we already saw that if the gas density inside is lighter. Then we should push the gas to the exit by pumping the purge gas on the bottom and vice-versa. So, introduce the input purge gas at a proper location either from the bottom or from the top or from one end push to the purge gas to the other end etcetera. So, that you make a proper and ensure a proper mixing of the purge gas with that of the vapour or the gas present inside the chamber other idea could be avoid differences and sharp changes in temperature. So, that thermal current can be avoided how this can be achieving use larger vents. So, that ready escape of displaced gas is possible.

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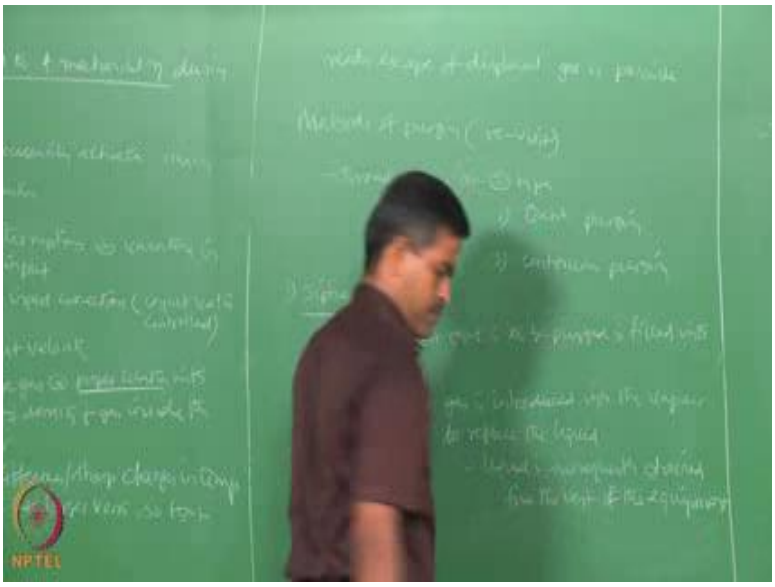

So, with this in mind after understanding different factors which can influence the purging operation and what are those safety precautions which should be taken care of to

ensure proper mixing and dilution during purging operation. Let us try to understand now with these perspective different methods of purging.

We already saw different methods of purging in terms of what should be inlet and outlet pressure control whether pressure control or pressure purging will follow vacuum purging etcetera. We also saw the quantity of gas required for such kind of purging operations of purging methods we will once again look at the method of purging in a different perspective.

Because now we have more information about the factors that can affect or efficiency of the purging operation together method of purging, let us say a revisit we want to once again look into this there are many methods of purging that are commonly practised in process industries broadly there are two types batch purging and continuous purging broadly. There are 2 types; one is called batch purging other is continuous purging. So, let us say common methods of purging which is practised in oil and gas industry let us start with siphon purging in this method equipment that is to be purged is filled with liquid purged gas is introduced into the vapour space into the vapour space to replace the liquid which is then drained from the equipment liquid is subsequently drained from the vent of the equipment in this case the volume of purged gas required for operation will be equal to the volume of the vessel.

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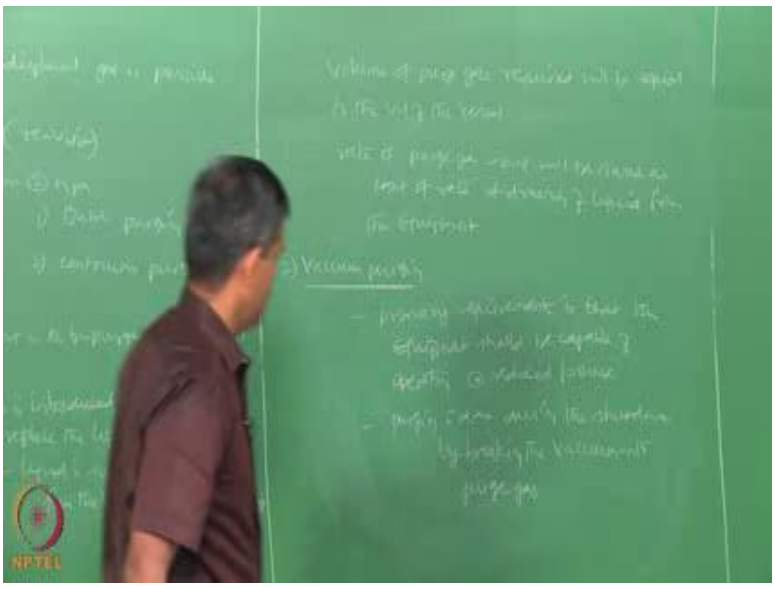

Rate of application will be as same as that of rated draining the next is vacuum purging in this method the equipment that normally operates at reduced pressure or equipment which is capable of operating reduces pressure is purged using vacuum purging. So, the primary requirement is that the equipment should be capable of operating at reduced pressure. Then only one can go for vacuum purging in this case purging is done by shut down or during the shutdown during the shut down by breaking the vacuum with the purge gas with the purge gas. If the initial pressure is not low enough to ensure desired low oxygen concentration then it is necessary to re evacuate and repeat the process that is why in case of vacuum purging you need to do more cycles, if the initial pressure.

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If the initial pressure is not lower enough to ensure desired low oxygen concentration then the cycle is repeated amount of purge gas required. In this case is determined with the number of application and number of cycles by the number of applications or let us say number of cycles required to develop the desired oxygen concentration.

If you are talking about purging parallely two or more containers which are joined by a manifold, in that case purging is done as a group then the vapour content of each container should be checked for completeness of purging that is very important the next could be pressure purging.

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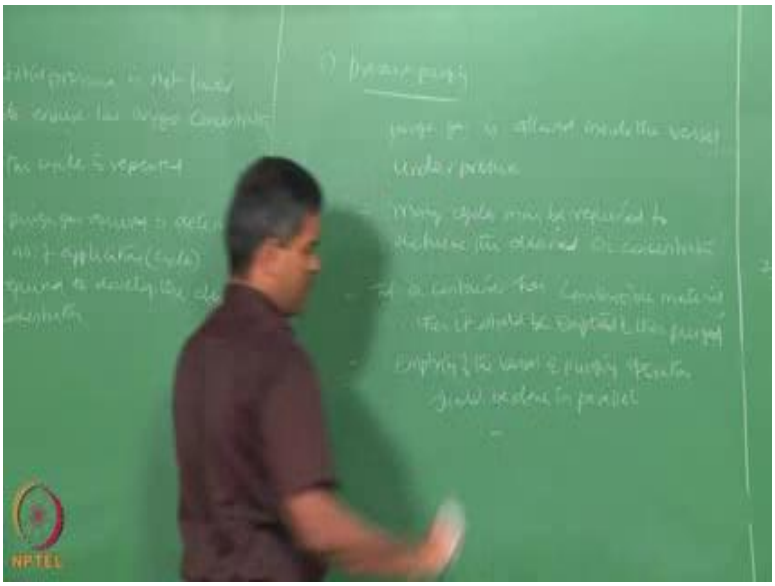

In this method enclosures might be purged by increase in the pressure within the enclosure this is carried out by introducing the purging gas under pressure, after the gas is defused the enclose is vented out to the atmosphere in this case more than one pressure cycle may be necessary as we saw in the last two lectures back, because this is helpful to reduce oxygen concentration to the desired percentage. So, purging is done under pressure or purge gas is allowed inside the vessel under pressure many cycles may be again required to achieve a desired oxygen concentration. When two or more containers or tanks are to be purged in parallel or when they are joined by a manifold and if they need to be purged together as a group then the vapour content of each container should be checked.

So, that the desire purging pressure is achieved when a container filled with combustible material is emptied and then purged. So, that is very important if a container has combustible material then it should be empty and then purged in that case purge gas is supplied to the vapour space at pressure consistent with equipment design and limitations emptying or the vessel and the purging of vapour space should be done in parallel that is very important. So, emptying of the vessel and purging operation should be done in parallel that is important sweep through purging.

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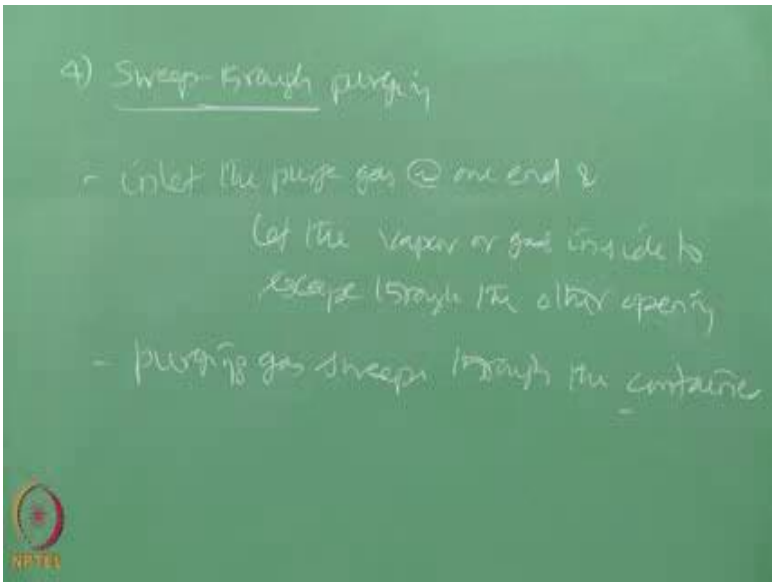

This method actually involves introducing a purging gas into the equipment at one year opening and letting the enclosure content to escape to the atmosphere to the other opening. So, inlet the purge gas at one end and let the vapour or the gas inside to escape through the other open that is why it is called sweep.

Through sweep through purging, purging gas sweeps through the content through the content in this case the quantity of purge gas required depends upon the physical arrangement you have pipe vents can be effectively purged with little amount of purge gas or volume of purge gas if the gas can be introduced at one end and the exit can be taken away or the mixture can be taken away at the other end and both operations happen in parallel.

Friends, in this lecture we understood what are the factors individually which affects the purging efficiency to make purging safe, which is one of the important vital requirements in oil and gas industries what are the factors and precautions one are need to consider while purging operation is being carried out what are different methods of purging which is now revisited with the better understanding in terms of safety practises. We will continue with this in the next class, as well before we move on to further safety practises as applicable to HSE in terms of oil and gas industries.

Thank you.