Chemical Process Utilities
Prof. Shishir Sinha
Department of Chemical Engineering
Indian Institute of Technology – Roorkee

Lecture – 34
Conveying System Types

Welcome to the conveying system types. You see that previously we were discussing about the various modes of pneumatic conveying. We discussed about the basic philosophy of the pneumatic conveying, we discussed about the dilute phase, dense phase, conveying air velocity, solid loading ratios etcetera in the previous lecture. We had a discussion about the advantages and disadvantages of the pneumatic conveying system apart from this the main components of the pneumatic conveying system.

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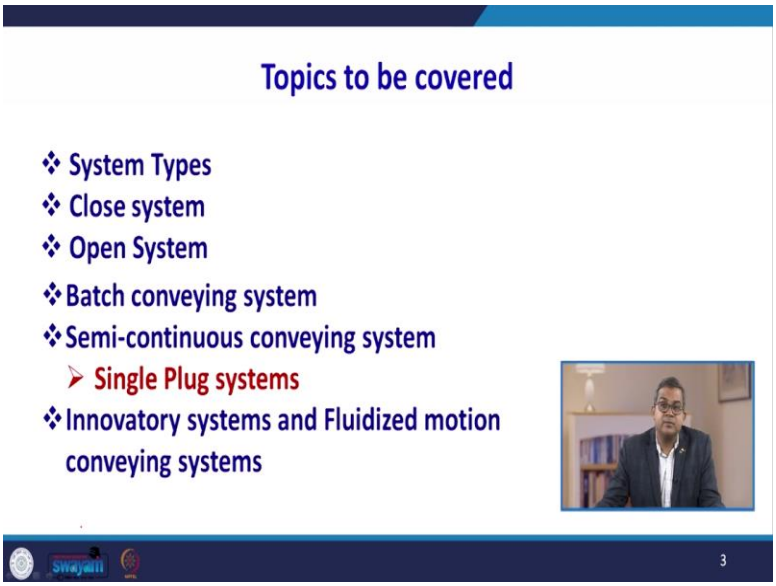

In this particular lecture we are going to discuss about the different types of system, close system, open system then we will discuss about the batch conveying system, semi continuous conveying system. We will discuss about the single plug systems and innovatory systems in fluidized motion conveying system.

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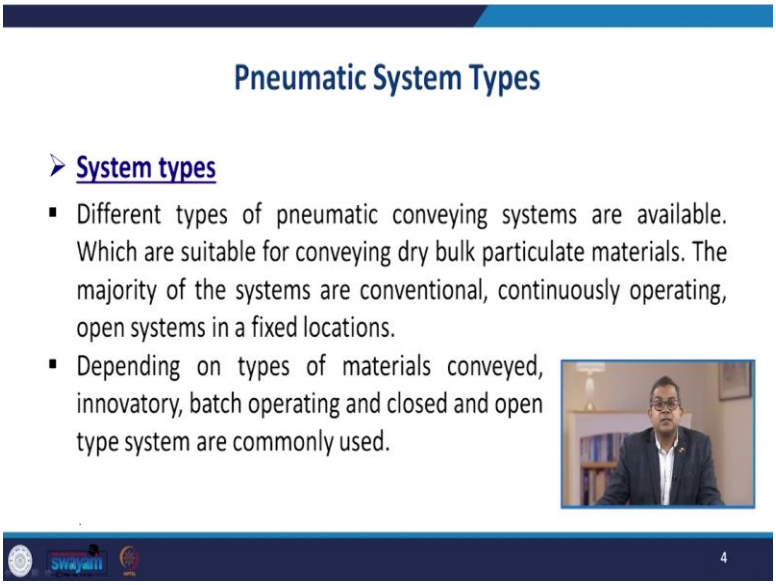

So, let us talk about the type of pneumatic system. When we were discussing about the system types, the different type of a pneumatic conveying systems are available as on date which are suitable for conveying dry bulk particulate materials. The majority of the systems are usually conventional, continuously operating system, open system in a fixed location etcetera.

So, depending on types of material conveyed innovatory, batch operating and a close and open type systems they are commonly used.

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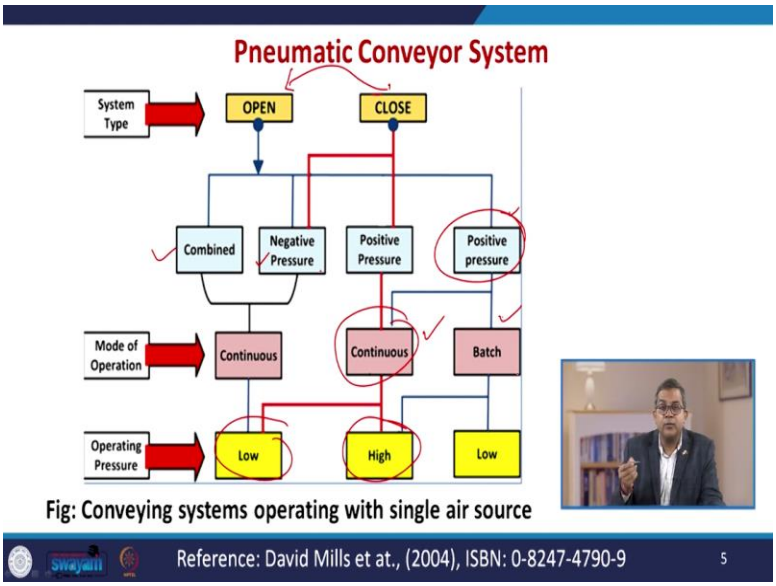

Now you see that different type of pneumatic conveyor system. There are two different type of system one open and close system. So, if we take the open system in question then again you can classify into the combined one negative pressure then positive pressure type of a system.

Now, if we say that the combined one or combined negative pressure then there are continuous and a low-pressure type of a system.

Similarly, if we talk about the close system then again, they are having the negative, positive and if we see the positive pressure system it is having the continuous type of a system with the very low and high operating pressure scenario. Similarly, if we talk about the open system with a positive pressure, it can be classified in the two operations; two mode of operation one is the continuous and second one is the batch one.

Now this batch is again if in terms of sub classify with respect to the operating pressure it can be either high or a low one.

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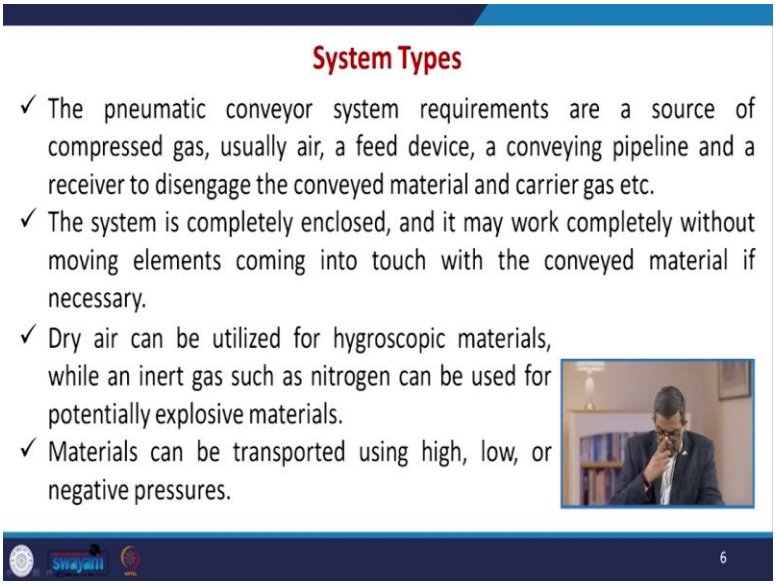

Now the pneumatic conveying system the requirement they are usually a source of a compressed air that is the foremost requirement and we can understand. Usually, we are using air under the (()) (03:23) we must have a feed device, conveying pipeline a receiver to disengage the conveyed material and a carrier gas etcetera apart from some allied systems. Now the system is completely enclosed.

It may work completely without moving elements coming into touch with the conveyed material if necessary. If we are using the hygroscopic materials then obviously, we need to use the dry air and if we are looking for some inert gas then nitrogen is the best option for this. The material can be transported using high, low or a negative pressure that depends upon the circumstances or the process in question.

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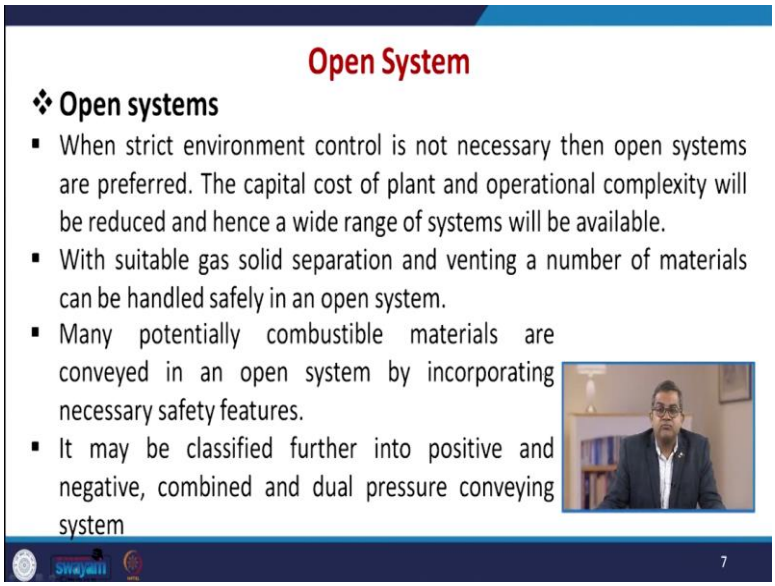

Now, let us talk about the open system. Now when strict environment control is not necessary then open systems are preferred. The capital cost of the plant and operational complexity will be reduced and therefore a wide range of systems will be available. Now with the suitable gas solid separation and venting a number of materials can be handled safely in an open system. Many potentially combustible materials they are conveyed in open system by incorporating necessary safety features.

We have already discussed various safety features in previous lectures. It may be classified further into positive and a negative combined and dual pressure conveying system.

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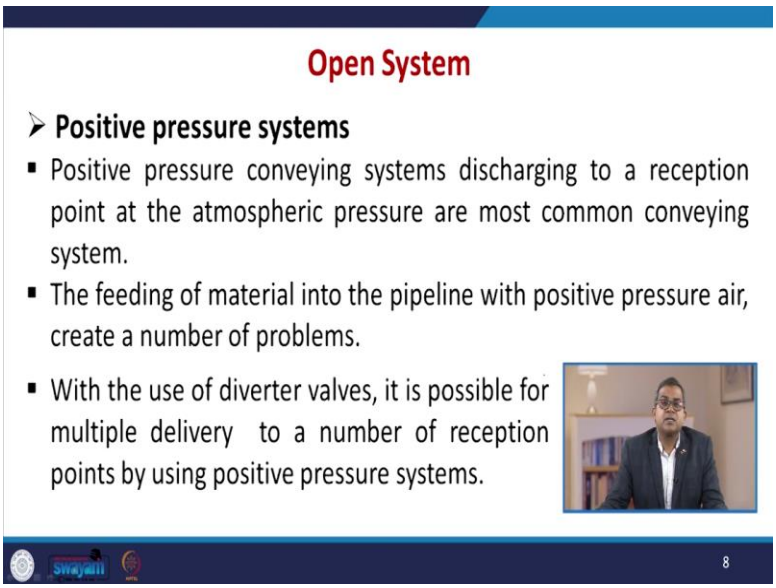

So, let us talk about the positive pressure system. The positive pressure conveying system discharging to a reception point at the atmospheric pressure they are more common conveying system. The feeding of the material into the pipeline with the positive pressure air it creates a number of problems. Now with the use of diverter valves it is possible for multiple delivery to a number of reception points by using positive pressure system.

Now, multiple feeding points sometimes into the common line this can also be arranged, but care must be taken particularly in the case of rotary valve feeding pipeline. Air leakage through these types of valves can be quite significant in the relation to total air required for conveying.

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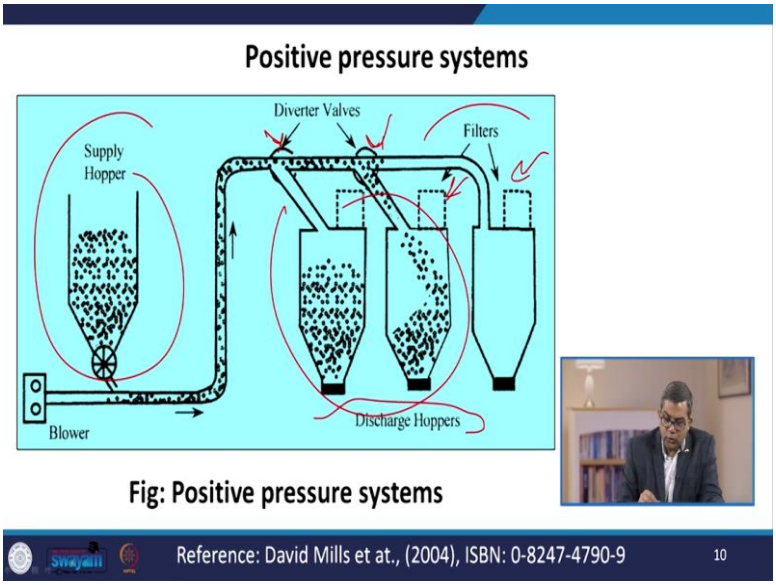

Now here you see the positive pressure system now you are having one supply hopper through which it is being conveyed. There are diverter valves and these are the discharge hoppers and all these systems are equipped with the filters.

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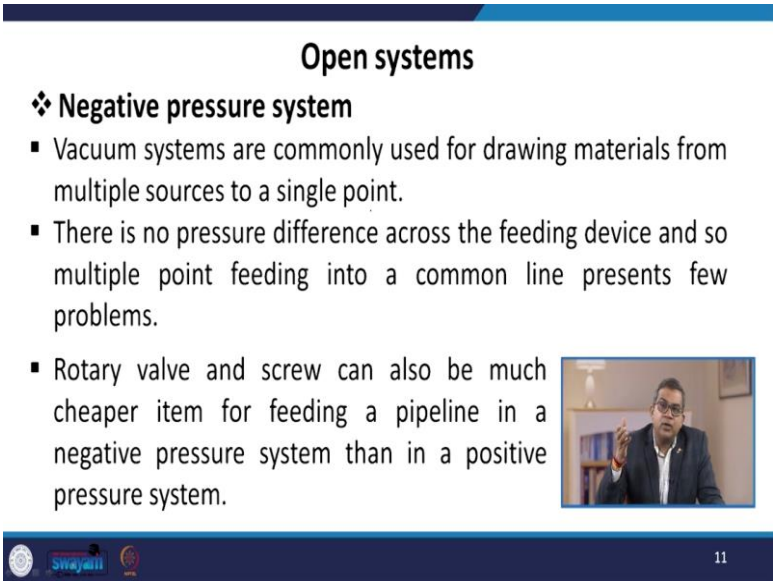

Now, let us talk about the negative pressure system. Now vacuum systems they are commonly used for drawing materials from multiple sources to a single point. There is no pressure difference across the feeding device. So, a multiple point feeding into a common line presents a several problems which need to be addressed. Rotary valve and screw can also be much cheaper item for feeding a pipeline in a negative pressure system than in a positive pressure system.

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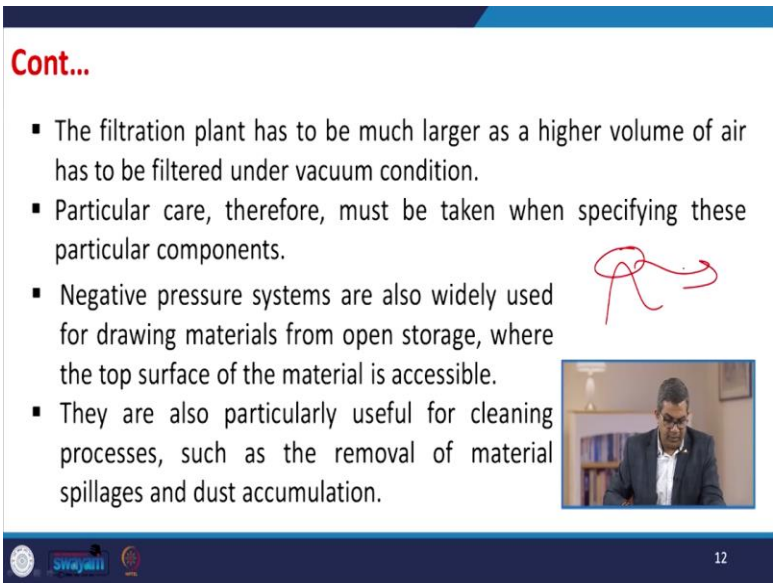

The filtration plant has to be much larger as a higher volume of air has to be filtered under vacuum condition. Particular care must be taken when specifying these types of a particular components. Negative pressure systems sometimes they are also widely used for drawing materials from open storage where the top surface of the material is accessible like this. Here

you are having a heap of coal and then you can carry out. They are also particularly useful for cleaning processes such as removal of material, spillage and dust accumulation etcetera.

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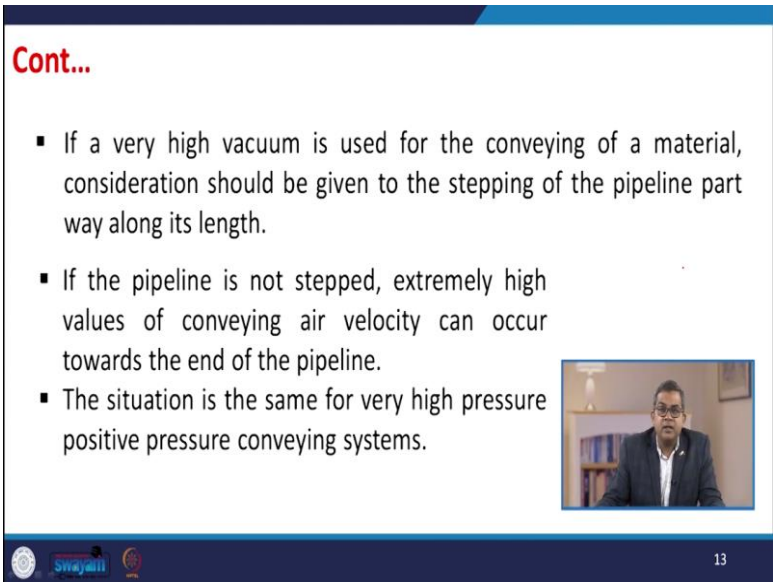

If a very high vacuum is used for conveying of a material consideration should be given to the stepping of pipeline part way along its length. Now if the pipeline is not stepped extremely high values of conveying air velocity can occur towards the end of the pipeline. The situation is usually seen for very high-pressure positive pressure conveying system.

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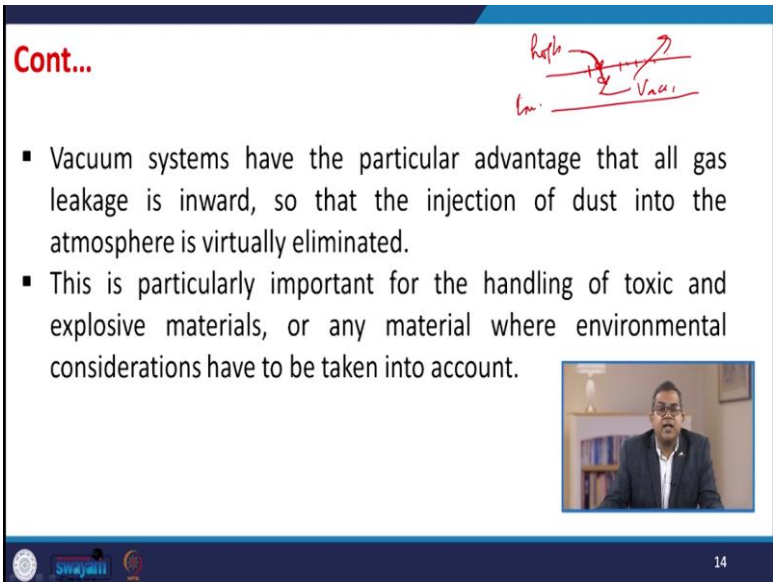

The vacuum systems have the particular advantage that all gas leakage is inward like here you are having this vacuum system and in case if any kind of a leakage is there because you are having a vacuum over here and here this is the high pressure zone and it is the low or negligible

pressure zone then obviously the material or a leakage will be inward. So that the injection of dust into the atmosphere is virtually eliminated because nothing will go out.

So, any kind of contamination to the outside atmosphere is virtually eliminated. This is important for the handling of toxic and explosive material or any material where environmental challenges have to be taken into consideration.

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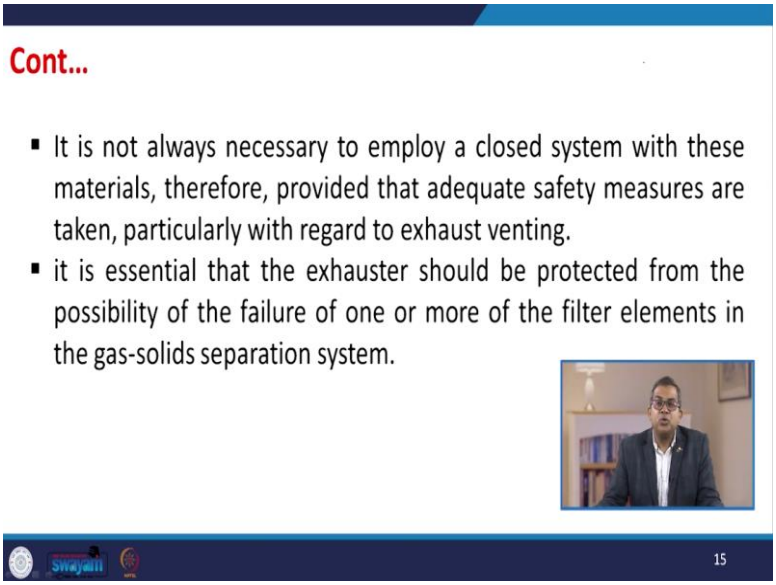

It is not always necessary to employ a close system with these materials therefore provided that adequate safety measures are taken and particularly with regard to the exhaust venting. It is also essential that exhauster should be protected from the possibility of the failure of one or more filter elements in the gas solid separation system.

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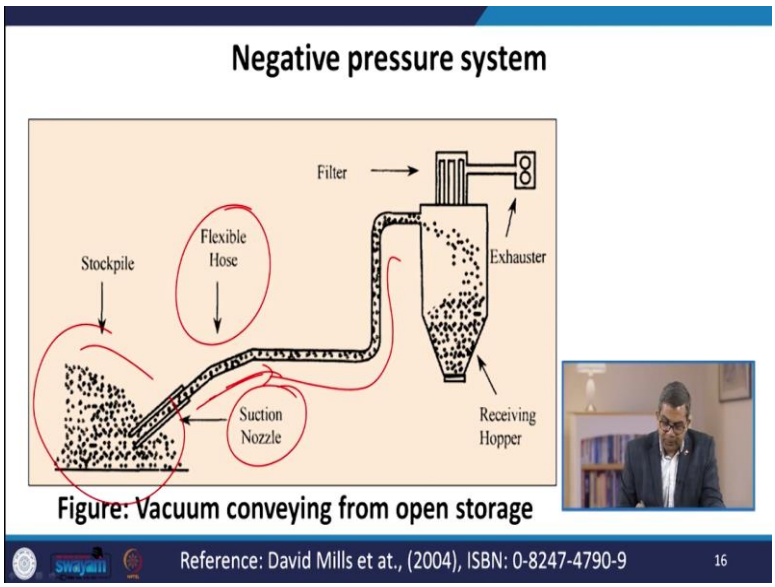

Now here you see that this is the negative pressure system. Here you are having some stockpiled and because of vacuum this material is conveyed through this pipeline with the help of this suction nozzle. We are having this flexible hose. Now here you are having this receiving hopper and this is the exhauster equipped with the filter.

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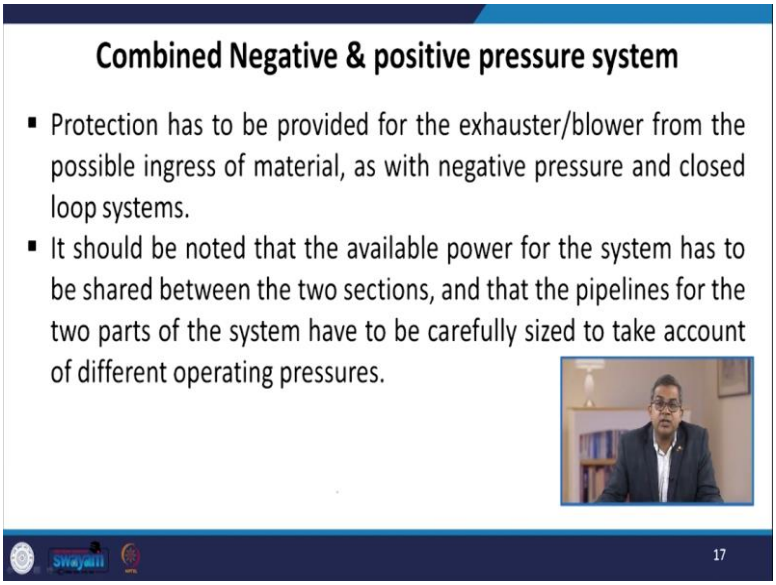

Now there are some certain combined negative and a positive pressure system. Now the protection has to be provided for the exhauster or a blower from the possible ingress of material as with the negative pressure and a closed loop system. It should be noted or it should be given a due consideration that available power for the system has to be shared between the two section and that the pipeline for the two parts of the system have to be carefully sized to take into account of different operating pressure.

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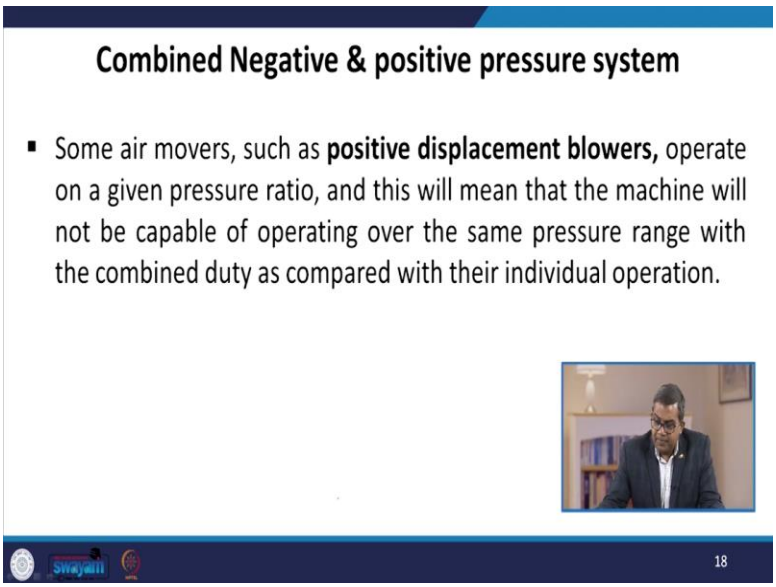

Now some air moves like some positive displacement blowers operate on a given pressure ratio and this means that the machine will not be capable over the same pressure range with the combined duty as compared with their individual operation.

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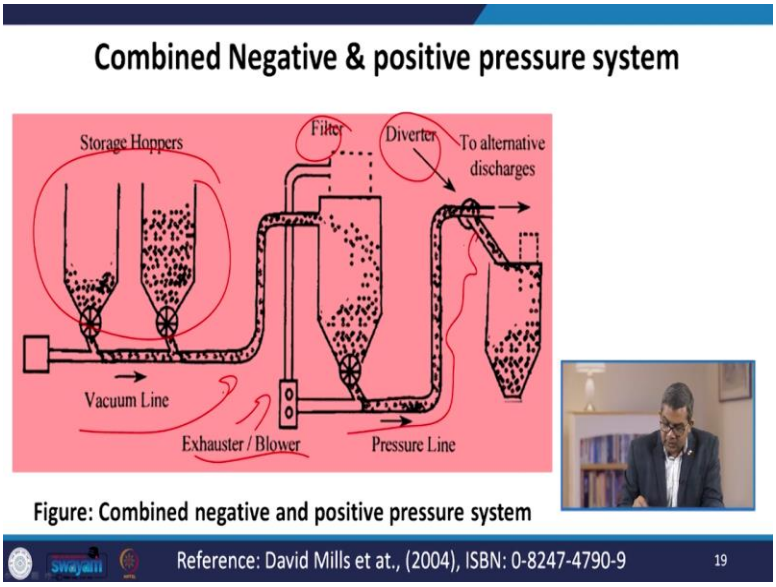

Now you see the typical figure of combined negative and positive pressure. Here you are having the storage hopper with the help of vacuum line. Now you see that it was equipped with the filter and a diverter now here you are having this exhauster and blower with the help of this, this can be disengaged.

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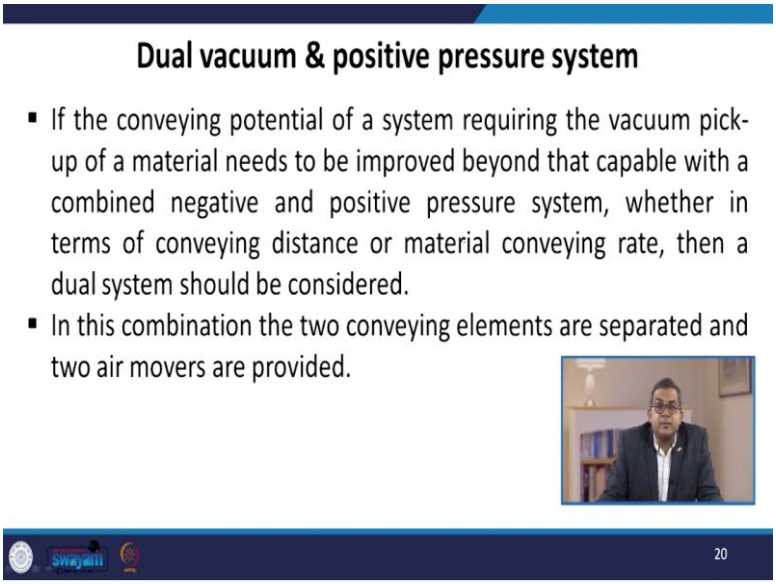

Now apart from this there are dual vacuum and positive pressure system. Now, if the conveying potential of a system requiring the vacuum pick up of material it needs to be improve or improvised beyond that capability with a combined negative or positive pressure system

whether in terms of conveying distance or material conveying rate then a dual system should be considered.

It is the good candidate to be considered. In this combination the two conveying elements are separated and two air movers are provided.

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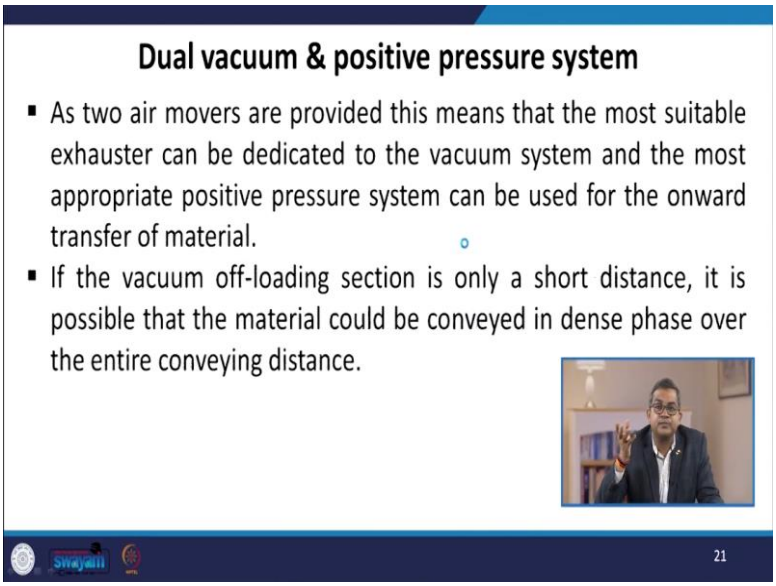

Now as two air movers are provided this means that the most suitable exhauster can be dedicated to the vacuum system and the most appropriate positive pressure where system can be used for onward transfer of material. Now, if the vacuum off-loading section is only a short distance it is possible that material could be conveyed in a dense phase over a entire conveying distance.

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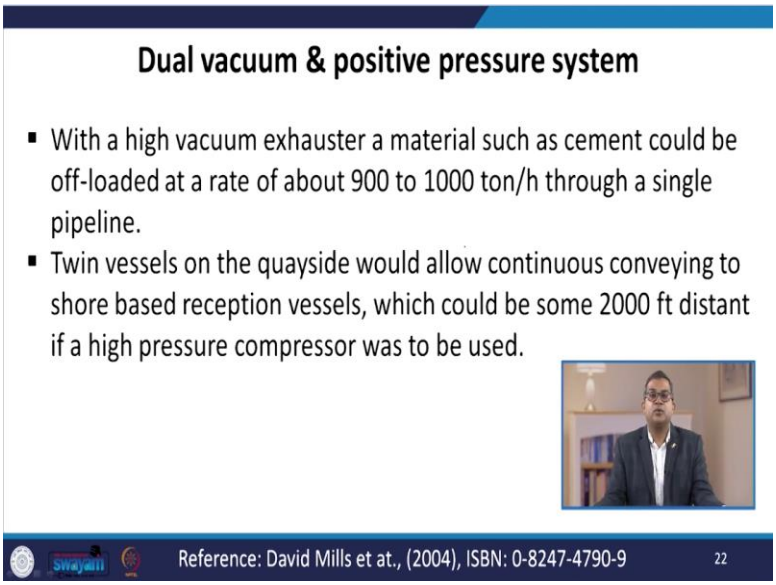

Now with the high vacuum exhauster a material such as like cement it could be off-loaded at a rate of about say 900 to 1,000 tons per hour through a single pipeline sometimes twin vessels on quayside would allow continuous conveying to shore based reception vessel which could be some say 2,000 feet distant if a high-pressure compressor was to be used.

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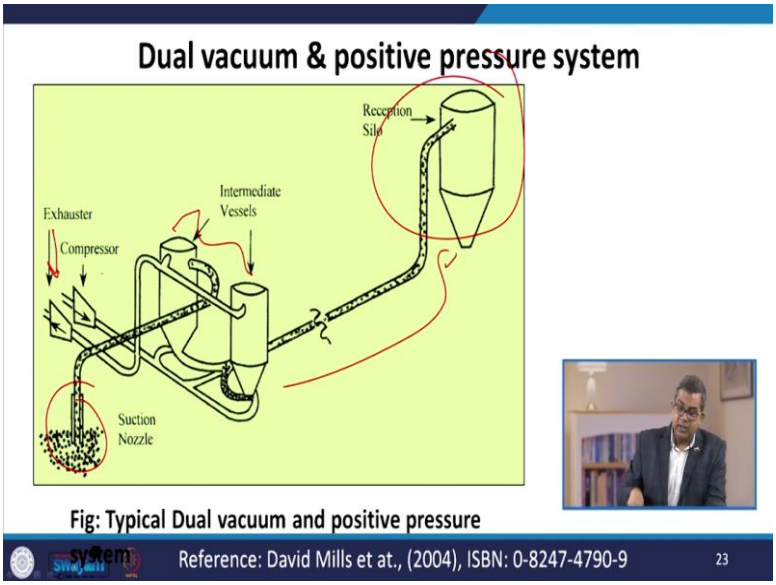

Now here you see the dual vacuum and positive pressure type of a system. We are having this suction nozzle and exhauster always having a compressor with it through this exhauster you are supplying to these intermediate vessels and here you are having the reception silo or reception arena.

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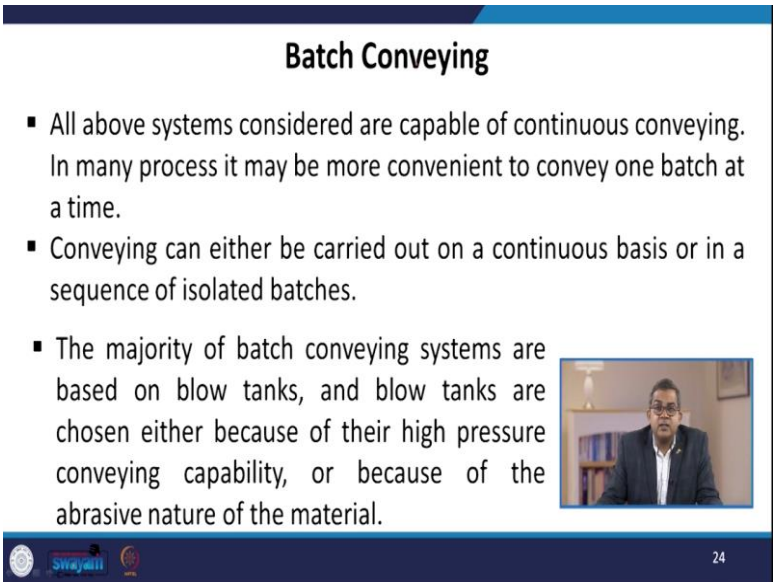

Let us talk about the batch conveying. Now all the system which we described previously they are considered they are capable of continuous conveying. In many processes it may be more

convenient to convey one batch at a time. Now these conveying can either by carried out on a continuous basis or in a sequence of isolation batches. The majority of batch conveying systems are based on blow tanks and blow tanks are chosen either because of their high-pressure conveying capabilities or because of the abrasive nature of the material.

Two type of system they are usually considered first is the semi continuous system in which the batch size is relatively large and a material is fed into the pipeline gradually. The other material is fed into the pipeline is a single plug.

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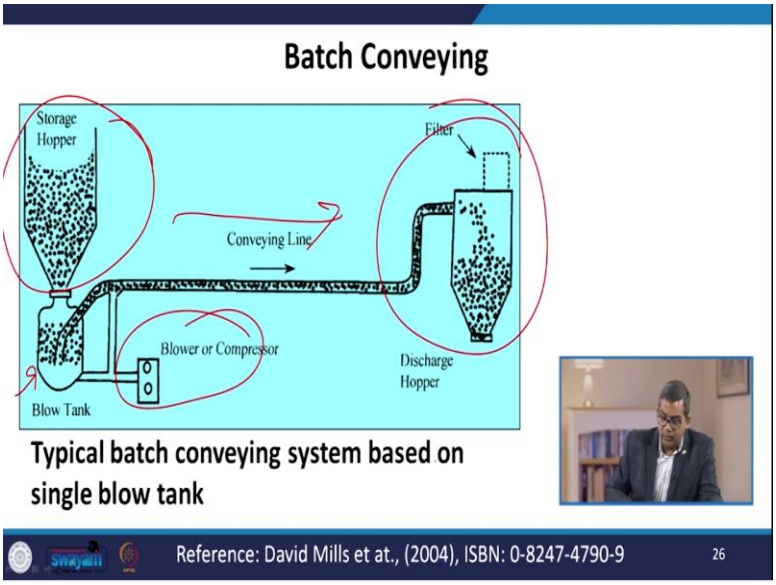

Now here you see the typical batch conveying system based on single blow tank. Here we are using the blower or a compressor this is the blow tank. We are having a storage hopper with this conveying line and you can collect the material over here with an associated filter.

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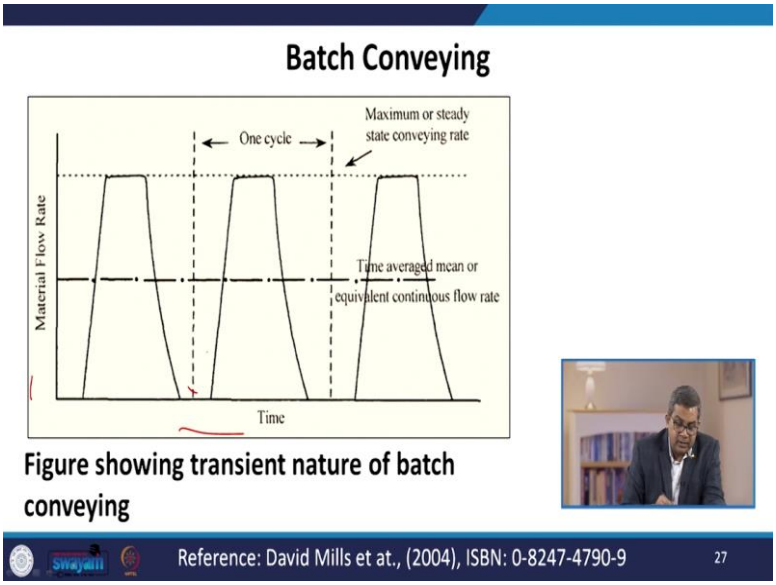

Now, if we see if we discuss about the transient nature of the batches with respect to the time versus material flow rate at the start the material is on the top and then it acquires the stagnant value over the period of time and thereafter it completes one cycle.

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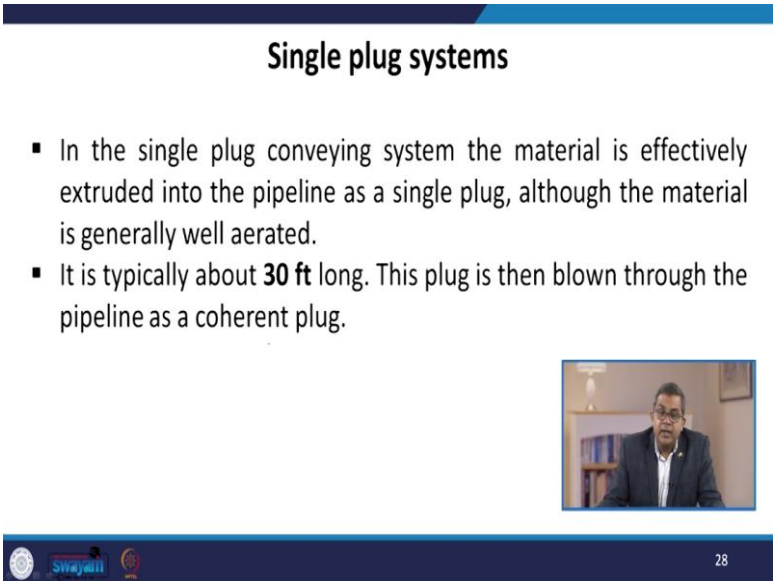

Now let us talk about the single plug system. Now in single plug system or conveying system the material is effectively excluded into the pipeline as a single plug. Although material is generally well aerated. It is usually 30 feet long. The plug is then blown through the pipeline as a coherent plug.

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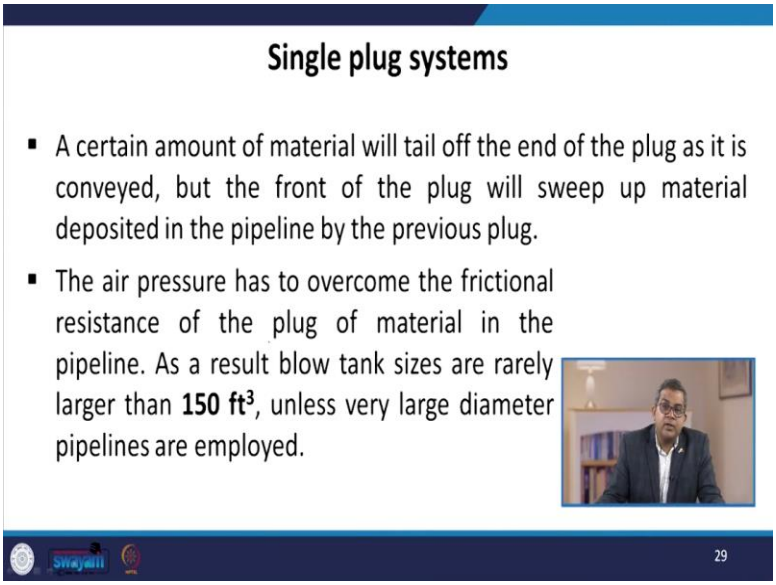

Now a certain amount of material will tail off at the end of the plug as it is conveyed, but the front of the plug will sweep up material deposited in the pipeline by the previous plug. The air pressure has to be overcome the frictional resistance of the plug of the material in the pipeline. Now as a result blow tank size are rarely larger than 150 cubic feet unless very large diameter pipelines are employed.

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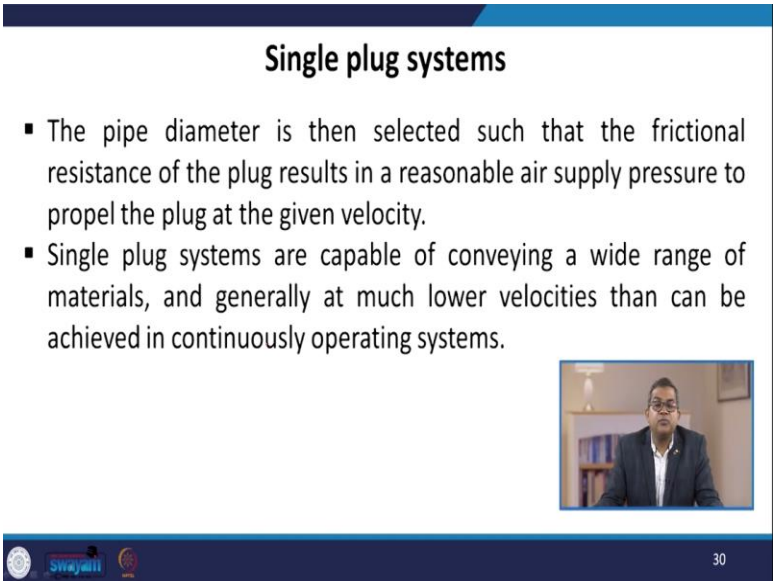

The pipe diameter is usually selected such that the frictional resistance of the plug results in a reasonable air supply pressure to propel the plug at a given velocity. Now single plug systems they are capable of conveying a wide range of material and generally at much lower velocity then it can be achieved in continuously operating systems.

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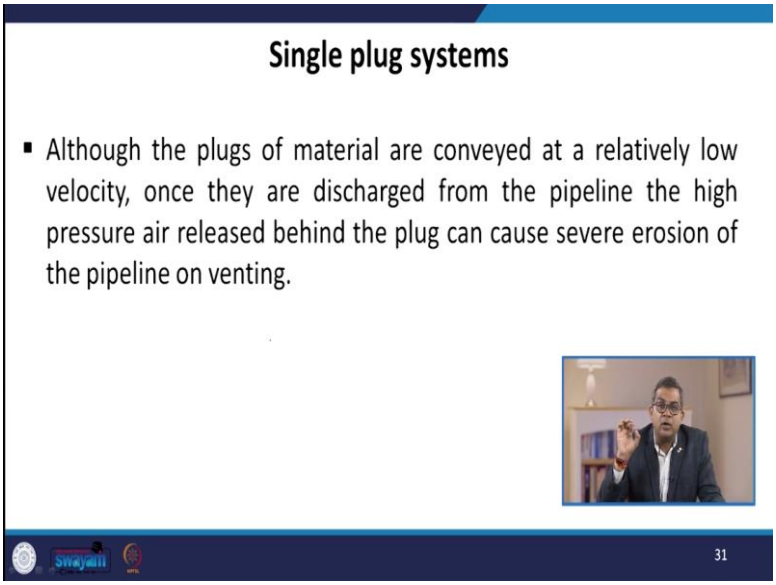

Although the plugs of material they are conveyed at a relatively low velocity once they are discharged from the pipeline the high pressure air released behind the plug can cause several erosionic options in the pipeline during the venting.

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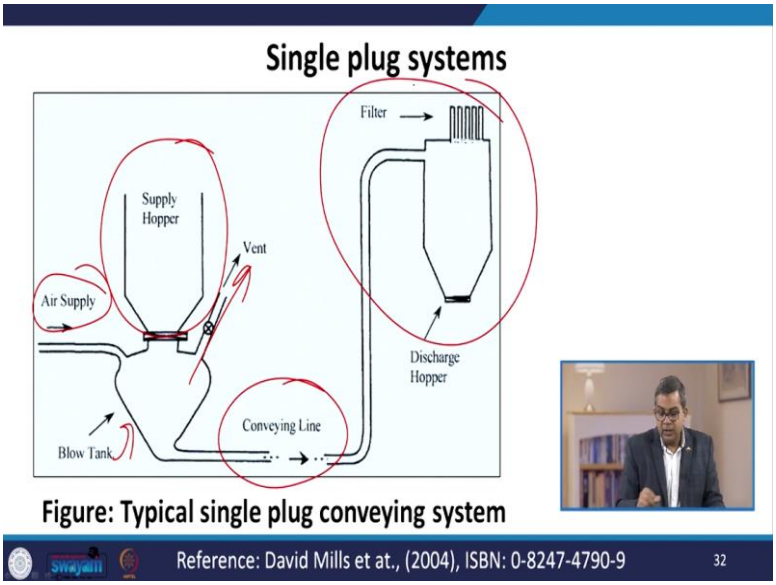

Now here you see the single plug system you are having the air supply equipped with the blow tank. We are having a supply hopper with the vent and this is the conveying line and usually with the help of filter we are having this discharge of hopper.

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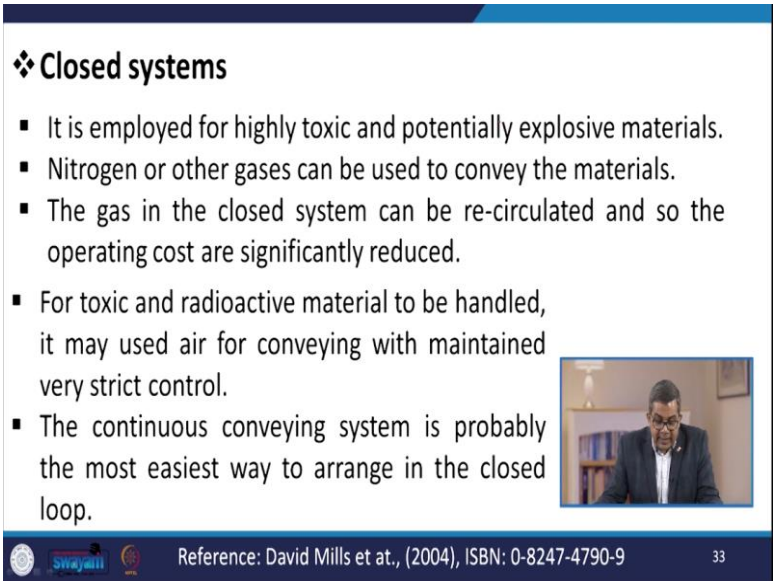

Let us talk about the closed system. Now it is employed for higher toxic and potentially explosive material. So, this is one of the added benefits. Nitrogen or other gases they can be used to convey the material. The gas in a close system can be re-circulated and so the operating cost are significantly reduced. For toxic and radioactive materials to be handled it may used air for conveying with maintained very strict control.

The continuous conveying system is probably the easiest way to arrange in the closed loop.

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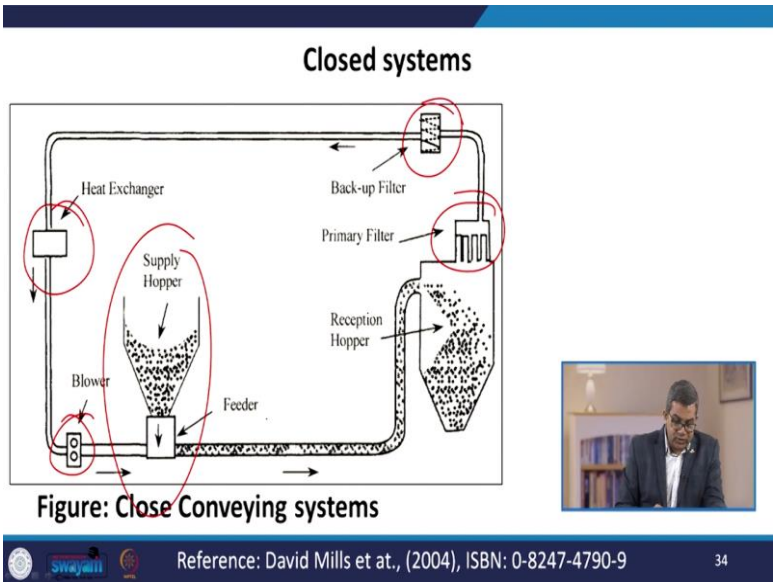

Now here you see this is the closed loop system we are having a backup filter over here apart from this primary filter and as usual we are having the supply hopper and blower is attached to somewhere here and it is equipped with the heat exchanger.

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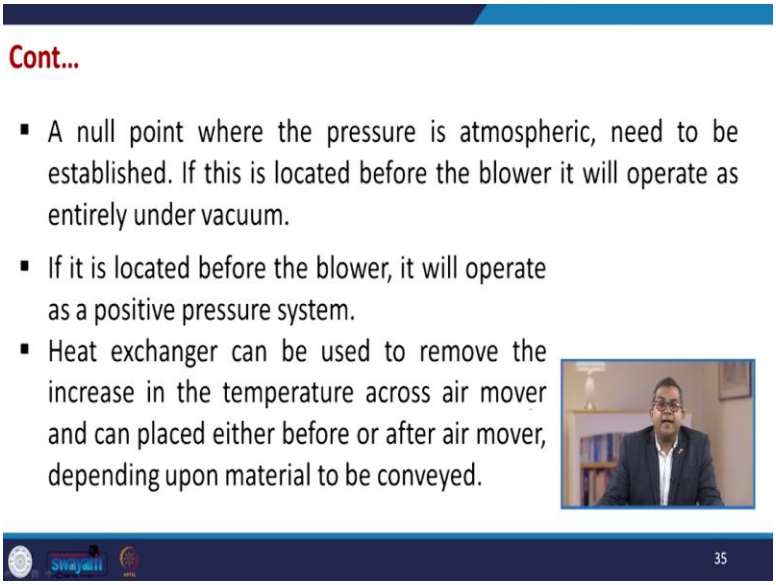

Now a null point where the pressure is atmospheric needs to be established. Now if it is located before the blower, it will operate as entirely under vacuum. Now, if it is located before the blower it will operate as a positive pressure system. Here you see in this figure. Now heat exchanger can be used here you are using the heat exchanger. The heat exchanger can be used to remove the increase in the temperature across air mover and it can be placed either before or after air mover depending upon the material to be conveyed.

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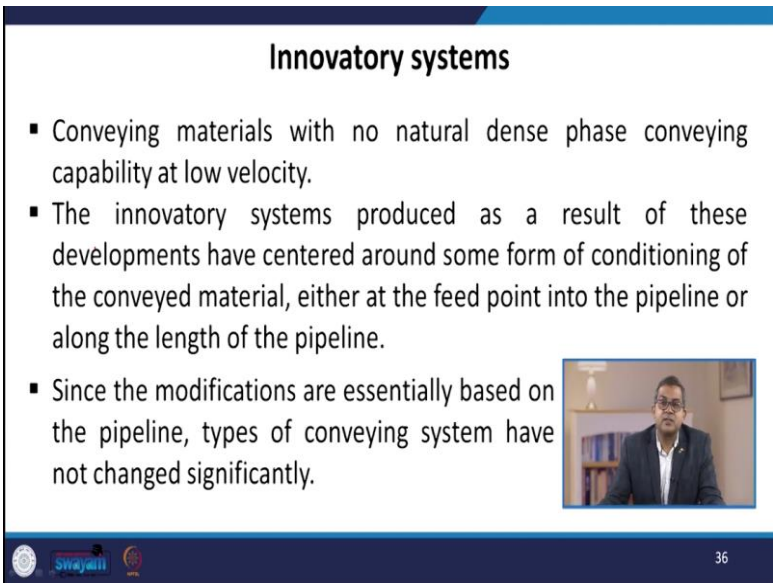

Now, let us talk about the innovatory systems. Conveying materials with no natural dense phase conveying capabilities at a low velocity. The innovatory systems produced as a result of these developments they have centered around some form of conditioning of the conveyed material either at the feed point into the pipeline or along the length of the pipeline. Since the

modifications are essentially based on the pipeline, types of conveying systems have not changed significantly.

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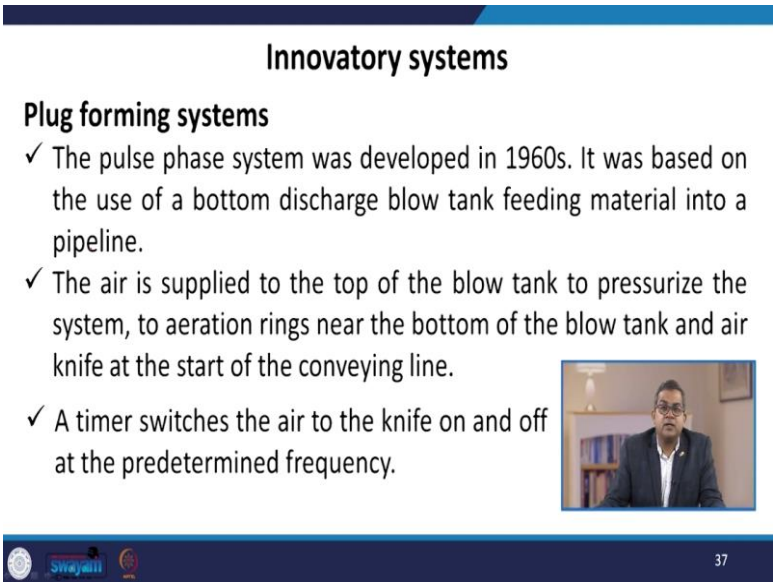

Let us talk about the plug forming system. The pulse phase system which was developed way back in 1960 it was based on the use of bottom discharge blow tank feeding material into a pipeline. The air is supplied to the top of the blow tank to pressurize the system to aeration rings near the bottom of a blow tank and air knife at the start of the conveying line. Usually, we have a timer switch. So, a timer switches the air to the knife on and off are the pre determined frequency.

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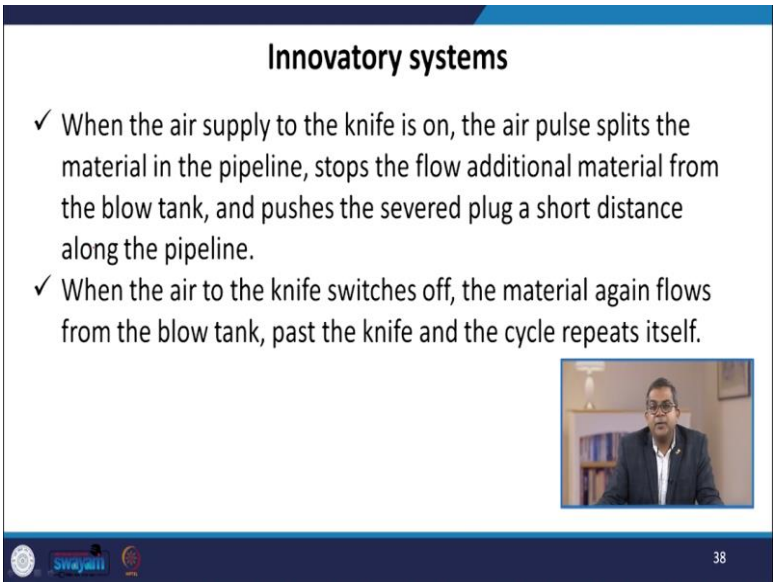

So, when the air supply to the knife is on the air pulse splits the material in the pipeline and it stops the flow additional material from the blow tank and pushes the severed plug a short

distance along the pipeline. So, when the air to the knife switches off the material again flows from the blow tank past the knife and cycle repeat itself.

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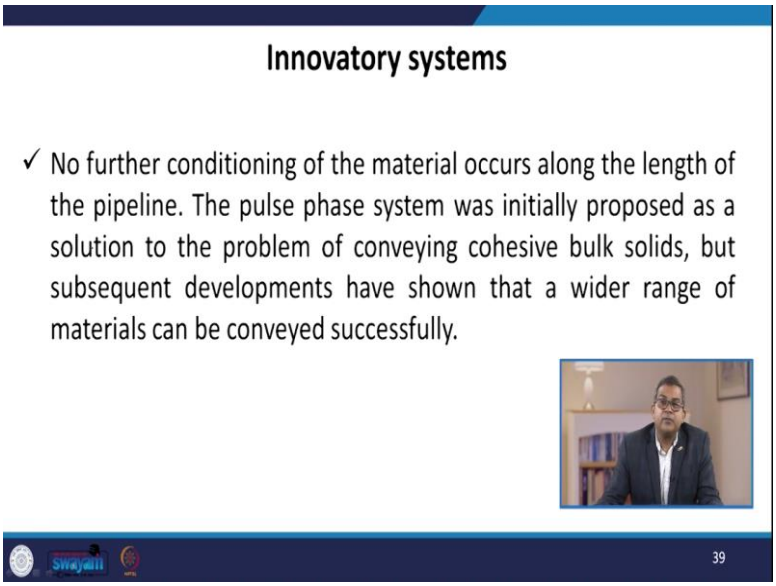

No further conditioning of the material occurs along the length of the pipeline. The pulse phase system was initially proposed as a solution to the problem of conveying cohesive bulk solids, but subsequent developments have shown that a wider range of a materials can be conveyed successfully.

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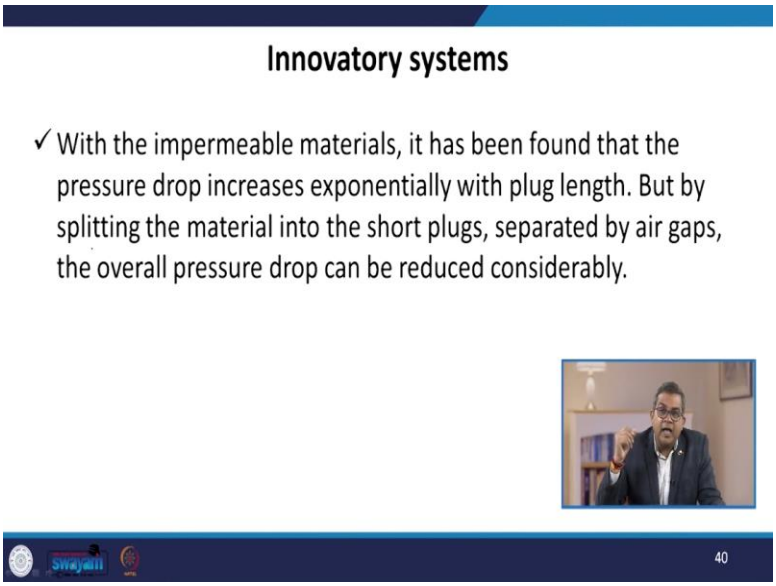

Now with the impermeable materials it has been found that the pressure drop increases exponentially with the plug length, but by splitting the material into the short plugs separated by air gags the overall pressure drop can be reduced considerably.

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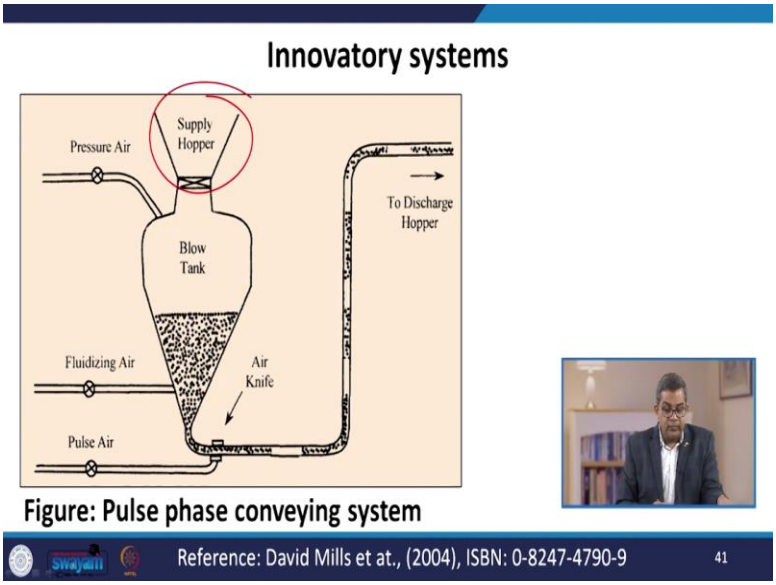

Now here you see the innovatory system. We are having the supply hopper if you compare with the previous figures. The blow tank is having this pressurize air and fluidized air is also supplying to the bottom of this blow tank. Here we are having this air knife with the help of pulse air and as usual we are having a discharge hopper.

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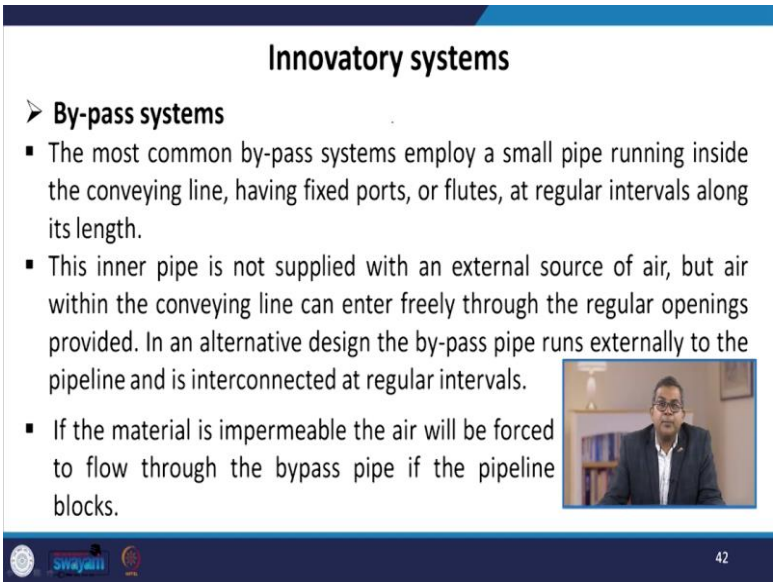

Let us talk about the bypass system, the most common bypass systems employ a small pipe running inside the conveying line having fixed ports or flutes at regular intervals along its length. Now this inner pipe is not supplied with an external source of air, but air within the conveying line can enter freely through a regular opening provided. In an alternative design the bypass pipe runs externally to the pipeline and interconnected at a regular interval.

Now, if the material is impermeable the air will be forced to flow through a bypass pipe if pipeline blocks.

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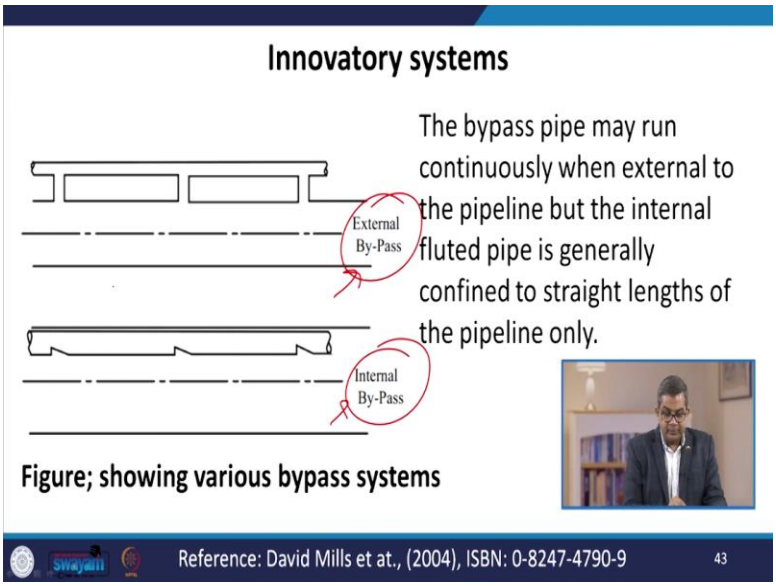

Now this is showing the various bypass line like internal bypass, external bypass and internal bypass. So, the bypass pipe may run continuously when external to the pipeline, but the internal fluted pipe is generally confined to a straight length of the pipeline.

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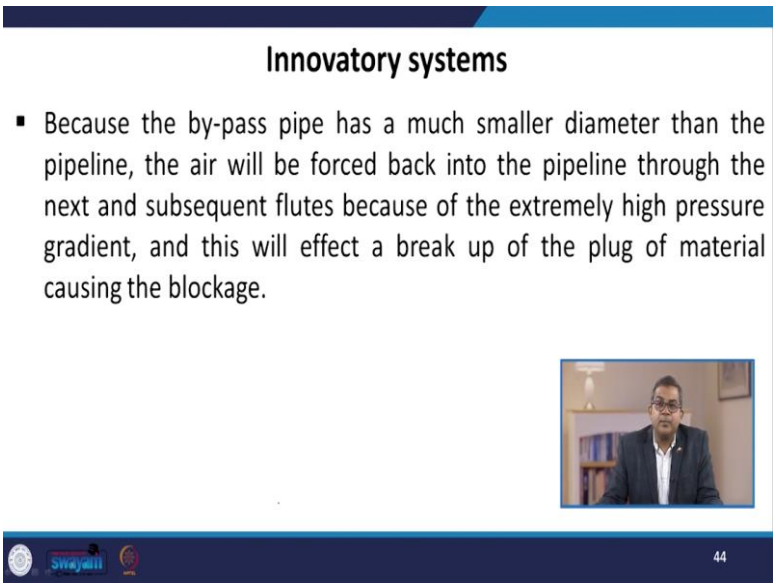

Now because the bypass line has much smaller diameter than the pipeline the air will be forced back to the pipeline through the next and subsequent because of the extremely high-pressure gradient and this will affect the breakup of plug of material causing the blockage.

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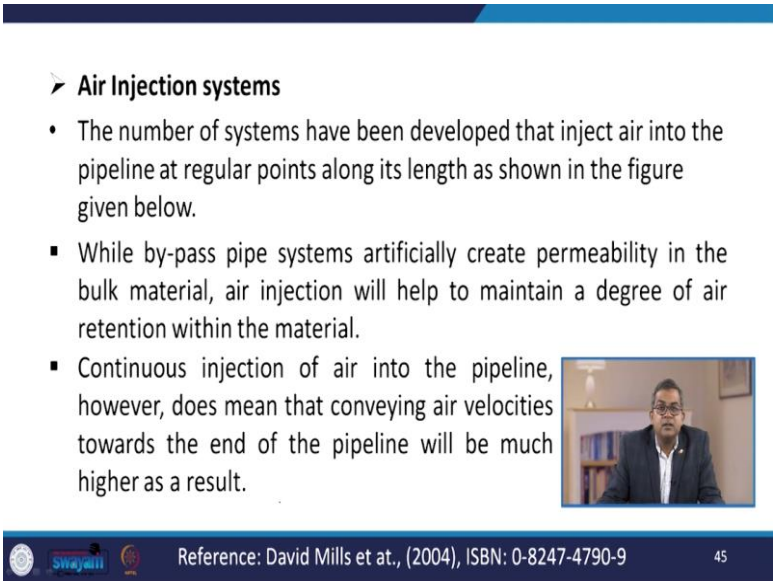

Let us talk about the injection systems. The number of systems have been developed that inject air into the pipeline at regular point along its length as per the figure which we have described. Now while the pipeline pipe system artificially creates permeability in the bulk material, air injection will help to maintain a degree of air retention within the material. Continuous injection of air into the pipeline however it does not mean that conveying air velocity towards the end of the pipeline will be much higher as result.

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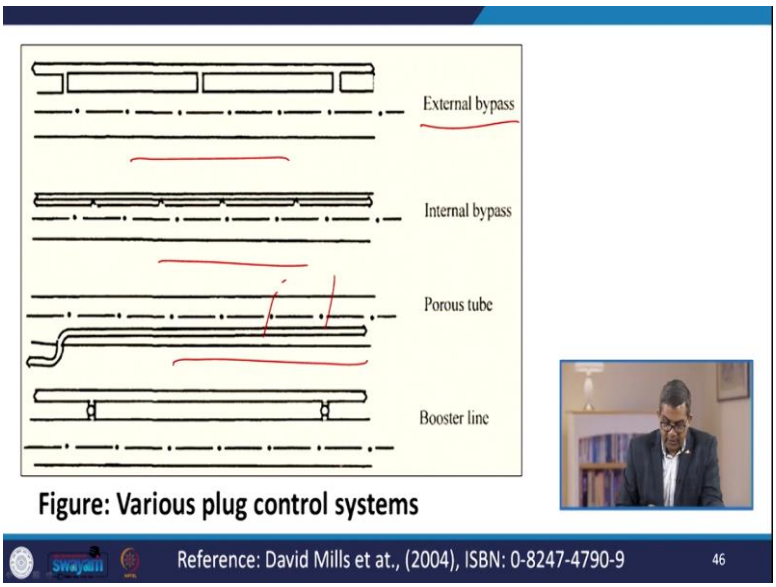

Now here you see the different type of plug control system like external bypass, internal bypass, porous tubes and the booster lines etcetera.

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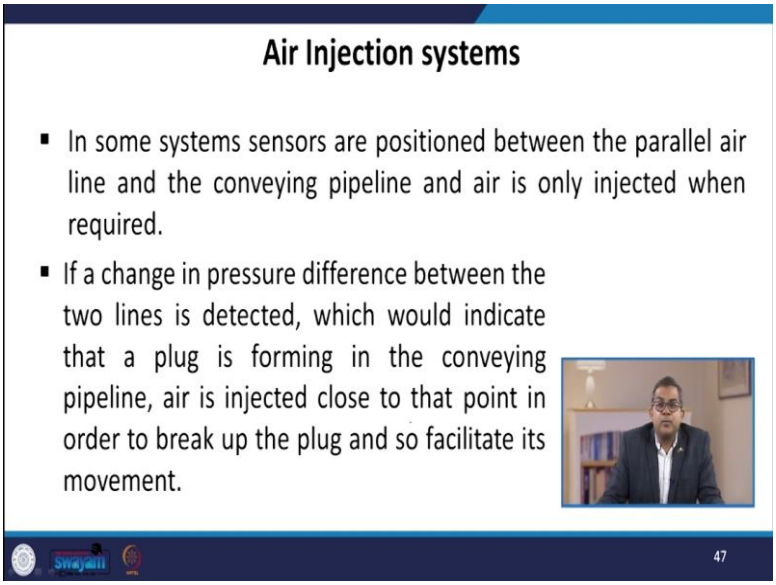

In some systems sensors are positioned between the parallel airlines and conveying pipeline and air is only injected when needed. Now, if there is a change in the pressure difference between the two lines is detected which will indicate that a plug is forming in the conveying pipeline, air is injected close to that point in order to break up the plug and so facilitate its movement.

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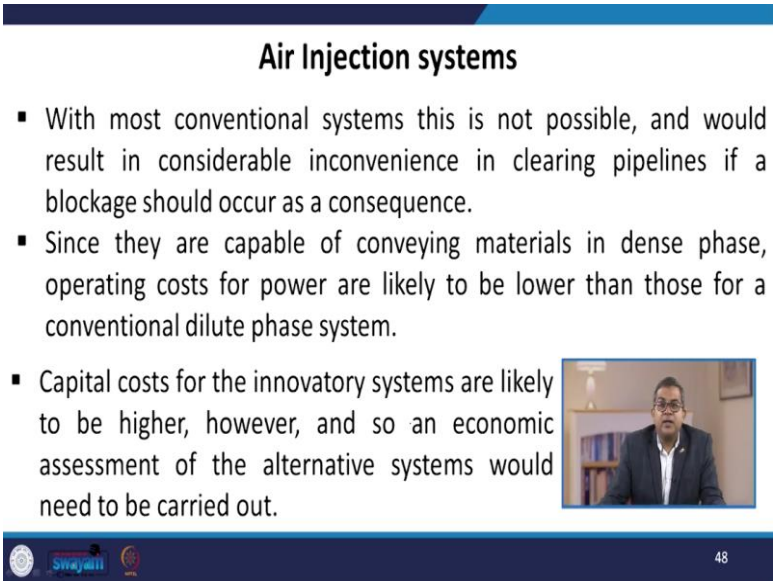

With most conventional system it is not possible and would result in considerable inconvenience in cleaning pipeline if a blockage occurs as a consequence. Since they are capable of conveying material in dense phase operating cost for the power is likely to be lower than those for a conventional dilute phase system. The capital cost for the innovatory systems are likely to be higher.

However, on a economical assessment of alternative system would need to be carried out while using such type of a system in practice.

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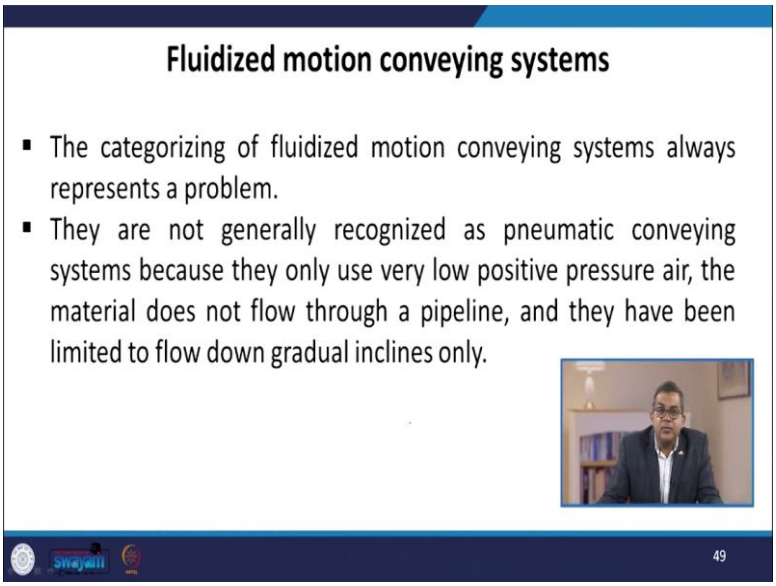

Now, let us talk about the fluidized motion conveying system. The categorization of the fluidized motion conveying system always represents a problem. They are not generally recognized as a pneumatic conveying system because they only use very low positive pressure air. The material does not flow through a pipeline and they have been limited to a flow down gradual inclination only.

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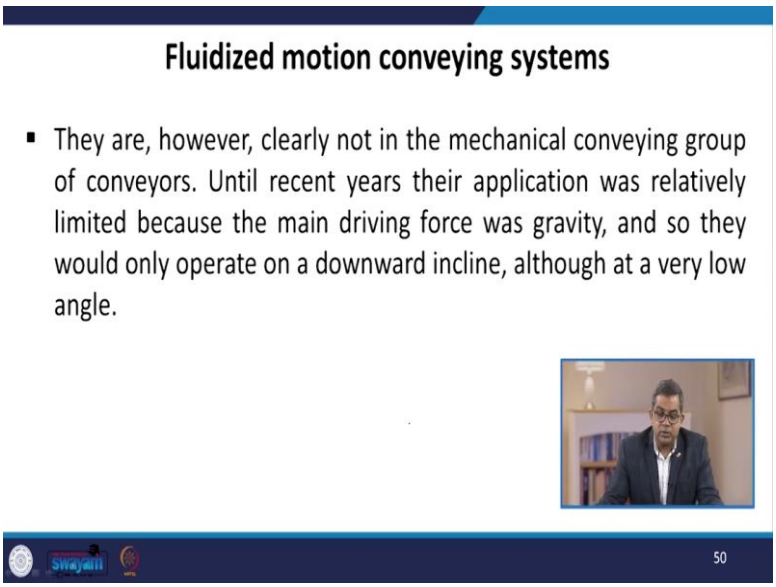

They are however clearly not in the mechanical conveying group of conveying until recent years their application was relatively limited because the main driving force was gravity and so they would only operate on downward inclination towards at a very low angle.

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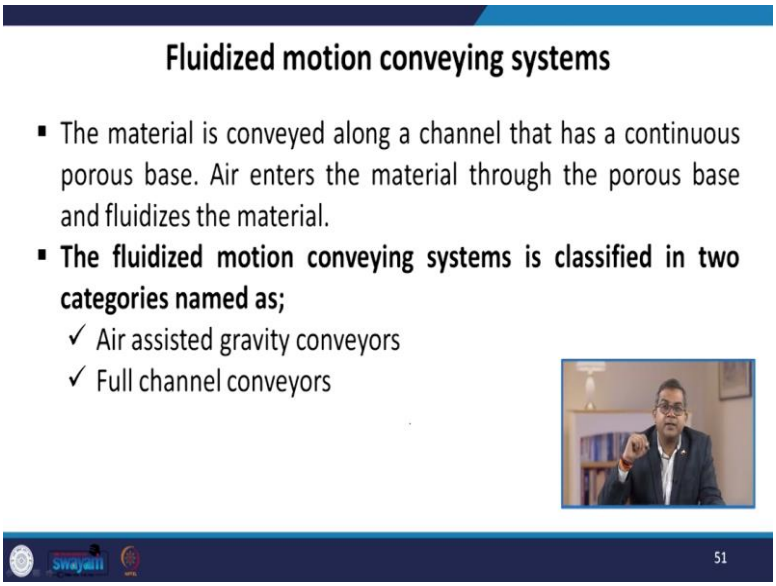

The material is usually conveyed along a channel that has a continuous porous base. Air enters the material through the porous base and fluidizes the material. The fluidized motion conveying system is classified in two broad categories. One is that air assisted gravity conveyors and second is the full channel conveyors.

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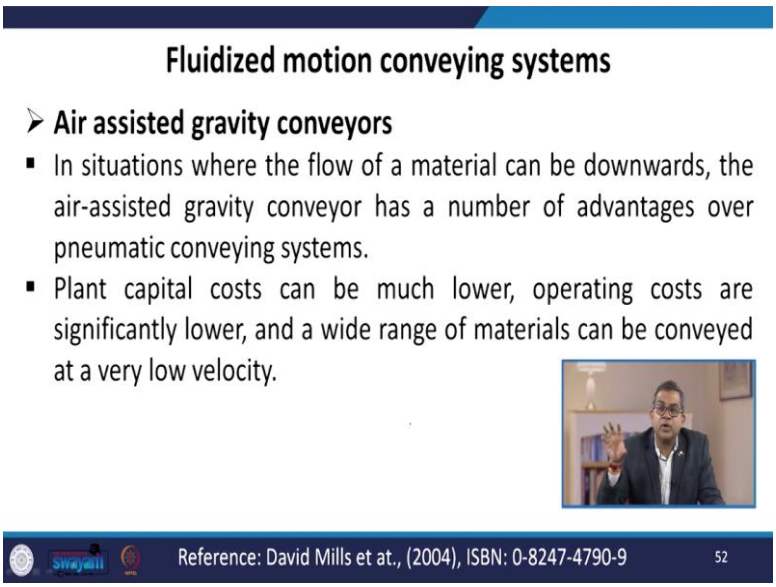

Now air assisted gravity conveyors in situation where the flow of material can be downward the air assisted gravity conveyor has a number of advantages over a pneumatic conveying system. The plant capital cost it can be much lower operating cost are significantly lower and a wide range of materials can be conveyed at a very low velocity.

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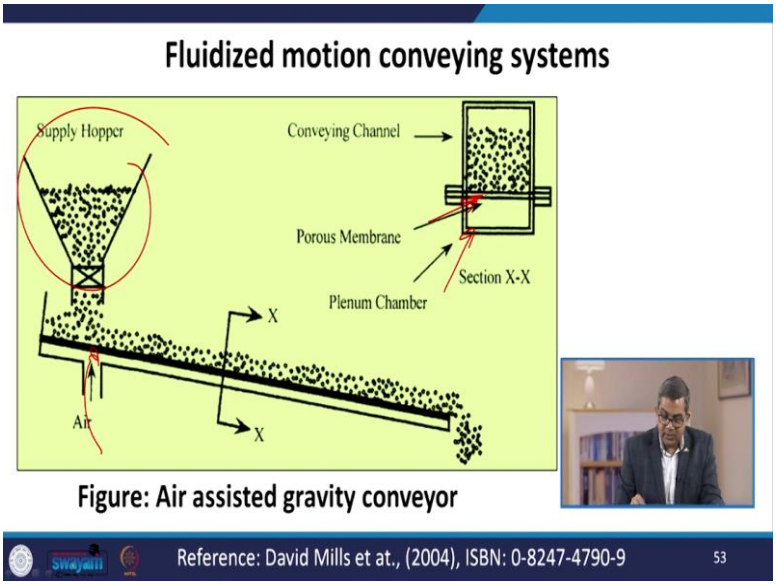

Here you see this is the air assisted gravity conveyor we are having the supply which the air and here you see in a section wise manner you see the side view we are having the plenum chamber, porous membrane they are situated here and this is the conveying channel.

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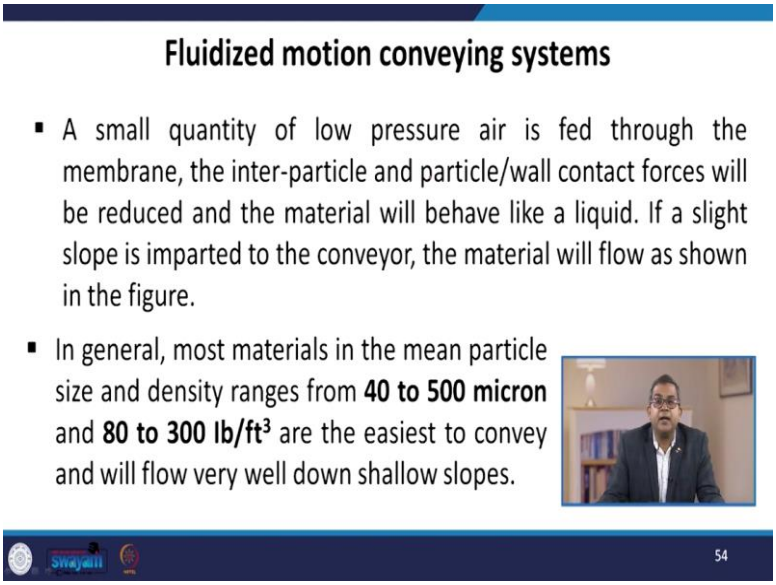

A small quantity of low-pressure air is fed through the membrane here through this particular membrane. The inner particles and a particle valve contact force it can be reduced and the material will behave like a liquid. Now, if a slight slope is imparted to a conveyor the material will flow as per the figure. Now in general most material in the mean particle size and density ranges from say 40 to 500 micron and 80 to 300 pounds per cubic feet are the easiest to convey and will flow very, very down shallow slopes.

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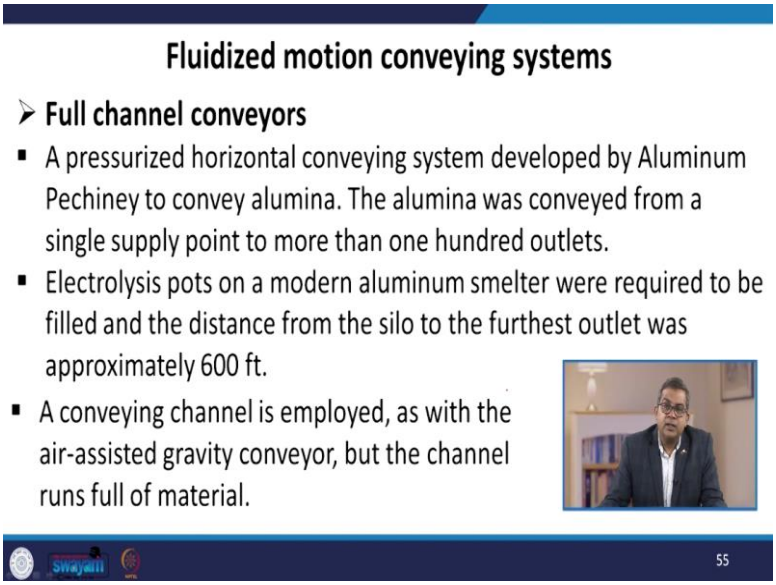

Now, as we talk about the full channel conveyor the pressurized horizontal conveying system developed by aluminum machinery to convey alumina. The alumina was conveyed from a single supply point to more than to more than one hundred outlets. Electrolysis pots on a modern aluminum smelter they were required to be filled and the distance from the silo to the furthest outlet was approximately 600 feet.

A conveying channel is employed as with the air assisted gravity conveyor, but the channel runs full of material.

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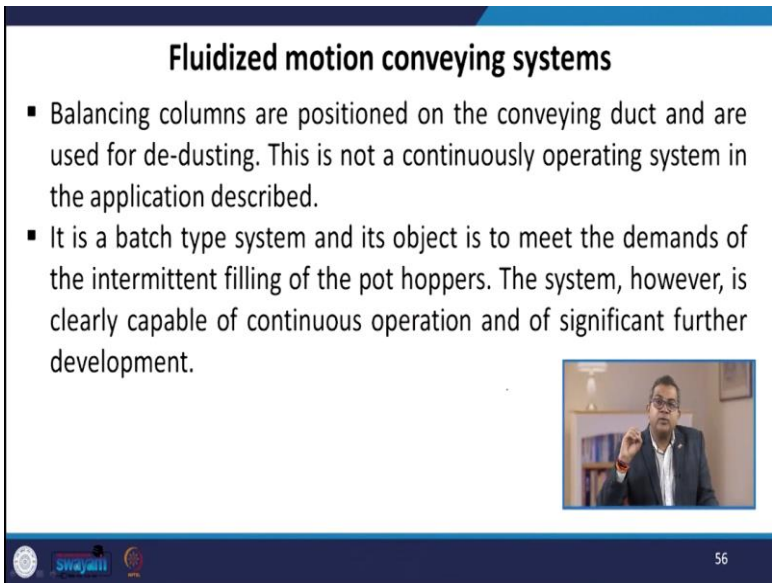

Balancing columns they are positioned on the conveying dust and are used for re-dusting. This is not a continuous operating system in the application described. If it is a batch type of a system and its objective is to meet the demand of intermittent filling of the pot hoppers. The system

however is clearly capable of continuous operating conditions and significant for the development.

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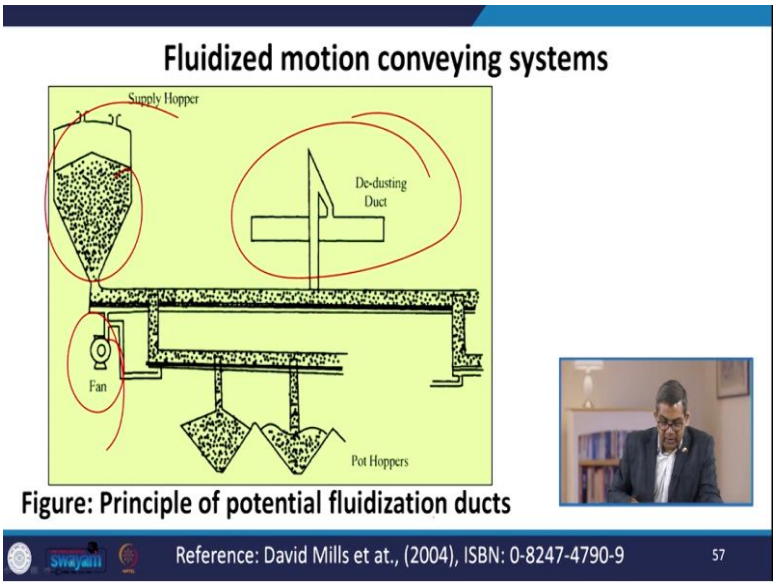

Here you can see this fluidized motion conveying system this is a potential fluidized duct, supply hoppers equipped with the fans and this is the de-dusting duct apart from this we are having the pot hoppers. So, in this particular lecture we discussed about different type of conveying systems, we described all different type of conveying systems which are used in practice and for your convenience we have enlisted four different references if you wish to have a further study then you can use these references. Thank you very much.