Downstream Processing
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Lecture - 3
Costing

The previous lecture we looked at different flow sheets, which involves both production as well as purification of different types of products. And in those flow sheets I was explaining the importance of the cost, the cost of raw materials, cost of equipments, and what is the contribution of various equipments in the overall equipment list.

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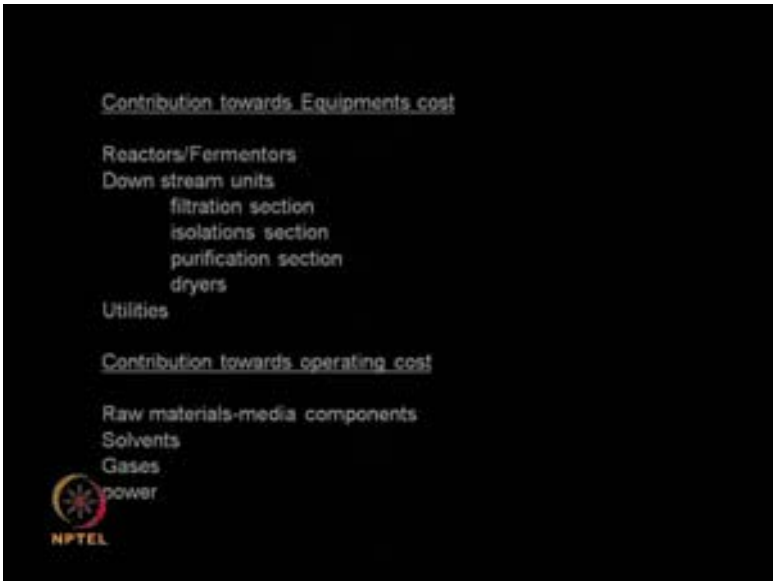

As well as, a cost of various operations in the overall manufacturing cost. So, cost plays a very important role in a flow sheet design, as well as in selection of a unit operation as well as in selecting the type of chemicals or solvents you will require. So, we are going to spend some time; considerable time on the concept of costing. And what are the various factors that contribute towards costing, and how do you make some times the decisions based on costing? So, if you look at equipment are made up of reactors, Fermentors, downstream units like filtrations, isolation units, purification units, dryers

and so on.

So, all of them add to the cost to the overall equipment cost. And if you look at the operating cost; there are solvents, there are raw material, media components, gases, power and so many other small utilities which add up to the operating cost. So, the cost of the final product will also depend upon your operating cost. And it also indirectly depends upon your equipment cost. How does it indirectly depend on equipment cost? For example, if you want to put up an big manufacturing site and with the equipments you are going to purchase those equipments based on some loan.

So, you may be have to pay interest on those loans. So, those interest gets added up into overall expenses during the manufacturing. So, you need to pay back the interest to the bank or some of the financial institutions. So, whatever profit you make is going to be deducted based on the interest which you have to pay to the original financier or the banker.

So, the equipments somehow indirectly adds up to the total manufacturing cost. So, if your equipment cost is very high you would have bought a large amount of funds from the banker. So, you may have to pay a large amount of interest to the bankers. So, your final cost of the product also has to be much higher to take care of this. So, equipment cost indirectly adds up to the overall operating cost as well as the overall product, selling prize. So, we let us look at the equipment cost first.

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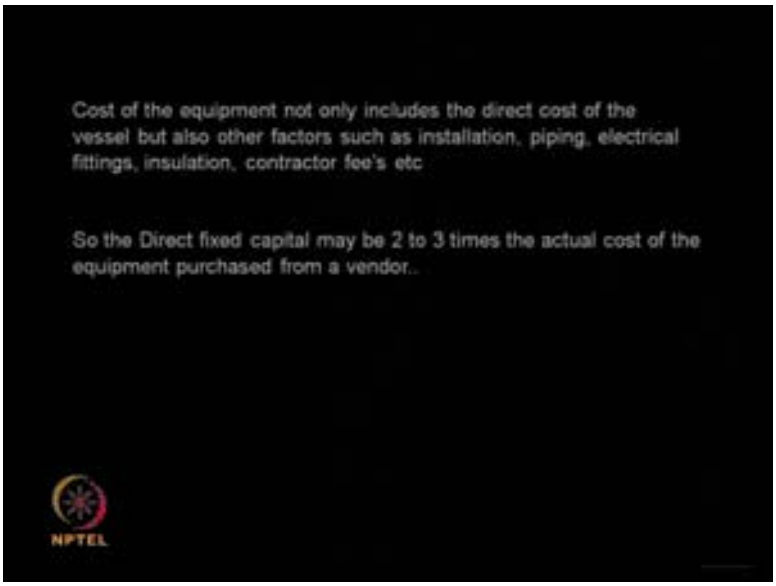

So, it includes not only the cost of the equipment alone suppose you are buying a fermentor; it is not only the cost of the fermentor. But it also has to include many other factors because the fermentor has to be made operational. That means, it will include the installing the fermentor, it will include the piping, the electricity, the fittings. If the fermentor requires cooling water; the cooling water lines; if it requires steam it requires steam lines. And then you may have to insulate the whole fermentor then if you are putting in motor and the motor requires power; so the power line, so many factors.

So, generally you have to make the equipment operational the overall cost of the equipment plus all these needs to be added up to that. So, sometimes it becomes almost 2 to 3 times the actual cost of an equipment. So, if you are buying a filter for say 1 lakh; you have to make it operational you may have to spend additional 1 lakh. So, the actual cost or the filter becomes twice that number. So, you need to keep those factors into mind. And of course there is one more cost that is the your consultant fee or engineering fees. So, you may have to add those also and if there is a patient on a particular equipment; you may have to pay towards the licenser as well.

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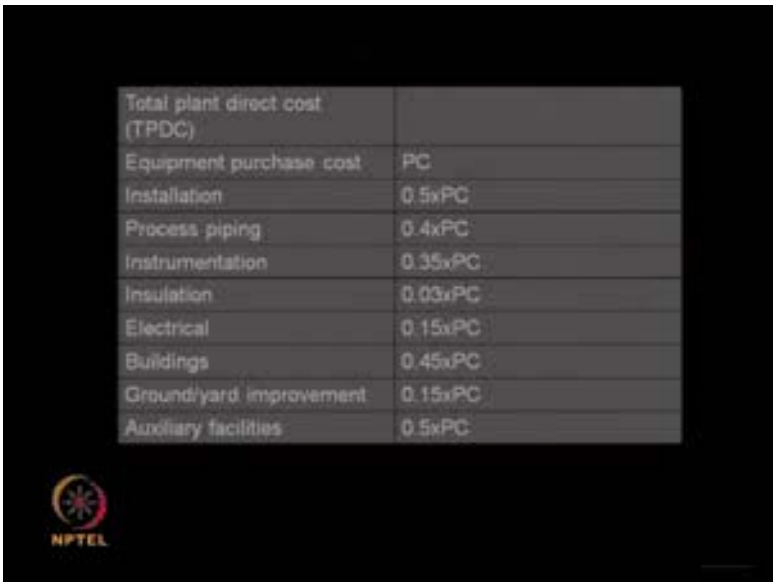

So, look at this table. So, if your equipment cost is say PC then the cost of the installation; the piping, the instrument, the instrumentation, insulation, electrical building, yard improvement even auxiliary facilities; all these are somehow related to the actual cost of the equipment. They just gives you a bulk part figure it is not exactly the number. So, about 50 percent of the equipment cost needs is needed for installing the equipment.

Then you need some amount of money which is about 40 percent of the equipment cost for piping; you are talking about different types of piping; hot water lines, steam line cooling water line, inlet feed line, outlet product line all these are called piping. So, large amount of money needs for that. Instrumentation you need instruments for measuring temperatures, you need instruments for measuring Ph, for measuring you are dissolved oxygen, for measuring so many other factors. So, you need instrumentation; then insulating the whole reactor.

So, it about 3 percent of the cost goes towards insulation, 15 percent of the actual equipment cost goes for electrical, wiring, cabling, high energy wires and so on actually. Then the building a most of the equipments are housed in a large building. So, you need to have some cost for the building; then the ground and yard preparation again 15 percent

of the total the equipment cost gets added up. And then you need auxiliary facilities like air or nitrogen on other gases. So, they are called auxiliary facilities. So, you see if you add up all these you may have to spend double the amount of how much you spent on buying the equipment from a vendor.

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That is the direct cost. Now, you are also have going to have indirect cost; that means you need to pay your contractor, you need to pay your construction agency, you need to pay the engineering agency and so on. So, they all get added up as well and these also is going to contribute towards the actual equipment cost. So, a equipment cost does not just include the cost of the equipment you buy from a vendor but you need to consider all these aspects. So, it gets doubled or even sometimes tripled to the actual cost of the equipment.

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Now, if you have something called a fixed cost and you have something called the operating cost or a variable cost. What is a fixed cost? So, the fixed cost of the sum of all cost requires to produce any product. So, they do not change if I change the volume of the production that means whether I make 100 tons today in my plan or I make 125 tons tomorrow or I make a 85 tons day after tomorrow; fixed cost are always going to be fixed.

That means, the facilities I have; I have a building, I have administration, I have to pay interest on the loan I have taken; the depreciation expenses all these are going to be fixed even if I do not make my product. Because there is a general strike today; still I need to pay for all these that is what is called the fixed cost. So, it is not going to change whether I make more today or less today.

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So, analogues to fixed cost we have something called the variable cost. Variable cost depends upon the amount of material I produce. So, today if I make 100 tons variable cost will be something. And tomorrow if I make 125 ton tons the variable cost will be more than what I have to spend for 100 tons. If day after tomorrow I make 80 tons then my variable cost will be less. So, variable cost is directly proportional to the amount of material I produce.

So, it could be combination of raw materials I buy. So, if I have to make 100 tons of product, I will require more raw material. If I am going to need 85 tons of product, I will be needing less raw material. So, it will be proportional to the raw materials I buy. Labor cost. So, if I am going to employ labor I will be paying for them. Transportation I am going to transport my raw materials to the factory; I am going to transport the product out of the factory. So, transportation cost; sales commissions so all these are combination of variable cost and they are directly proportional to the amount of material I make.

So, this is variable cost is the cost associated with producing one additional unit. So, the total cost is some of fixed cost and variable cost. So, whether I make any product today or not fixed cost is always expenses I will be incurring. And if I make a product I will be spending on raw materials, electricity, man power, transportation, sales, commission; so

that will be the variable cost. So, total cost is a combination of all these two items actually.

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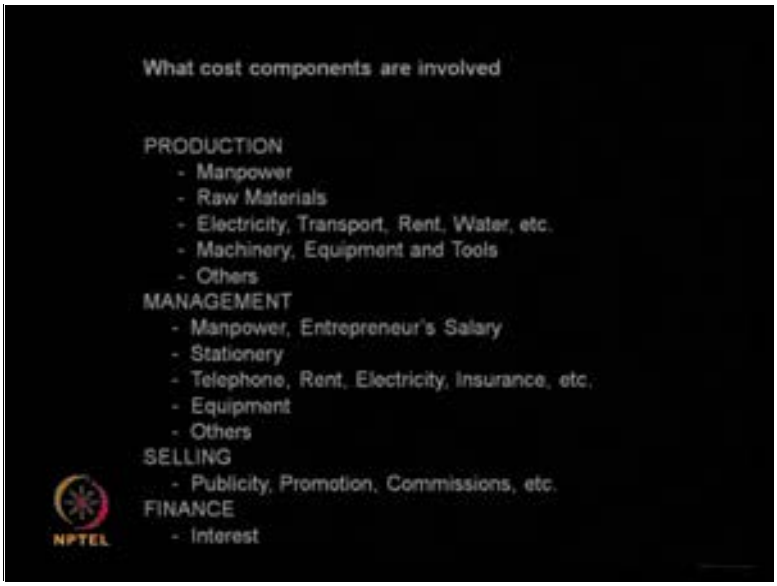

So, what cost components are involved let us look at the various components in my manufacturing process; when I am going to produce I need man power. So, I need technicians, I will require supervisors, I will require floor managers, I will require general managers so on. So, that is call the man power I will require raw materials, various raw materials, media components, I will require carbon source, nitrogen source, they all add up to raw material.

Then of course I will require electricity, transportation; maybe I am paying rent to the somebody else. So, rent cost, water different types of water; process water, chilled water, cooling water all those water. And then I will be having machinery, I will be having equipments, tools. So, all these add up to the production cost. Then, I will be spending on the management; man power, salary of the man power, stationary, telephone, rent, electricity insurance on my factory, insurance on my equipment, insurance on my raw materials; all these are called management cost.

And then you come to selling. Selling means publicity, promotion, commissions,

commissioning agents, storage of the products in various godowns; so all these add up to selling. And finally the finance the interest I pay on the amount of capital I borrowed from banks or financial institutions. So, all these are cost which I will be incurring when I decide to manufacture a product. So, I need to consider all these aspects. So, my selling prize of the product will depend upon all these aspects. If my interest rates is very high I need to make up.

So, my selling prize of the product also has to be high otherwise I if I sell it at a lower cost than my interest rate I will not be able to pay my interest; if I have too many manpower then I will be paying for manpower quite a lot. So, my selling prize of the product has to be sufficient enough to take care of the paying the salaries of the people. If my rent is very high then obviously I have to have a very high product selling prize, so that I can pay my rents. So, you see all these contribute towards the selling a prize of my product either directly or indirectly.

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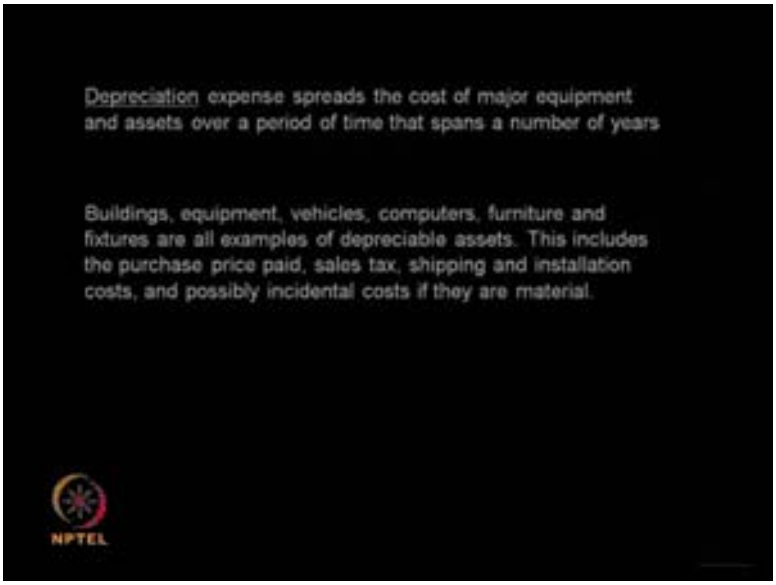

There is something called depreciation. You need to understand what is depreciation practically every equipment gets depreciated over a period of time; I buy a car after few years its value is very low practically 0; nobody is going to buy the car at the same prize at which I bought my car because the value has depreciated. So, any equipment, a

building anything gets depreciated; even computers they get depreciated with you buy a laptop today for say 50000 rupees; if you sell it next year nobody will buy for 50000 rupees. They would like to buy it for 30; after 2, 3 years it will be just throw away 10000, 5000.

So, practically every hardware gets depreciated over a period of time. So, buildings, equipments, vehicles, computers, furniture, fixtures they all get depreciated. So, if you want to calculate the total cost it should include the purchasing prize; paid sales tax, shipping instillation, all incidental cost. So, the overall cost which includes all these gets depreciated over a period of time. The period varies buildings will get depreciated in about 15 years; computers will get depreciated in 3 years.

That means, the technology is so fast that the same computer within 3 years has become useless; tables and chairs get depreciated in 10 years. So, each equipment gets depreciated depending upon the technology or depending upon the development. So, if I am buying a filter today for 5 lakh rupees; tomorrow if you next year you want to sell it you will not be able to sell it for 5 lakh rupees. You will be selling it only may be 4 lakh rupees; after 5 years the value may be only 10000 rupees. So, you have lost that amount of 5 lakh rupees; so the resale value is practically 0. So, you need to consider the rate of depreciation of the equipments as well.

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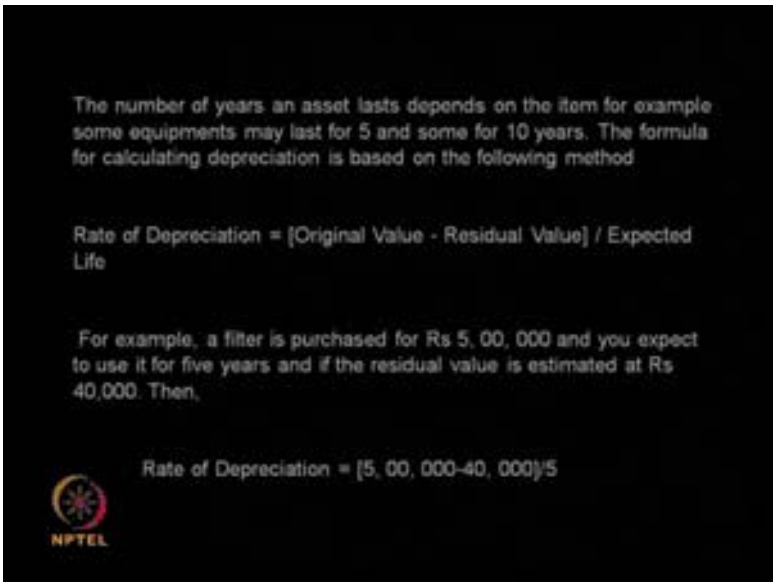

So, the number of years a asset last depends on the item. For example, some equipments so may last for 5 years, some of the equipments may last for 10 years. So, the rate of desperation is given by this formula rate of desperation is equal to original value minus residual value. That means, resale value sometimes cars are like your old premiere ((Refer Time: 14:24)) it may be sold for a scrap value.

So, the residual value will be practically 0 rupees whereas, if you take a big high tech car may be it will have some resale value so or the residual value. So, rate of desperation is calculated as original value minus residual value divided by the expected life. How do you decide on expected life it is based on lot of experience?

For example, I said a building may last for 10 to 15 years. So, that is the expected life if you take a computer 2 years because technology changes very fast. So, in the denominator you may put 2 years for a building; the denominator expected value you will put it as 10 years. So, you take a table or a chair it may last for 5 to 10, 8 years. So, you the denominator expected life will be 5 to 8 years.

So, these are based on experience if you take a membrane filter; the membranes do not even last for about few months. So, the expected life of a membrane is few months. So,

for example I buy a filter for 5 lakh and you assume it will last for 5 years. And finally if you want to sell it off as scrap after 5 years; assume it is it can be sold for 40000 rupees then what will be the rate of depreciation 5 lakh minus 40000 divided by 5 years. So, this is the rate of depreciation.

So, this is the rate at which the filter value keeps going down. So, we assume a linear decrease in the value of the particular filter item. So, there are it is a approximation it need not be linear; first year to second year it may decrepitated very fast; and after that it may be flat depreciation. But generally we assume it as a linear reduction in the value of the particular item.

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There are few more technical terms you need to know which are related to costing; one is called the net present value, other is called the discounted cash flow. So, we need to understand both very; these are very important net present value or NPV it tells you what is the value as of today? And what is the value in the future taking into account inflation and returns.

So, that means money for example in the future is not as valuable as the money that is today. For example, 1000 rupees today is more valuable than a 1000 rupees; I get it in a

1 year later, because money has lost its value or because its inflation, because my purchasing power has gone down. So, a 1000 rupees today is more valuable than a 1000 rupees I get it in 2011 or 2012. So, a 1000 rupees; 2 years later is much less than compared to a 1000 rupees; 1 year later or 1000 rupees today.

So, that is what is called the net present value if somebody tells you that do you want 1000 rupees today or do you want 1000 rupees next year you will obviously take the 1000 rupees today isn't it. Because 1000 rupees next year has less value when compared to the 1000 rupees you have today in hand. Because the money loses value, the inflation happens, the interest rate changes, the purchasing power have gone down. So, all this factors make the 1000 rupees next year much less valuable than 1000 rupees today.

That is what is called net present value it is very useful if you are trying to do investment. If you are going to invest today in some shares or bank or bonds. And then the bond they say that you will be getting certain returns in the year next; 1 year, 2 years later, 3 years later. So, you can calculate what will be the net present value if the same money you are going to get it in the next year or year after next. So, we will spend more time on this with examples.

And that will make it very clear for you as well actually; the next terminology is called the discounted cash flow. Discounted cash flow is related to the net present value. So, what will be the cash of 1000 rupees which I am going to get in the next year can be calculated using this discounted cash flow. That means, it will project; what will be the value of that 1000 rupees which I am going to get next year when as of today based on certain discount values.

So, 2 terms; one is the net present value and the other one is the discounted cash flow. Net present value tells you if I am going to get a 1000 rupees next year what is its value today? Is it the same as having 1000 rupees today? And discounted cash flow tells us the how you calculate that current value of that 1000 rupees which I am going to get it next year.

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So, as I said getting 1000 rupees today that is year 2010 is more valuable than getting 1000 rupees in 2011; that is a future. Because that 1000 rupees in 2011 has a value lesser than today's money; because of so many factors as I said. So, this reduction is a function of many parameters; it includes inflation, it includes reserved bank the lending rate, it includes the purchasing power of the money and so on actually.

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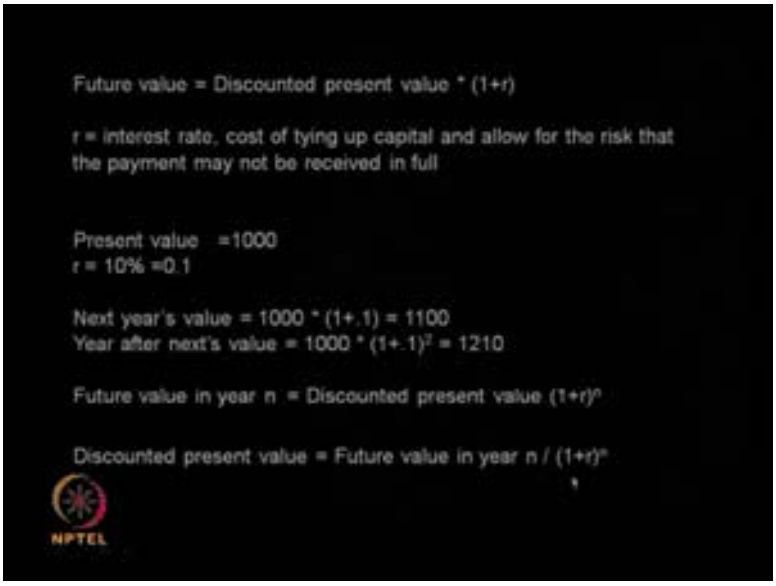

So, there are formula to calculate the net present value of the 1000 rupees; which I am going to get in the next year, so any value so if you have a future value that is equal to the discounted present value multiplied by 1 plus r. So, r is called the interest rate or r is also called the cost of tying up capital; and allows for the risk that the payment may not be received in full. So, if the present value is 1000 then the next year value for the 1000 will be 1100; if you assume r as 0.1. So, that is 1000 into 1 plus 0.1 do you understand. So, 1000 rupees today is almost like a 1100 rupees in the next year; if you assume r is equal to 0.1.

So, a just I am just using this formula here next year value, the current value multiplied by 1 plus r; r is 0.1. So, you get one 0.1 so it becomes 1100. So, what will be that value year after next? So, what you do is 1 plus 0.1 raise to the power 2. So, it becomes 1.1 square. So, it becomes 1210 that means a 1000 rupees today is like a 1100 rupees next year and equal to 1210 the year after next; like that it goes actually. So, the formula will be 1 plus r raise to the power n that will be the future value in year.

So, you see based on this particular number the r the 1000 rupees will be more in the next year or year after next. Now, let us look at it conversely. So, that means we take this 1 plus r by n in the denominator. So, what happens is discounted present value will be future value divided by 1 plus r raise to the power n? So, what does this formula mean? So, if in the future I am going to have next year I am going to have 1000 rupees the current value of that 1000 rupees will be less. Because it will be divided by 1.1; you understand. So, the current value of a money will be equal to less than the next years value based on this particular formula.

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So, I have a big table here. So, imagine in 2010 I have1000 rupees and 2011 I have 1000 rupees. So, this 1000 rupees has to be less than certain number right; that is based on the formula of 1000 divided by 1 plus r; and if you assume r as 10 percent or 0.1. So, 1000 divided by 1.1 is 909.1. So, in 909.1 rupees today is equivalent to a 1000 rupees; next year or conversely a 1000 rupees next year is discounted to 909.1 this year. So, you can extend this same formula for the second year, third year, fourth year, fifth year.

So, if in 2012 if I am going to get 1000 rupees that is equivalent to 1000 divided by 1.1 square; 1.1 into 1.1 that is 826.4. That means, if somebody tells me I will give you 1000 rupees in 2011 that is equivalent to having 826 rupees 0.4 today. And if somebody is telling I will give you 2000 in 2011 that is equivalent to having 909.1 rupees today, because a 1000 rupees in 2011 has lost its value because of inflation, because of interest rates, because of decrease in purchasing power.

So, a 1000 rupees in 2011 is not same as a 1000 rupees in 2010. And it has reduced based on the formula of 1000 divided by 1 plus r; where r is equal to 0.1. So, let us look at the table again. So, a 1000 rupees in 2011 will be 909; in 2010 a 1000 rupees in 2012 will be 826.4. And at 1000 rupees in 2013 will be equal to 1000 divided by 1.1 into 1.1 into 1.1; 3 times which is equal to 751.3; a 1000 rupees in 2014 will be equal to 1000

divided by 1.1 raise to the power 4 at 683; a 1000 rupees in 2015 is only 622 rupees today. So, if somebody promises you that he will give a 1000 rupees in 2015 that is equivalent to having 620.9 rupees today.

So, imagine if somebody saying that they will give you 1000 rupees in 2011, in 2012, 2013, 2014 and 2015. So, somebody is promised. So, using this discounted present value formula; you can say this money is equal to 909, this money is equal to 826.4, this money is equal to 751.3, this money is equal to 683, this money is equal to 620.

So, although they promised 1000, 1000, 1000, 1000 in the 5 subsequent years; if you convert that into present value it will be only this much some of this, this, this, this and this. So, it will be approximately 3600 or 3700; if you add up all these numbers; so understand. So, by bringing those values to the present value you will know where you stand. So, all though he promises that he will give 5000 rupees spread over the next 5 years.

But actually if you bring it to net present value he would have been giving you only around 3600 or 3800 rupees. So, by bringing it to the present value you can compare things as of today. And of course, the may the most important assumption here is the r value remains constant over the period of time. So, every time we keep dividing only by 1.1 or 1.1 square or 1.1 3, 1.1 per 4 or 1.1 per 5. So, that is the most important assumption. So, you have to keep that in mind.

So, this table tells you how to calculate the discounted present value? And this also tells you the cash flow; discounted cash flow. So, somebody has promised you 1000 rupees for the next 5 years. So, you are going to get 1000 rupees in those years but if you bring it down to today value you will be getting only 909, 826, 751, 683 and 620.9. So, that is called the discounted cash flow.

So, it is very useful if you are doing if you want to invest in different types of shares or bonds. And you are going to get different amounts of interest over a period of time; you can bring them down to today's present value. And calculate is it profitable or is it not profitable. So, that is the main advantage of doing this type of discounted cash flow

calculation.

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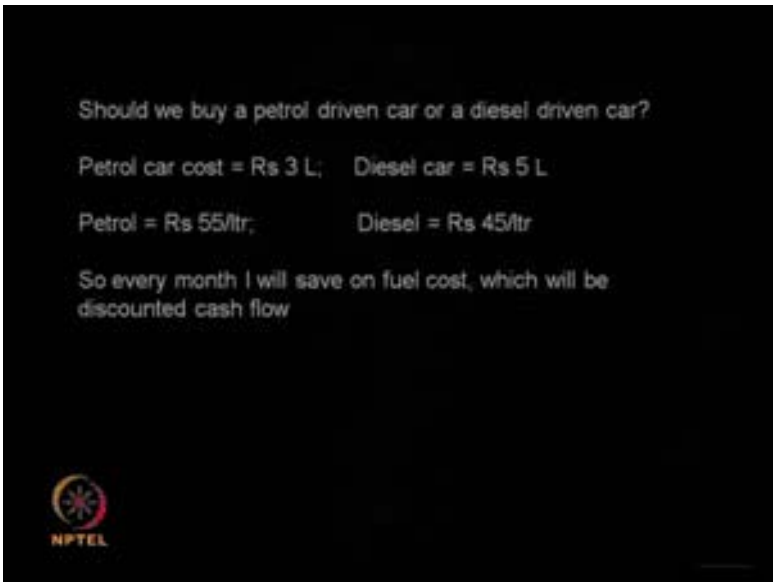

So, the formula is once again discounted cash flow is equal to the cash flow in year 1; divided by 1 plus r raise to the power 1. So, if somebody is promising you so much amount in year 1; what is its value in year 0 that is today's value will be the money divided by 1 plus r raise to the power 1; r is your discount rate generally we take it as 10 percent, it can be between 5 or 10 percent. For example, let us look at it; I bought a chromatography chromatograph for CC rupees.

And then I get some profit of CF 1 in year 1. But I spend the money for chromatograph today that is year 0 but I got a profit in year 1 that is next year of C of 1. So, can I say it is good the investment is good or investment is bad? I cannot just subtract CC by CF 1 it is wrong right because CF 1 is the money or profit I am going to get in the next year. But CC is the money I have spent today.

So, you need to convert that CF 1 using the discount cash flow formula understand using this. So, obviously the DCF will be less than CF 1 because you are dividing by 1 plus r raise to the power 1. And then see whether CC minus DCF is greater than 0 or CC minus DCF is less than 0; do you understand? So, if it is greater than 0 I have spent more on the

chromatograph. So, it is a loss if CC minus DCF is less than 0 than I have spent I got more profit than how much I have bought the chromatograph. So, it is a profit.

So, you understand you do not subtract CC directly by CF 1 because CF 1 is the money I am going to get next year whereas; CC is the money I spent today this year. So, the CF 1 has to be recalculated as DCF using this formula and of course, DCF will be less than CF 1. Because you are dividing by 1 plus r; and then see whether it is a profit or whether it is a loss this is how you calculate cash flow based on the DCF formula. So, this you can extend it to many years.

So, if I am going to a profit from the chromatograph the next year, year after next, third year, fourth year, fifth year I can bring all those profit money into the current value. And see whether over all I am making a profit or over all I am making a loss. Why do you need to do this because you are buying the chromatograph today? But if you are profit is coming next year, year after next, third year, fourth year, and so on that is why you need to bring all those money into today's current value.

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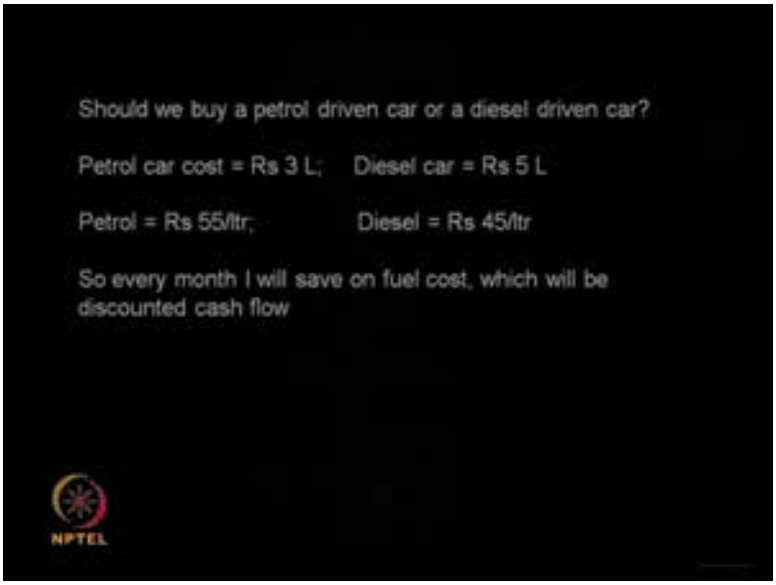

This type of formula we can use it for even our day to day life; sometimes you want you wonder should I buy a petrol driven car or should I buy a diesel driven car. You all know

petrol cars are cheaper may be 3 lakhs, diesel cars are 5 lakhs. But then petrol is more expensive than the diesel. So, approximately say I rupees 55 per liter, diesel is say 45 per liter. So, imagine I spend 100 liters. So, there is a difference between about 10 rupees per litre.

So, in the fuel I will be saving if I have diesel rather than petrol. But fuel I will be putting it next month, second month, third moth, four month. So, every subsequent month I will be saving on the fuel because I have diesel. But in year the first day one; I will be spending on buying the car and the diesel car is more expensive than the petrol car. But every month I will be saving on the fuel cost. So, I can use this type of discounted cash flow to see whether it is advantages to have a petrol driven car or is it advantages to have a diesel driven car. So, you can use this type of a approach you are day to day regular life.

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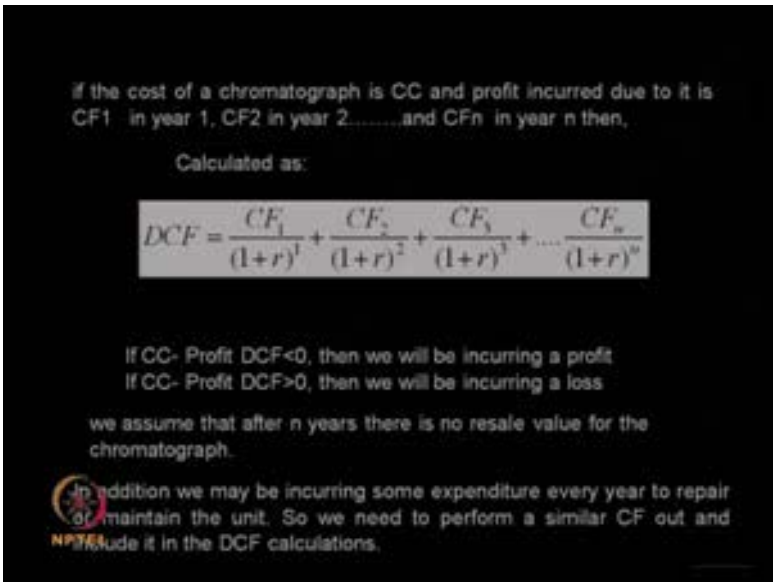

So, if I am going to get a profit in the same chromatographic problem in year 1, year 2, year 3, year 4, year 5 and so on n year. Then what will be the total profit; you use the same formula CF 1 divided by 1 plus r raise to the power 1, CF 2 divided by 1 plus r raise to the power 2 plus CF 3 divided by 1 plus r raise to the power 3 and so on CF n divided by 1 plus r raise to the power n. So, imagine my chromatograph were will last for

10 years; then you are n will be 10. So, if one year 0 I buy a chromatograph and I am because of the chromatograph for 10 years I am going to make profit. The profit amount is CF 1 in year 1, CF 2 in year 2, CF 3 in year 3 and CF n in year 10; I can calculate all these profit; and bring it to the net present value using this formula.

And then again go back to CC is the cost of my chromatograph minus DCF if it is less; that is the profit. Then I will say I am in incurring a profit if it is more than a I will say I am incurring a loss do you understand. So, I bring the profit I will be getting in year 1 to today's net present value, the profit in year 2 to net present value, profit in year 3 to net present value, profit in year 10 to net present value. And then subtract from the cost of the chromatograph which I incurred today.

Of course, in this we did not assume any resale value for the chromatograph; if there is a resell value. That means, in the 11 th year I sell the chromatograph for a very cheap but still I get some money out of that I can include that also. I can calculate the net present values for the amount of money; I got by selling the chromatograph we can also make it more complicated, because every year I will be doing maintenance on the chromatograph.

So, I will take up a annual maintenance contract on the chromatograph. So, I will be spending some money every year on the AMC for the chromatograph. So, those also we can include in our calculations. So, we can include the profit I get on the chromatograph the expenses I incur. Because I have to do maintenance on the chromatograph; I can include a resale value after 10 years. So, all these I can include and then I can see is it profitable to have a chromatograph, is it profitable to buy a chromatograph or not.

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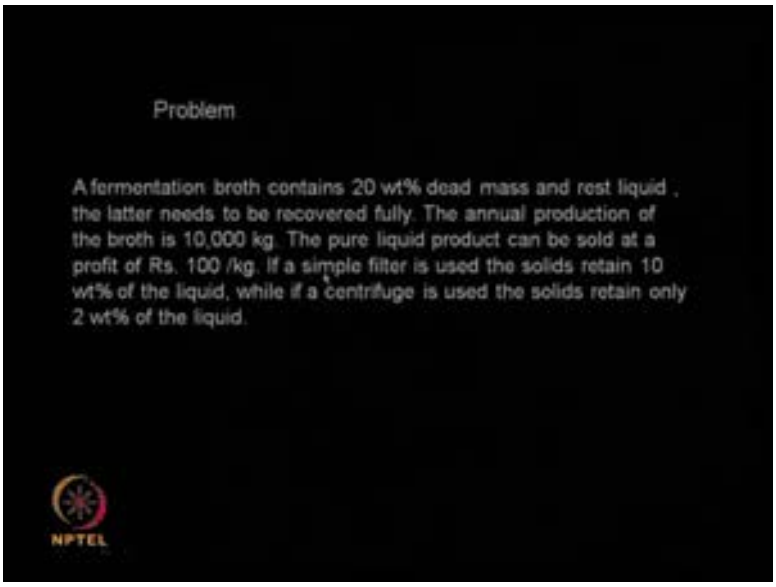

So, let us look at a problem which is based on the net present value and the discounted cash flow; this always happens in our downstream processing should I buy a filter or a centrifuge, should I buy an extractor or should I buy an absorber or should I buy one particular type of chromatograph or another type of chromatograph. So, the performance may be different the recovery may be different cost also may be different.

So, how do I balance between performance, the yield, recovery of my product and the cost? So, we can use this type of a discounted cash flow type of approach in solving and making our decisions. Let us look at this problem. So, I have a fermentation broth; the broth contains 20 percent dead mass and rest all liquid. I am interested in recovering all the liquid because the liquid is the product which needs to be sold.

So, I make a profit out of the liquid part not on the bio mass part. So, whenever I say sell 1kg of liquid I will get a profit of rupees 100. So, every year I produce 10000 kg of the total broth; that means the 10000 kg will contain dead biomass and liquid. So, I need to put a filter or some separating unit to remove all the solid; collect as much liquid as possible and sell. So, if I use a filter I can remove the solid and the liquid. But what happens is I will lose 10 percent of the liquid; because you know filter there it is always bit little the solids are always little bit ((Refer Time: 38:14)).

So, some liquid gets retained but if I use a centrifuge most of the liquid can be removed. Because centrifuge as you know works very efficiently it is very high ((Refer Time: 38:50)) are there. So, most of the liquid comes out from the solid. So, I lose only 2 weight percent of the liquid. So, you see if I use a centrifuge I can get more liquid out. That means, I can more make more profit; if I use a filter more liquid is stored inside the solids. So, I am losing some liquid. So, when you look at it you think I will go for centrifuge, right.

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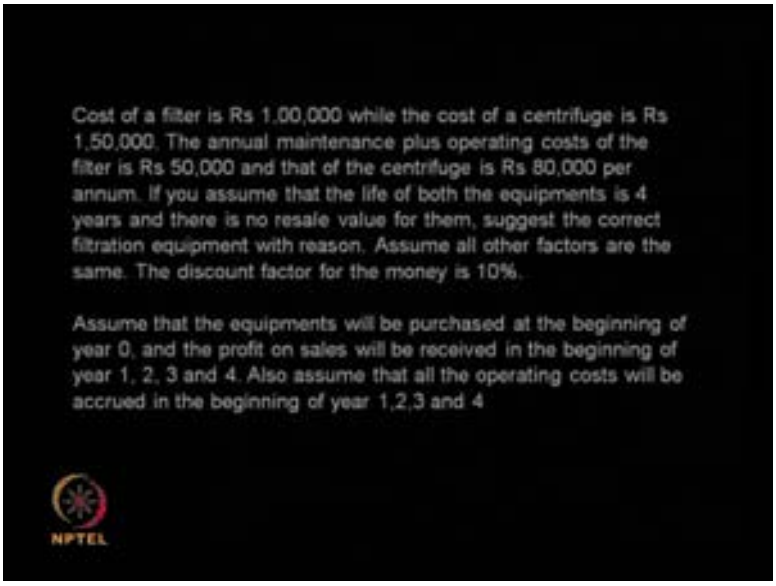

But a cost of a filter is 1 lakh rupees, cost of the centrifuge is 1.5 lakh rupees. So, centrifuge looks expensive whereas centrifuge will perform better; look at the maintenance cost for a filter I spend every year 50000 rupees as maintenance, for a centrifuge I have to spent 80000 rupees; it is like having a Maruthi 800 or a BMW. If I have a Maruthi 800 I will spend only 100 rupees a month as maintenance. If I have a BMW may be I will spend 10000 rupees a month.

So, if I have a centrifuge I will be spending 80000 rupees per year; if I have a filter I will spend 50000 rupees. So, it is very difficult problem. So, should I buy a centrifuge or a filter; centrifuge is more efficient but filter is cheaper, maintenance cost of a filter is less; maintenance cost of a centrifuge is very high.

So, what should I do? Assume both the equipment last for 4 years there is no resale value I just simplified the problem; I said there is no resale value. That means, after 4 years filter and centrifuge you do not get any money out of it; it have to be thrown out. So, suggest the correct equipment. So, we will assume a discount factor as 10 percent. So, we can take it as 0.1. So, what happens so zeroeth I buy the centrifuge or the filter.

So, after zeroeth year, first year, second year, third year, fourth year I will make a profit on the centrifuge; I will make a profit on the filter. But the amount of profit I make differs because I will get more liquid in the centrifuge, I will get less liquid in the filter. I will also spend maintenance cost, I will spend more maintenance cost on the centrifuge, I will spend less maintenance cost on the filter.

So, what should I do? So, I can do the same net present value, discounted cash flow formula and calculate in today's value. How much profit I will make with centrifuge? How much profit I will make with filter and I can decide should I go for a filter or a centrifuge. So, I would like all of you to think 3 things are happening; one is centrifuge is more efficient than the filter. So, I can get more liquid using a centrifuge and the liquid is my product. So, I make profit out of the liquid but the centrifuge cost more money than a filter. And I have to put in more maintenance cost on the centrifuge and compare to the filter; so 3 factors. And I all the numbers are given and it runs for 4 years.

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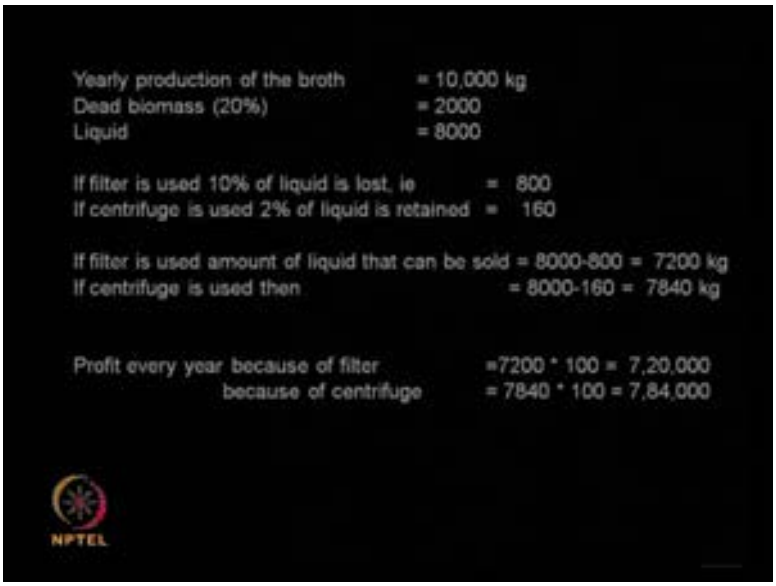

So, you can make a large table. Let us look at it yearly production of the broth is 10000 kg that is given in the problem. Now, the dead biomass is 20 percent that is 2000 kg right. So, the liquid is remaining 10000 minus 2000 is 8000. So, if the filter is used we lose 10 percent. So, that means we are losing 800 kg of the liquid is gone that means we get only 8000 minus 800 is 7200 kg if you use filter.

If I use a centrifuge 2 percent of the liquid is gone that means I lose 8000 into 2 by 100 is 160. So, I get 8000 minus 160 is 7840. So, you see if I use a centrifuge I will get 7840 kg of liquid; if I use a filter I get 7200 kg of the liquid. So, profit every year if I use a filter 7200 into 100 this is given the profit is rupees 100 per kg it is given.

And then if I use a centrifuge 7840 comes here into 100. So, you see the profit every year I will make because of a filter is 720000; and if it is a centrifuge I make 784000. So, every year; year 1 I will make the profit, year 2 I will make the same profit, year 3 I will make the same profit, year 4 also I will make the same profit. But then I will have maintenance cost for centrifuge, I will have maintenance cost for filter every year; year 1, year 2, year 3, year 4. But year 0 I have bought the centrifuge at 1.5 lakhs; and I have bought the filter for 1 lakh. So, we bring all these and make the large discounted cash flow table.

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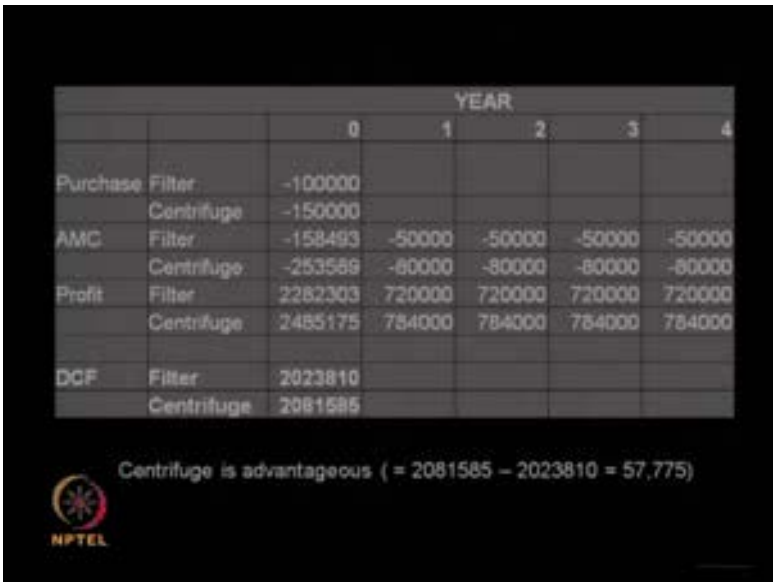

I want you to look here this is the table I want you to look at it very carefully year 0; this is when I buy the centrifuge or the filter then I have year 1, year 2, year 3, year 4. So, year 0 I am purchasing the filter that means 1 lakh; centrifuge 1.5 lakh I put negative here, because this is money going out of my pocket right. So, I have put a negative number. So, profits I put as plus and if I am spending the money I put a negative. Now, let us look at the annual maintenance contract for the filter, for the centrifuge.

So, year 1 for filter I will spend 50000 correct, year 2 I will spend 50000, year 3, year 4 agreed for the centrifuge I will spend 80000, 80000, 80000, 80000. So, again I have put negative please note because it is the money I am spending and the numbers are always constant in reality changes. Because you know when a car is new my maintenance is very less. So, if I buy a car today next year I will spend very little on maintenance, then year after next my maintenance will go and if the car becomes old I will spend lot of money on maintenance.

So, normally maintenance cost will change; but here we have assumed the maintenance cost is the same over the year agreed. Now, what do I do? I bring these expenses to today's value. So, how do I do simple this will be 50000 divided by 1.1 because 0.1 is my discount rate; this will be 50000 divided by 1.1 square, this will be 50000 divided by

1.1 cube, this will be 50000 divided by 1.14 and then add up all of them. So, it comes down to 158493 that means I will spend on AMC for the filter 158493; it is not 2 lakhs you see 50000, 50000 if you add up all these it looks 2 lakhs. But in today's value I will spend on it will be 158493 do you all understand.

Same thing I can do for centrifuge what I will do? I will do 80000 by divided by 1.1, 80000 divided by 1.1 square, 80000 divided by 1.1 cube, 80000 divided by 1.1 raise to the power of 4 then add up all of them. So, what happens I will get 253589? So, whereas if you just look at these numbers and add up it looks like 3.2 lakhs. So, it is not that I will spend 3.2 lakhs today's value; in today's value I will spend 253589 do you understand.

So, in today's value on AMC on filter I will spend this much, and today's value on centrifuge I will spend this much. Now, let us look at the profits. In profits as I said I have put positive whereas if I am spending money I am putting it as negative. So, profit from the previous page you saw I will make a profit if I have a filter of 72000,72000,72000,72000.

So, if I convert this 72000 to today's value it will become 72000 divided by 1.1; and this will be 720000 divided by 1.1 square, this will be 720000 divided by 1.1 cube, this will be 7.720000 divided by 1.1 raise to the power 4. So, if you add up all these numbers this is the profit I will make if I have a filter in today's value; that is net present value. Same thing I do for centrifuge in centrifuge I will have more profit. Because I am able to collect more liquid as I showed in the previous slide 10 percent loss if I have a filter, And only 2 percent loss if I have a centrifuge. So, I again I do the same thing and this is the profit I will make on the centrifuge.

So, you see this is the profit I will make on filter, this is the profit I will make on the centrifuge in net today's value; this is the expenses on the filter, this is the expenses on the centrifuge, these are the AMC's. So, if I add up all these for the filter I get this much amount. That means, for the filter I get it as 2023810 and centrifuge I get 2081585. So, which is better it is good to have a centrifuge because my profit on centrifuge is more than the profits on filter by 57775 you understand.

So, it is very contradictory problem I make more profit on the centrifuge than filter because my recovery is good. But I spend more on the maintenance of a centrifuge when compared to the filter; my centrifuge is more expensive than the filter. So, 3 things, 3 are contradictory but when I bring the amount to today's value and do a calculation. I see that it is more profitable to have a centrifuge when compared to a filter. So, the decision how do I decide I will buy a centrifuge.

So, you see in this particular problem we have combined efficiency of the unit operation, we have combined the cost of the unit, we have combined the profit I will make on the unit, we have combined also the maintenance cost on the unit; and then I have brought all together. And that is how you make your decision. You decide based on this particular that you will go for a centrifuge.

So, a combination of many factors have to be made whenever you decide on should I buy this equipment or should I buy this equipment or should I go for some other type of a downstream or should I go for some other type of downstream. So, you can you use this type of approach for your investment portfolio should I buy a bonds or should I buy something else. So, it is like say filter and centrifuge you can say should I buy this or should I buy that.

But the profits I am going to buy on investment A may be different, the profits i may get on invest B may be different, but I am going to get the profit in the next year; year after next and subsequent years. So, you need to be bring all those numbers to today's value and then you need to make a decision based on today's value. And the whole concept is that the money you have today and the money you have next year are very different; the money you have next year is not the same as the money you have today it has lost its value.

Because of so many factors the inflation, the purchasing power, the reserved bank, interest rates and so many factors. So, a 1000 rupees today is always better than a 1000 rupees next year; and a 1000 rupees next year is less than a 1000 rupees based on the reduction in that value generally it may be 950 rupees or 940 rupees and so on actually. So, that is why it is better to invest on something which increases rather than something

which remains which decreases.

In this problem we could have complicated it by adding the resale value for a filter. That means, the scrap value for the filter which I will get in the year 5. Similarly, I could have in included the scrap value for the centrifuge in year 5; and then brought them again to today's present value. And I can again decide should I go for a centrifuge or should I go for a filter. We will stop with this.