Process Design Decisions and Project Economics
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Module - 8
Chemical Project Economics
Lecture - 41
Simplified Cost Model and Depreciation

In the previous lectures we saw the cost distribution or cost composition of a project. There are two types of cost, first is the fixed capital investment or total capital investment which comprises of fixed capital startup cost and also working capital and there is total production cost. We have seen in detail, what are the cost components of this particular cost, these particular two costs, that is the fixed capital investment or total capital investment and the total production cost. Now, in we take the theme further in this lecture and try to develop some simple cost models.

For example, when we are trying to develop a process conceptually that means, basically on pen and paper, we cannot go for detail design of each and every equipment at the initial stage and that is what because of several process variables that are there we get very large number of process alternatives. And therefore, we need to have some quick method of estimating the little prices of different flow sheets.

Now, the cost model of the detailed cost model we have seen in previous lecture it is quite comprehensive. So, if you start estimating each and every cost well then it becomes a very tiresome in their size and you may not be able to screen many alternatives in that way. So, what we will do in this lecture is that we will try to simplify or convert the total capital investment in some quantity, which we can estimate very quickly on pen and pen.

So, what we have to do like for example, if you have to estimate a total capital investment for a particular flow sheet. Then you return only the major equipment of the flow sheet and design them only to the extent, where you can estimate their cost with accuracy. And that is known as the onsite cost well, that thing we have seen in previous lecture, that the total capital investment is onsite cost or what is known as inside backer limit cost and offsite, which is the outside backer limit cost.

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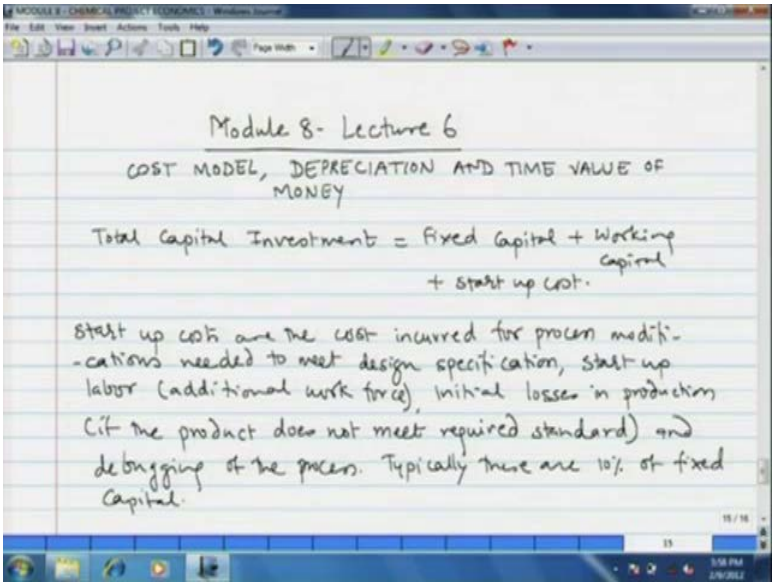

So, we have to now develop in this lecture, we have we will develop a simple model with which we can estimate total capital investment only on the basis of the cost of major equipments of the process which we are going to design. Total capital investment is fixed capital plus working capital per startup cost. Now, startup cost are additional cost that are incurred at the beginning of the process or at the startup of the process these are incurred because of process modifications that we need to meet to the design specification of equipment or the startup labor, additional work force will be required at beginning of the process or at the startup of the process.

Then the product that is formed may not meet required standard initially, when the process is reaching steady state. And therefore, that is an initial loss or the loss of raw material, that is also included in the startup cost, then we may have to debug the process like, if some variable is chosen wrongly some pressure temperature that correction, we have to make. And then there are means the cost required for that particular modification is also included in the startup cost typically, the startup cost are 10 percent of the fixed capital investment. In some companies the startup cost are included in working capital, so that is taken care of or sometimes they also include in fixed capital that startup cost.

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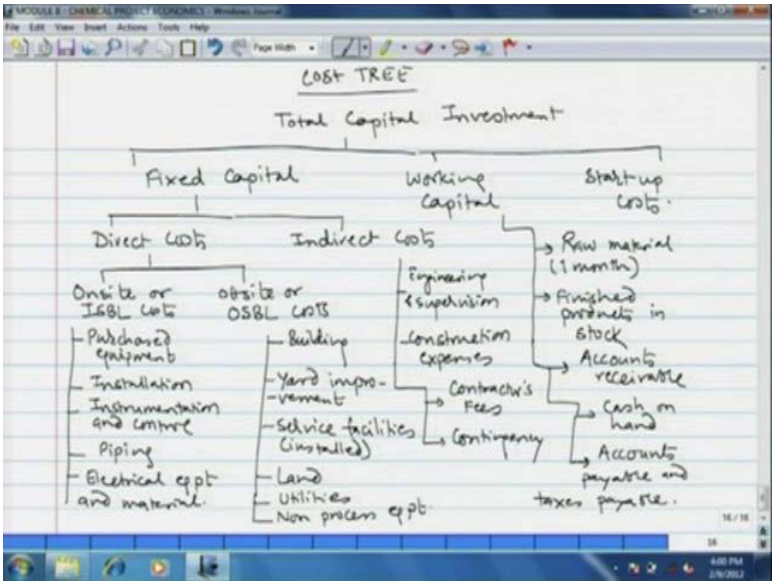

Now let us revise briefly, the cost tree or that composition of total capital investment with this, we have seen in detail in last two lectures. The total capital investment has three components, as I said fixed capital working and startup cost, fixed capital is further divided into direct cost and indirect cost. Direct cost are further divided into onsite or in site backer limit cost or offsite and onsite backer limit cost, onsite cost include purchased equipment, the installation of equipment commissioning of the equipment instrumentation and control that you need to provide, then the piping then electrical equipment and material that is all I S B L. Offsite cost include the cost of building process, building administration building, then the yard improvement service facilities and their installation, land, cost, utilities, non process equipment like for example, packaging, distribution having a ware house for storage of finished products.

The indirect cost, include the cost of engineering and supervision, the construction expenses the contractors fee and the contingency, this is the money result for un forcing expenses. Working capital includes, this working capital is the actual cost that is incurred for running of the plant this includes, the cost of raw material you have to keep one month supply, one month stock, in case the raw material supply is interrupted.

Then the finish productions stock with the products are not going to find immediate market, then you need to store them for sometime before, they are actually transported to the market. Then the accounts receivable your customers may not pay money

immediately, so you have to some margin for that money that is due accounts receivable cash on hand, this is for salaries wages so on and so forth. And then accounts payable and taxes payable, so that is composition of working capital. Now, with this tree we will try to see whether, we can estimate the total capital investment, only on the basis of the onsite cost, which is the total cost of major equipments, that we are going to design, now let us develop a simple cost model.

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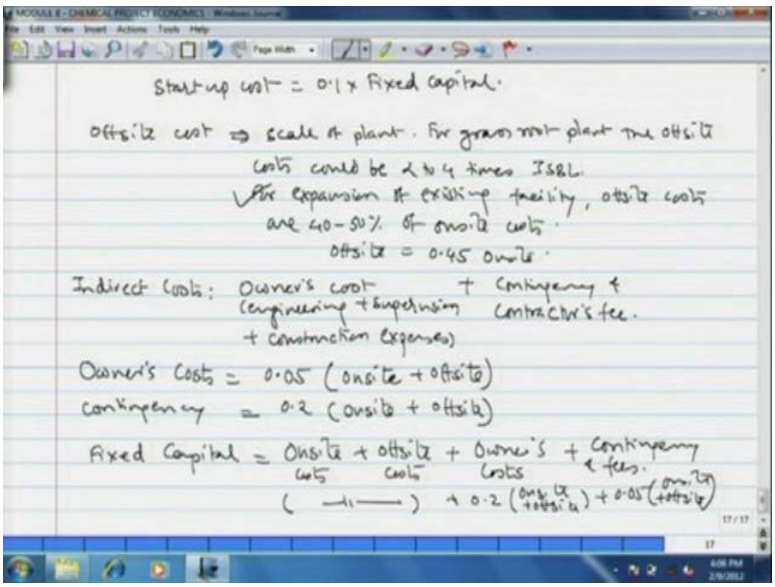

As I said the startup cost typically, 10 percent of fixed capital as far as the offsite cost are concerned those depend on what scale of plant, if you are going to for a grass root plant, a plant from scratch the offsite cost may be 2 or sometimes even 4 times the cost of onsite cost. However, if we are going for expansion of an existing facility, then the offsite cost are typically, 40 to 50 percent of the onsite cost and therefore, we take the offsite cost we are developing a simple model for expansion of existing facility and therefore, we take offsite cost as 0.45 times the onsite cost.

Now, let us see the indirect cost, indirect cost has components as the owners cost, that is the engineering supervision and construction expenses that we call as owners cost plus the contingency and contractor's fee. Now typically owners cost are about 5 percent of the total onsite and offsite cost and the contingency, now this depends on what kind of process you are going to implement, but typically contingency could be taken as 20 percent of the onsite and offsite cost. Now with this approximation, we can write that

fixed capital is equal to onsite cost plus offsite cost plus owner's cost plus contingency and contractor's fee and this typically, gives 0.2 times onsite plus offsite, this is 0.05e times onsite plus offsite and then this is as it is and therefore.

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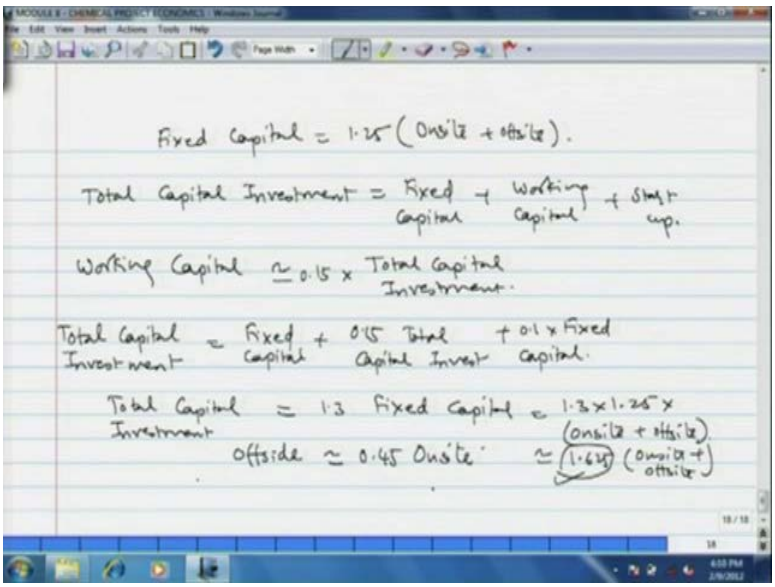

We have simple expression for fixed capital, that is 1.25 times onsite plus offsite cost, now total capital investment has three components, that is the fixed capital plus working capital now working capital is typically 15 percent of total capital investment and startup cost, I already told you is 0.1 times fixed capital investment. Now, if you substitute everything here, then what you get is total investment, total capital investment is equal to fixed capital plus 0.15 times total capital investment, that is for working capital and 0.1 times fixed capital that is for startup cost.

And then, if you rearrange this you get total investment is equal to if you simply, this you get 0.13 times fixed capital. But, fixed capital itself is a sum of onsite and offsite cost and then with the assumption that, we made few minutes ago offsite cost are typically 0.45 times onsite cost, if you substitute this here. Then we get a very simple formula for total capital investment, that is equal to 1.3 here, we have to multiply by a factor by 1.5 that I missed out please make this correction fixed capital is 1.25 times onsite and offsite cost please make this correction. So, this is typically 1.625 times the onsite plus offsite cost total capital investment is, so 1.625 times this thing. So, now we go further and then, we substitute the offsite cost in terms of onsite cost.

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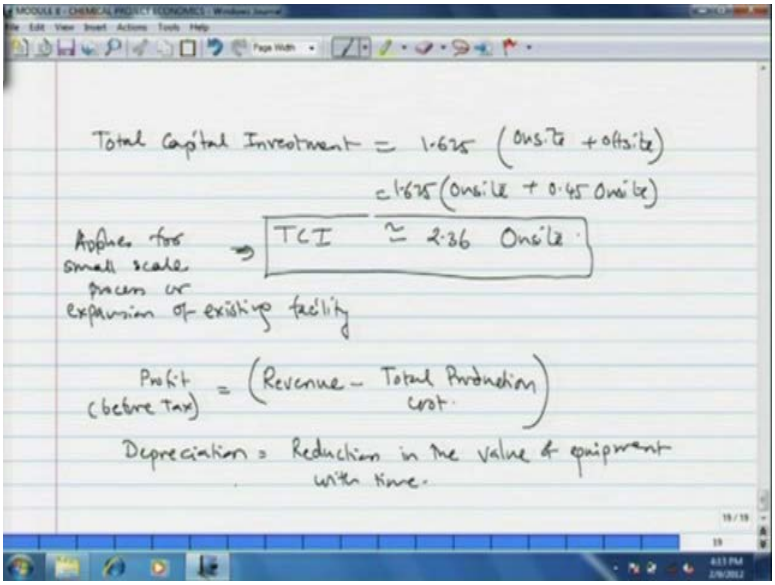

Total capital investment is 1.625 times onsite plus offsite cost, that is 1.625 times onsite plus 0.45 times onsite cost and then, this is 2.36 times onsite cost. This is an important formula that we had derived of course, this applies only for expansion of existing facility applies for small scale process or expansion of existing facility, but still it gives a very handy tool of estimating, the total capital investment just by estimating the cost of major equipments, that are there on the flow sheet having done this. We shall go further and see what are the profit for the process or profit here before tax is the revenue that you earn minus the total production cost. This is on the assumption that you have borrow you won the capital that you have invested, if you have borrowed the capital from bank or some other funding agency. Then the interest that you have to pay or the a term installment on that loan that, you have to pay is also detected from this.

Profit is revenue minus total production cost the equipment of the plant varies time for example, that applies for everything suppose, you buy a car or truck for business then, a vehicle will wear out with time. And therefore, we have to set a side some funds for replacement of this equipment, once it is life time is over or replacement of certain parts of the equipment, once they when the those parts wear out. Now government considers this particular cost as a legitimate cost and therefore, it allows a deduction of a fraction of cost of equipment as it wears out from the revenue before, you show the profit for paying the tax, so that is known as depreciation.

Depreciation is essentially the reduction in the value of the equipment with time and you have to set aside some funds from your profit to replace the equipment, once its life time is over or replace the parts of equipment, when it is required or repair or so on and so forth. You can deduct the depreciation fund from the profit before tax in each year, but the equipment will run for 5 years or 10 years.

So, the funds that are deducted for the replacement of equipment may not be actually, used for this purpose, they might be listed in some other ventures or a portion of profit invested in other businesses for expansion of your own facility or in other businesses. So, that thing is completely dependent on the component, but you are allowed to deduct some part of the profit as depreciation.

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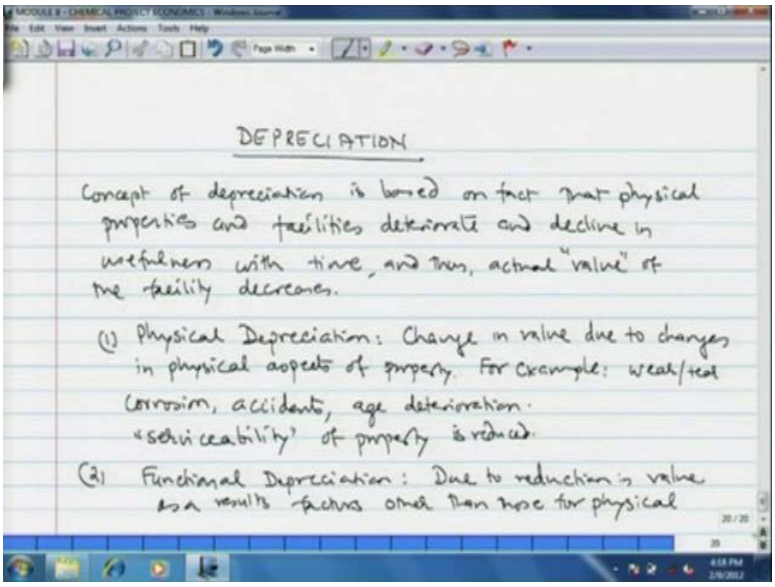

Now, let us see the concept of depreciation in detail, what I told you was a very basic depreciation, The concept of depreciation is based on the fact that physical properties and facilities deteriorate and decline the usefulness with time and thus the actual value of the facility decreases. What are the types of depreciation, the first one is physical depreciation, this is a reduction in value due to changes in the physical aspects of the property. For example wear tear corrosion then accidents or deterioration due to age and then because of this the serviceability of the property is reduced. The next is functional depreciation and this is due to reduction in value as the result of factors, other than those listed, than those for physical depreciation.

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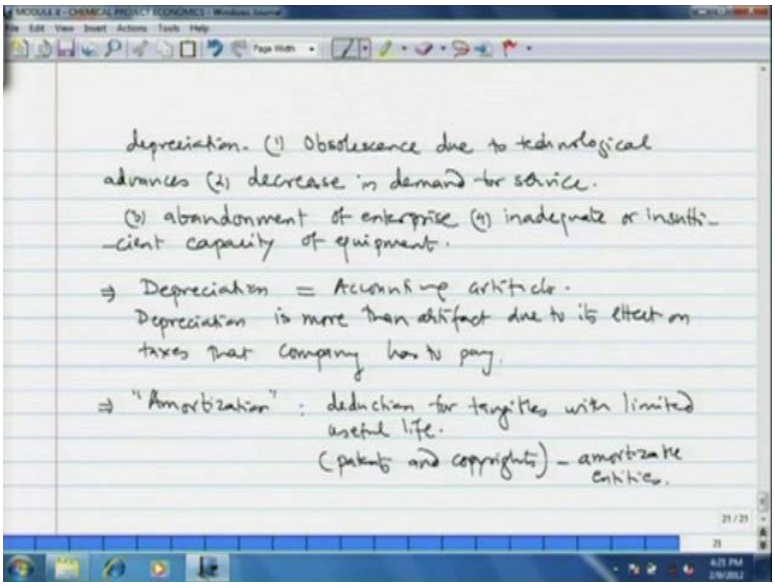

Now, these are essentially the obsolescence due to technological advances, this is many times mostly applicable for electronic devices. Then decreasing demand for the service given by equipment, then abandonment of the enterprise or it could be the inadequate or insufficient capacity of the equipment. Depreciation is called accounting artifact or why because it gets added and subtracted from corporate books however, the major impact of depreciation is in terms of income tax type the corporation has to pay.

So, that point to note depreciation is more than artifact, due to it is effect on taxes that one has to pay. Now, in some cases amortization is the word that is used in case of depreciation. Amortization means, deduction for tangibles with limited useful lives and thus the patents and copyright are also included in the depreciation or patents and

copyrights are the amortizable entities. Now let us see some basic aspects, what are the depreciable properties and what are non depreciable properties.

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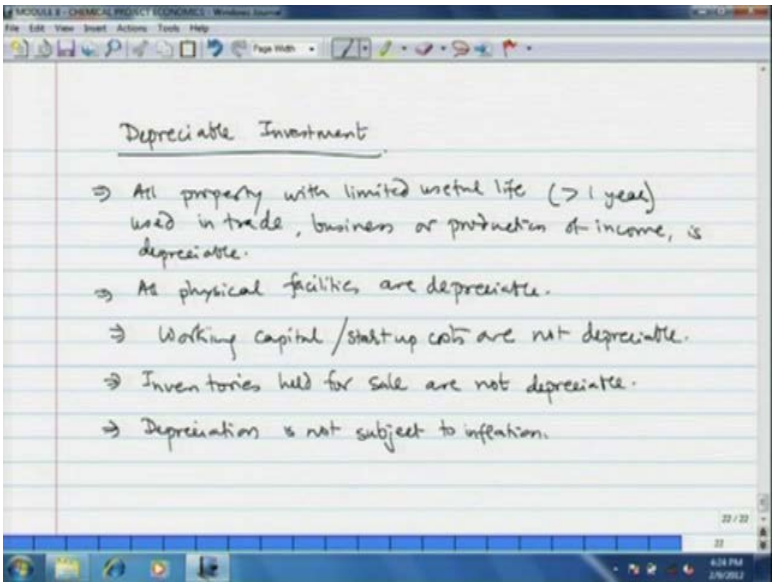

How do you distinguish between them depreciable investment, depreciable investment is basically all property with limited useful life, typically more than one year used in trade business or production of income is depreciable. So, that you how we define the depreciable property, all physical facilities plus the cost such as, design and engineering, shipping and field deduction that are depreciation symbol, all physical facilities are depreciable.

What are not depreciable? Working capital is not depreciable, startup cost is not depreciable, more over the inventories that are hailed for self are not depreciable I talked up accounts receivable that sometimes or the product in stock. So, product in stock or inventories held for a sale or not considered in depreciation and finally, depreciation is not subject to inflation.

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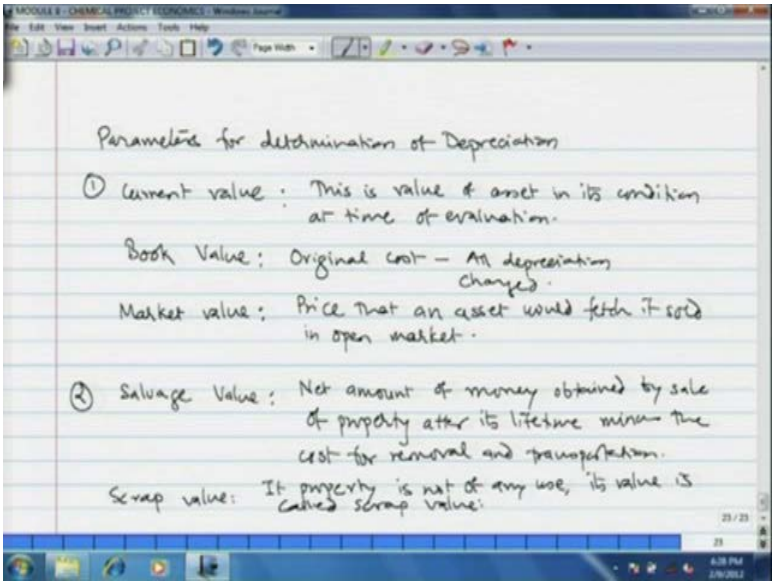

To calculate depreciation we need to know certain parameters and these are first the current value. Now this is the value of the equipment or of an asset in it is condition at the time of evaluation, this is not the initial value. Now the book value is the difference between the original property cost and all depreciation charged up to a time is original cost minus all depreciation charged market value is the price that, then asset would fetch, if it is sold in open market and then we have the salvage value.

Salvage value is the net amount of money that is obtained from sale of used property, when it is life is often, now in most of in the time, we used property is sold as is varies condition as is varies means, the owner will not pay the cost of transportation. But in some cases in some rare cases, the transportation or the removal of equipment from it is place is the dose charges are incurred by the owner or the original owner and to the deducted from this.

So, that point we also note salvage values is the net amount of money obtained by sale of property after it is life time minus, the cost for removal and transportation, in some cases you have to also pay charges for selling the equipment, if you are using an e-market to the site owner that is one, if the property is not of any use then it is value is called as scrap value.

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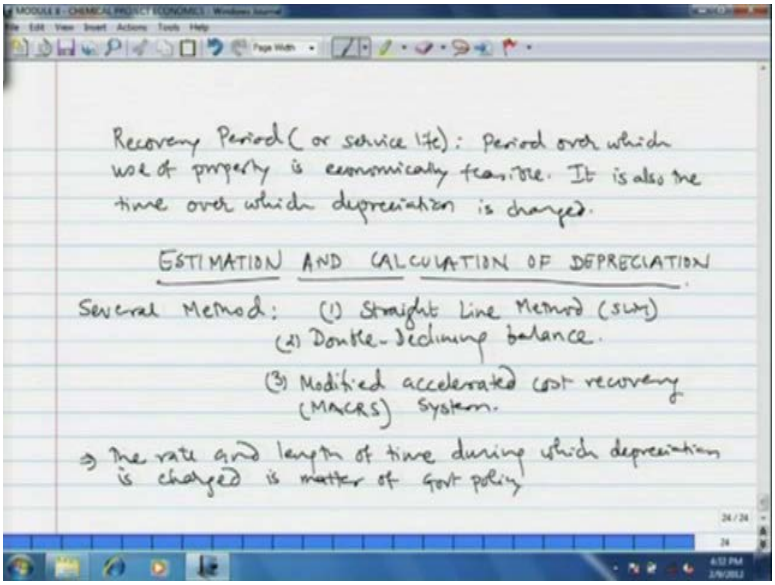

Then the third term that, we need to define is the recovery period, recovery period is the period over which, the use of property is economically feasible, that is also known as the service life recovery period or service life. So, that point you note this is the period over which, use of property is economically feasible, now it is the recovery period over which the depreciation is charged, now let us see some simple methods for estimating depreciation estimation and calculation of depreciation.

There are several methods available, for this the simplest method is the Straight Line Method also abbreviated as S L M, the second is the double declining balance method and third is Modified Accelerated Cost Recovery method, that is abbreviated as M A C R S accelerated cost recovery System. The length the rate and duration or length of time over which or during, which depreciation is charged is a matter of government policy, but let see these different methods or depreciation.

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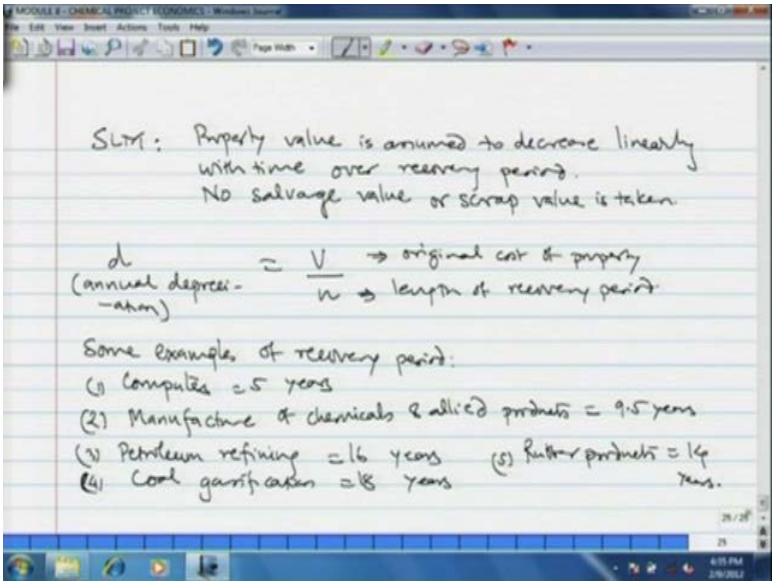

The simplest one is the straight line method S L M, here the property value is assumed to decrease linearly with time, over the recovery period or in that case more salvage value or scrap value is taken. So, then the depreciation angle depreciation d that, we denote is equal to v the original investment in property at start divided by n, where the length of straight line recovery period, v is the original investment in property or original cost of property and n is the length of recovery period.

Now the recovery period varies from industry to industry, now some examples are like for example, information systems including computer they have a life span of five years then manufacture of chemical and allied product, they have typical life span of 9.5 years, then petroleum refining sixteen years, coal gasification eighteen years or rubber products fourteen years. So, that is the straight line method for estimating depreciation.

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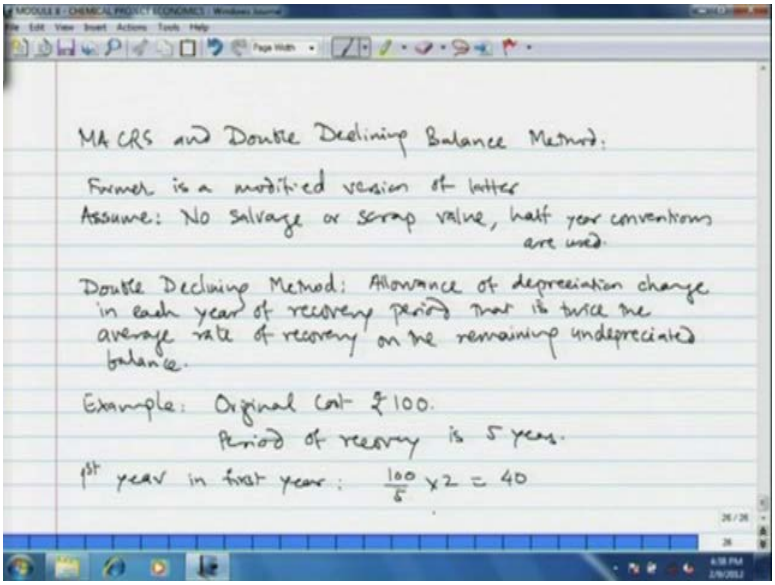

Now, let us see the M A C R S method modified accelerated this thing, but before that we shall see the double declining balance method because M A C R S method is based on the classic double declining balance method. The former or M A C R S is a modified version of latter, now here we assume no salvage or scrap value and then half year conventions are mutually used.

Now double declining balance method the basic principle is that the method allows a depreciation charge in each year of recovery, that is twice the average rate of recovery on the remaining un-depreciated balance for full recovery period that point to note allowance of depreciation charge in each year of recovery period, that is twice the average rate of recovery on the remaining un-depreciated balance, now let us see an example how it is calculated let us say that the original cost of item is rupees 100 and the period of recovery is 5 years. Then the depreciation in the first year according to double declining balance method is 100 divided by 5, that is recovery per year into 2 twice the recovery, so that is 40.

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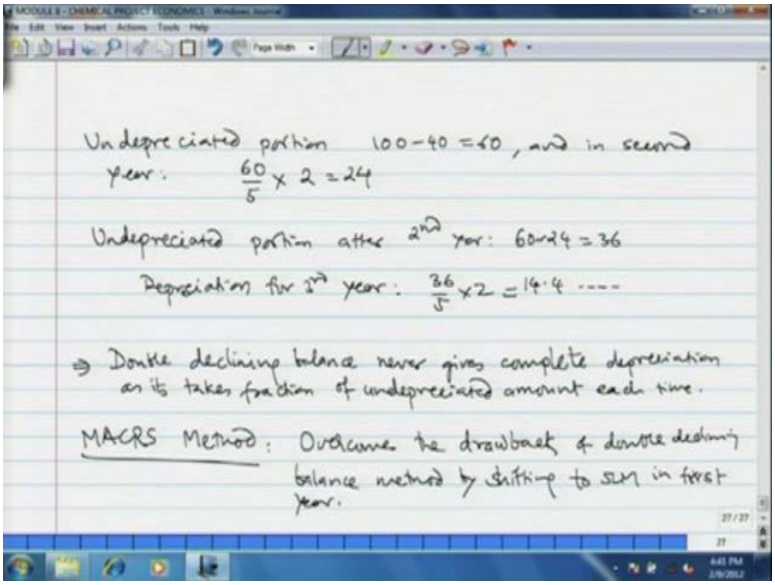

Now, the un-depreciated portion is 60, 100 minus 40 60 and then in the second year it is 60 divided by 5 into 2 that is 24, then the un-depreciated portion after second year is 60 minus 24 that is 36 and then depreciation for the third year is 36 by 5 into 2 that is 14.4 and so on. So, this is how we have to calculate the depreciation. Now the double declining balance method always takes fraction of the remaining balance therefore, the asset is never fully depreciated that point to note double declining balance never gives complete deprecation as it takes the fraction of un-depreciated amount each time. Now how does M A C R S method is different from this one, I told you that M A C R S method is a special case or modified case of double declining balance, now M A C R S method over comes the drawback of double declining balance by shifting to straight line method of depreciation for the first year.

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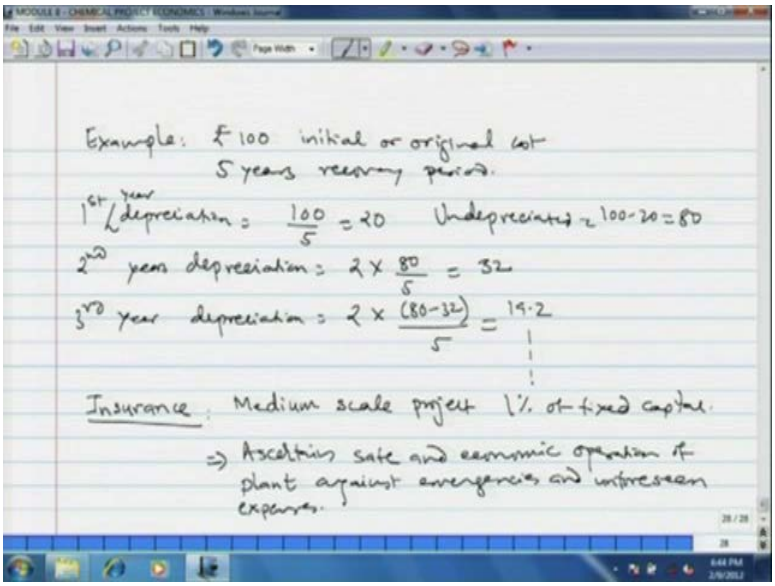

Now let us see how the same problem rupees 100 asset initial value, how does it decline and five years of, now here the first year depreciation is the straight line method, that is 100 by 5 20 un-depreciated amount is 100 minus 20 that is 80 and then the for second year depreciation is 2 into 80 by 5 that is 22, in third year depreciation is 2 into 80 minus 32 by 5 that is 19.2 and so on.

So, you can prepare a table for different properties with different age. So, that was all about the depreciation now let us see another aspect of this thing that is insurance, now medium scale project typically, incur about 1 percent of the fixed capital investment as

annual insurance cost. Now insurance cost may form very small fraction of the project cost, if it is necessary to consider insurance carefully to ascertain economy kind shape operation of plant against emergencies and un-foreseen developments. So, that point to note asset and a insurance is basically to ascertain safe and economic operation of plant against emergencies and un-foreseen expenses

Now, there are different types of insurances I mentioned briefly, major insurance requirement, first is the fire insurance or similar emergency insurance on buildings equipment and all other owned used or stored property the republic liability insurance, that includes, bodily injury and property loss or damage the then business interrupt insurance, which is for loss of income due to business interruption caused by fire or other emergency calamities, which also result in loss of property then workers compensation insurance and marine and transportation insurance for all property that is in transit.

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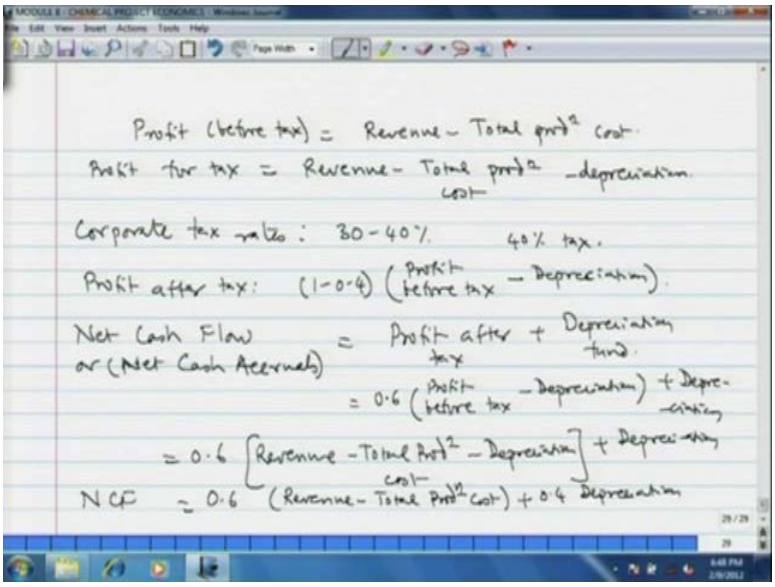

Now having said this let us develop brief expression for the net profit, before tax as I told you is revenue minus total production cost, now out of this some funds are reserved for depreciation. So, the profit for tax on which tax will be charged in the revenue minus total production cost minus depreciation, now the typical tax rates, corporate tax rates are 30 to 40 percent in India. So, we take a value of 40 percent that we assume.

So, the profit after tax is 1 minus 0.4 or 0.6, which is profit before tax minus the depreciation cost. Then the net cash flow to the company or which is also known as, net

cash accruals is equal to profit after tax plus the depreciation fund. So, this is profit after tax is 0.6 into profit before tax minus depreciation plus depreciation fund and profit before tax is revenue minus total production cost and therefore, what we have is in the net cash accrual is 0.6 into revenue minus total production cost plus 0.4 into depreciation.

So, this is the net cash accrual of the company per year or net flow of the company, based on this net cash flow, we shall estimate in the next lecture, the profitability parameter but before that we shall see the time value of this money company is going to earn on each year and let us say, if the operation of company is over a fifteen years and if the company is depositing this particular fund with some other agency or such thing then the that money, this money grows over time and therefore, the net cash flow of the company changes from year to year, so that we shall see in the next lecture.