Technologies for Clean and Renewable Energy Production
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Lecture - 39
Energy Conservations

Hi friends, now we will start discuss on the topic energy conservations. So far, we have discussed on the production of energy from fossil fuels and from different renewal energy resources and we have discussed how the energy can be produced in more cleaner way from the fossil fuels also. After taking sufficient efforts to develop newer cleaner technology we are able to reduce the emissions and to achieve sustainability goal, but there are still some scope, that is not fully technical, but that is based on the practice.

So, that is called energy conservations. So here, our target is to know about the practices or the ways which we can implement to reduce the need of electricity to perform the specific work, that is to prevent the loss of electricity on other way also.

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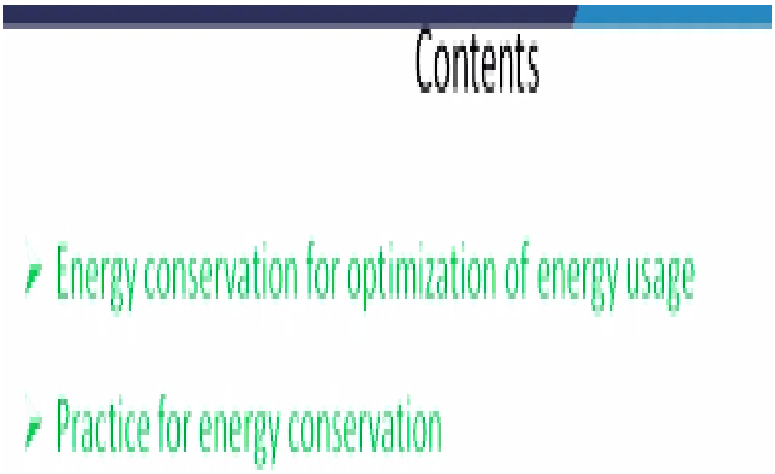

So in this class, we will discuss on energy conservation for optimization of energy usage and practice for energy conservation. Now we will see the energy conservation for efficient use of energy. There are some energy efficiency and GDP. If a country has more GDP, this does not mean that it is also energy efficient country then as you see energy efficiency may be less also, that we have discussed in our previous classes.

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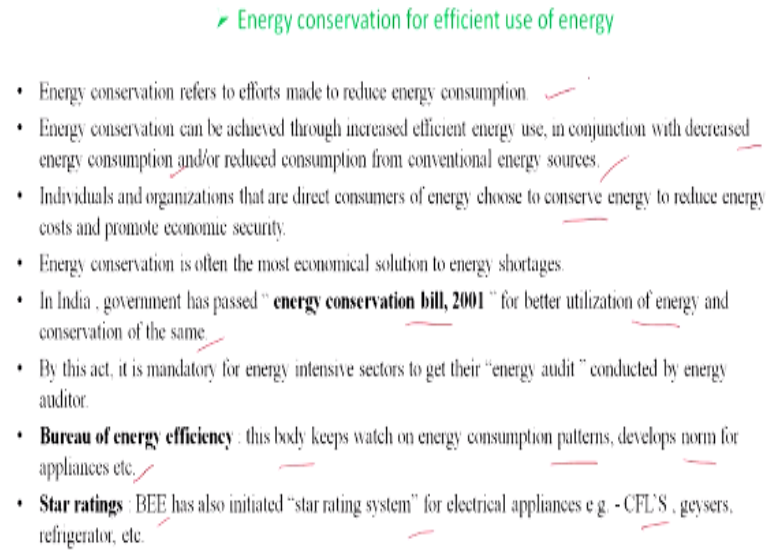

So here how we can increase that efficiency that is the point of discussion, and if we can develop some practice, we can improve that energy efficiency and government of India has also taken some measures to achieve this target the energy efficiency to increase the energy efficiency. The energy conservation bill in 2001 the government has passed for better utilization of energy and conservation of the same, that is energy. Bureau of energy efficiency had been established and this body keeps watch on energy consumption patterns and develops norm and appliances.

They have developed the star ratings, that is BEE has also initiated star rating system for electrical appliances and CFLs, geysers, refrigerators, etc. and energy conservation can be achieved through increased efficient energy use in consumption with decreased energy consumption and or reduce consumption from conventional energy sources. So any individual or any organization can develop the practices and they can choose to conserve energy to reduce energy cost and promote economic security. So this energy consumption refers to efforts made to reduce energy consumption basically.

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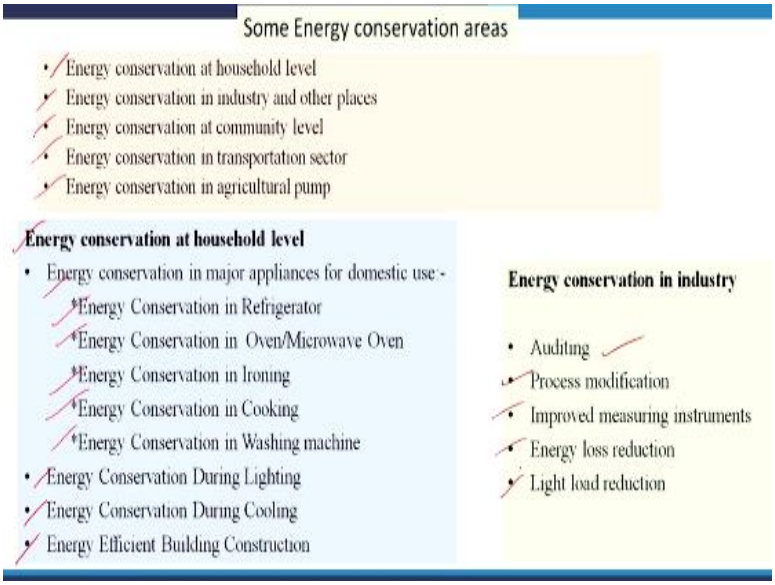

We will see some energy conservation areas where there is a good scope for energy conservation. So energy conservation at households, at each household level we can develop some practice so that the energy wastage will be reduced and utilization will be improved. Energy conservation in industry and other places also, there are lot of scopes. Energy conservation at community level, then also we have scope here, energy conservation in transportation sector, energy conservation in agricultural pump.

So these are some area where there is a good scope for the conservation of energy and will discuss that part. So energy conservation at household level, so at household level energy conservation in major appliances for domestic use are say refrigerator, so we can conserve energy here refrigerator. We can conserve energy at oven/micro oven, we can conserve energy in ironing, conserve in cooking, energy conserving in washing machine, etc.

For example if we in case of cooking, if we use less gas flow rate, then it takes some more time for cooking, but the loss of heat is reduced significantly. Similarly for iron, we do not to keep the iron on for a longer period, we if we use auto control mode then it is better, it will be you conserving electricity and similar for refrigerator, we may maintain the temperature which is required for us, we may not go for sharp temperature. So, there are some specific applications, when we need we will go to that extent, otherwise we will be using in normal range, so that way also we can do.

Energy conservation during lighting, so during lighting, we can also follow some procedure so that our eye will not be affected, will be getting sufficient illuminations from this and at

the same time will be able to reduce the wastage or unnecessary use of electricity. Energy conservation during cooling, the cooling system also there are some natural cooling systems are also that can be used, say water spray, that also can gives good cooling, one example of that energy conservation of that.

Energy efficient building construction, building can be constructed in such a way so that passive building constructions that we have discussed in the previous class also that helps to take heat from the outside into the room in winter days and in summer days the reverse, it prevents the passage of heat from outside to inside. Energy conservation in industry, that is so to conserve energy in the industry, the one practice is very very important than it is revealed that is energy auditing and process modifications.

If you have some process which is using more energy, then we can replace that one. There are number of techniques that is pinch analysis that is optimization of the energy use in the or heat loss, to reduce the heat loss in the unit or process industries, those are also used, so process modification. Improved measuring instruments, energy loss reductions by pinch technology that we are talking about and that can also help the process modifications and light load reduction. So these are some process through which the industry can achieve more energy conservation.

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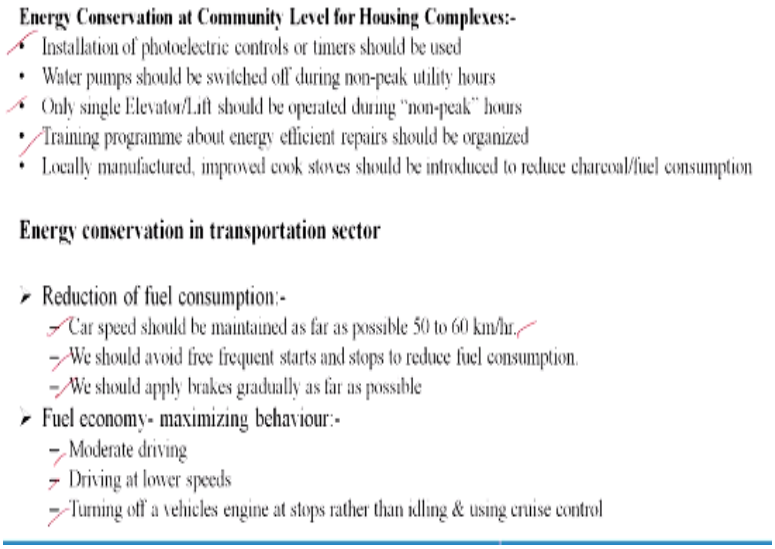

Energy conservation at community levels and housing complexes also. So if there is housing complex, if we can develop some technique that all lights will be stopped when it is not necessary. So some timers may be used. When the people will go on that way, the light will

be on and when there will be no one, the light will be off automatically, that way also the energy conservation can be achieved. Training program about energy efficient repairs should be organized.

Only single elevator lift should be operated during non-peak hours and non-peak hours then we do not use multiple lifts. Water pump should be switched off during non-peak utility hours. Installation of photoelectric controls or timers should be used that we are discussing. Then energy conversions in transportation sector, so in transportation sector also if you can develop some practices, then also we will able to control the loss of the energy and conserve energy like the car speed should be maintained as far as possible 50 to 60 km per hour.

So engine are designed in such a way this time the oil requirement becomes less, fuel requirement becomes less or optimum. We should avoid free frequent starts and stops to reduce fuel consumption. We should apply brakes gradually as far as possible. Fuel economy that have maximizing behavior, moderate driving and driving at lower speeds and turning off vehicles' engine at stops rather than idling and using cruise control. So these are some practices which can adopt to conserve energy in this sector.

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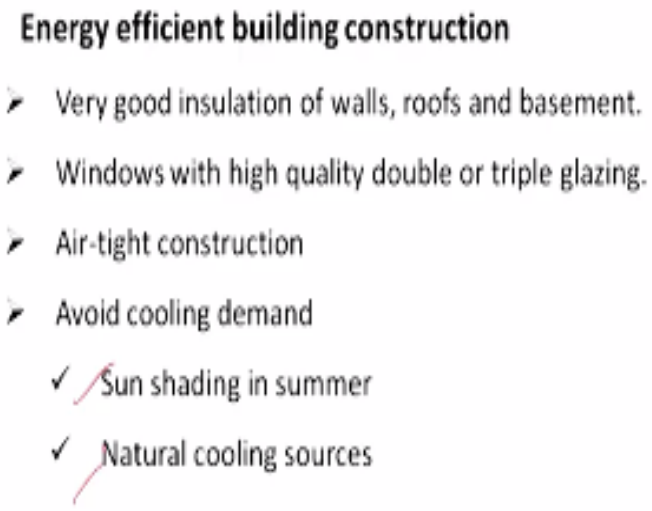

Energy efficiency in building construction, that is very good insulation of walls, roofs, and basement. Then windows with high quality double or triple glazing, so that also helps the energy conservation. Air tight construction. Avoid cooling demand that is sun shading in summer and natural cooling resources, so that way we can do it.

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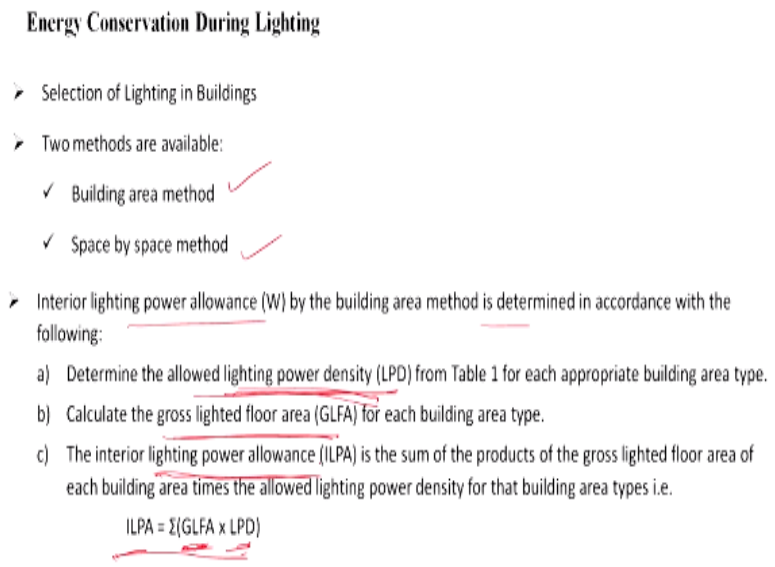

During lighting when we will use the lighting systems in the residences, we can think about the requirement of energy and then how much energy we are actually putting. So interior lighting power allowance that is called interior lighting power allowance by the building area method is determined by some procedures. So there are 2 methods to determine how much light is required in a building that is building area method and space by space method.

So we will be discussing the building area method. So what is the meaning of this method that we have to determine allowed lighting power density LPD, lighting power density?

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TABLE 1: INTERIOR LIGHTING POWER FOR BUILDING AREA METHOD

Building Area Type	LPD (W/m^2)	Building Area Type	LPD (W/m^2)
Automotive Facility	9.7	Multifamily Residential	7.5
Convention Center	12.9	Museum	11.8
Dining: Bar Lounge/ Leisure	14.0	Office	10.8
Dining: Cafeteria/ Fast Food	15.1	Parking Garage	3.2
Dining: Family	17.2	Performing Arts Theater	17.2
Dormitory/Hostel	10.8	Police/Fire Station	10.8
Gymnasium	11.8	Post Office/ Town Hall	11.8
Healthcare-Clinic	10.8	Religious Building	14.0
Hospital/ Health Care	12.9	Retail/ Mall	16.1
Hotel	10.8	School/ University	12.9
Library	14.0	Sports Arena	11.8
Manufacturing Facility	14.0	Transportation	10.8
Motel	10.8	Warehouse	8.6
Motion Picture Theater	12.9	Workshop	15.1

Lighting power density in table here. So if we have different parts of the residence, that is automotive facility, then we have convention centre, we have dining, we have bar lounge or say cafeteria, family dining, dormitory, gymnasium, healthcare and clinic and hospital, hotel,

library, manufacturing facility, motel, motion picture theatre and multifamily residential, museum, office, parking garage, performing arts theatre, police/fire station, post office, religious building, retail or mall, school, university, sports arena, transportations, warehouse and workshop.

In these different areas, this is the LPD so that is the lighting power density. So these are the lighting power density we need. We do not need the lighting power density of 11.8 watt per metre square in case of automotive facility which is required for museum. So more energy is required, more light is required in case of museum, more is required in case of arts and theater. So less is required in case of warehouse, less is required in case of automotive facilities, but many time we cannot identify these areas and the requirement and we use more energy.

So if we have some idea on this, the requirement of energy for different areas, accordingly we can use different power of the bulbs, then we can consume some amount of energy. So this is the concept of this energy conservations in lighting area. How can you calculate the total energy required, that can be done by this formula, ILPA that is interior lighting power allowance, so that is equal to sum of GLFA x LPD.

What is LPD, that is your allowed lighting power density and so GLFA that is what is the total area we are having, different types of area we are having, so that will be multiplied by LPD of this that is gross lighted floor area GLFA. So different types of area we have, say somewhere we may have 2 kitchens, we may have 2 garage, so all those cases we have to multiply this with the number. So area so we are having gross lighted floor area x LPD, that is the lighting power density.

So type of building or area, type of area and the area of the type x LPD of that type, then we will sum up all those things, all areas, then that will give us ILPA, that is the interior lighting power allowance. So that way it is calculated.

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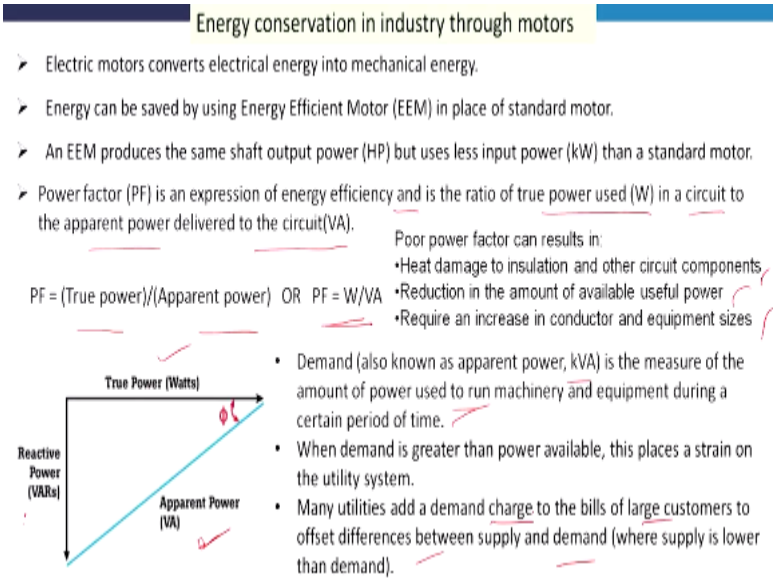

Now energy conservation in industry through motors. When we use the motors in industry, then we have to be careful for the operation of this because you know there are in some cases what happens the power which is coming to the motor, that is not completely converted to the work. So there are some power factor. So the power factor is there that is equal to true power/apparent power. So true power W/VA that is mentioned here, that is equal to true power/apparent power. So power factor is an expression of energy efficiency and is the ratio of the true power in a circuit to the apparent power delivered to the circuit. So this is the definition of the power factor.

So motor has that power factor also. So in case of more the power factor, we will be get more true power, so how much power the motor is getting and how much it is converting to the usable form that is our power factor. So here, we have some correlation. True power and this is apparent power, so watt and this is VA. So this is a relationship and this is reactive power. So how much true power, reactive power, apparent power, so these 3 types of powers we have and these are related like this.

So say we need to get certain amount of work done by the motor, that is what amount of work is being done that is your true one, that is actually have done it, that energy used for that application and what amount is coming as input of the motor that is our apparent power, so this ratio is power factor. Now, poor power factor can result in heat damage to insulation and other circuit components, reductions in the amount of available useful power, and require an increase in conductor and equipment sizes.

Demand which is also known as the apparent power kVA is the measure of the amount of power used to run machinery and equipment during a certain period of time. So if I have increased my demand, but the supplier is not able to meet that requirement, so the supplier may impose some restriction on need and can impose some tax on it, means that some demands of charges to the bills of large customers to offset differences between supply and demand, so that way that is practiced, so many utilities at a demand charge okay, when the demand is greater than the power is available.

So now will see one examples, so up to this which we understand that the power factor if you can increase, then our energy loss will be less and energy conservation will be more, we will be able to save more energy or get the work done with using lesser amount of energy, so that is the case, that is why the motor which is used that is called energy efficient motor which is having high power factor.

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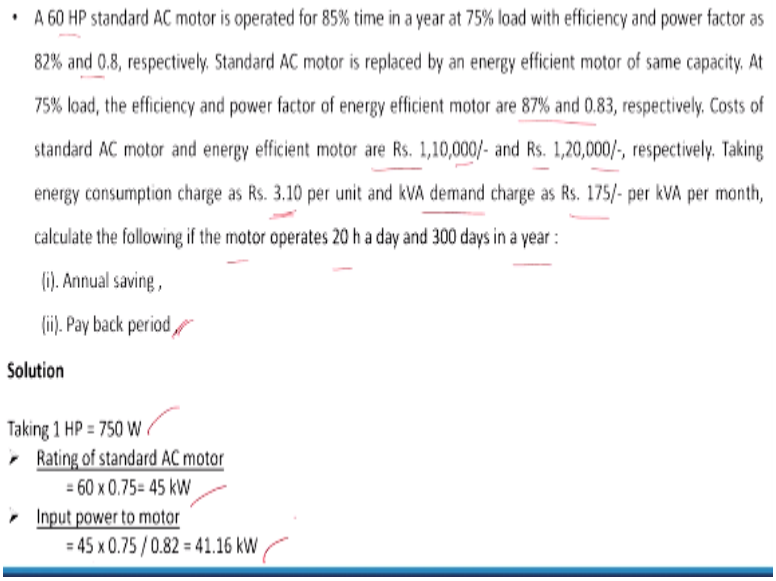

We will see some numerical problems. Say a 60 horse power standard AC motor is operated for 85% time in a year at 75% load with efficiency and power factor as 82% and 0.8 respectively. Standard AC motor is replaced by an energy efficient motor of same capacity that is at 75% load. The efficiency and power factor of energy efficient motor are 87% and 0.83 respectively. Cost of standard AC motor and energy efficient motor are 1,10,000 and 1,20,000 respectively.

Taking energy consumption charge as Rs. 3.10 per unit and kVA demand charge as Rs. 175 per kVA per month, calculate the following if the motor operates 20 hours a day and 300

days in a year. So we have to calculate annual saving and pay back period. So this is the problem statement. If you want to do it, then what we have to calculate. We have to calculate the energy requirement in case of standard motor and energy requirement in case of energy efficient motor.

So in this case energy efficient motor will be using less energy and that amount of less energy is our saving and to get, we will multiply this by the unit price of the electricity, then that is the total monetary saving and then annual saving we can calculate and payback period we can get that this is the time at which the total investment will be done in terms of expenditure or money, and then there may be 2 cases, one is total amount which are investing or another is the gap between two standard and efficient motor.

So now, the problem statement 60 HP it is given. So 1 horsepower is equal to 750 watt we know if we can assume, then 60 horsepower is 60 x 0.75 kilowatt. So this is the rating of standard DC motor, and then input power to the motor that will be 45, it is with 75% load, so 0.75 again, 45 x 0.75 and with 82% efficiency, so 0.82, that is 41.16 kilowatt the input power to the motor.

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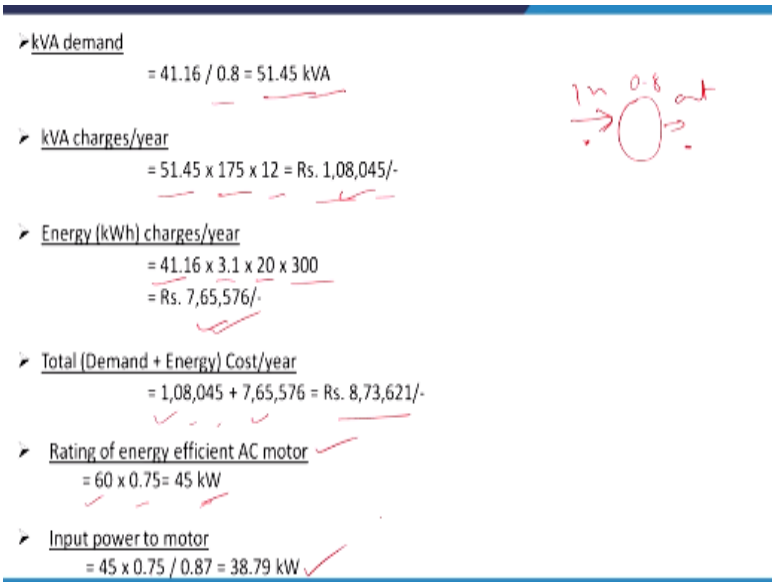

Then what will be the output power of the motor, it has 80% efficiency. What is the power the motor is taking, this motor is taking how many power, so it will be giving out input, this output that is equal to 0.8, so this will be 0.8 of input, so that is so. So what is the kVA demand, so kVA demand is equal to power factor is equal to given here, 0.8, so that power factor is 41.16/0.8 that is equal to 51.48, so if it get 51.45, then it will give us 41.16.

Then what is the kVA charges, this kVA demand x charge is given here 175 rupees per KV per month and per year, we have 12 months, so it will be for 51.45 x 175 x 12 that is equal to 1,08,045 rupees. Energy charges, so how much energy it is using, 41.16, we are using this energy, so this x 3.14 per unit and we have 20 hours a day and we have 300 days per annum. So this is the total amount for electricity charge. So demand + energy charge or cost per year that is equal to this amount + this amount, so 7,65,576 + 1,08,045 if we add 8,73,621 we are getting this much of total expenditure for standard motor.

If we use the energy efficient motor, then the rating of energy efficient AC motor, again it is also 60 HP and so 60 HP equivalent to 60 x 0.75 that is 45 KW and its efficiency is higher, that is 87%, so input power to the motor will be this 45 x 0.75 that is actually it is using, but as it is 87% efficient, so that has to be divided by 0.87, so this is 38.79 kilowatt, this is the input power to the motor.

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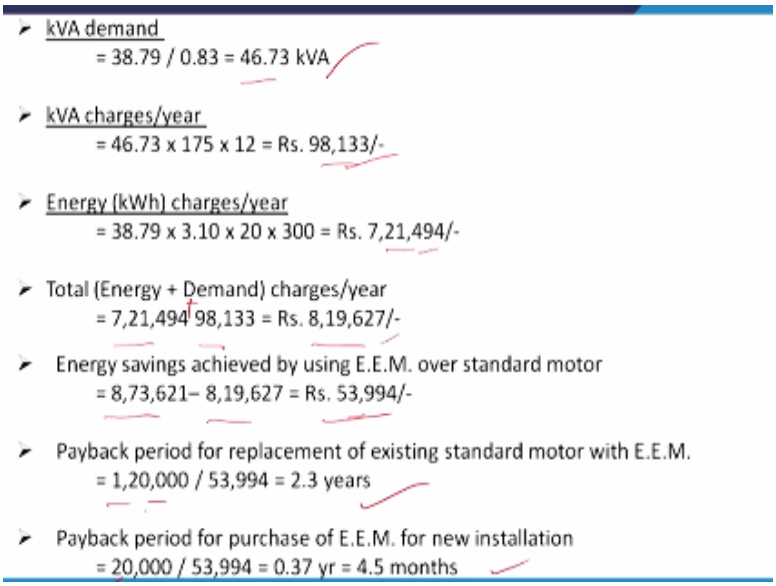

Then what would be kVA demand, then we have to know the power factor. Power factor in this case is equal to 0.83, so will divide it by 0.83, so 38.79/0.83, so it is 46.73 kVA. So this is our demand. So now kVA charges how much, again this x 175 x 12, so that is equal to 98,133 rupees and what would be the energy charge in this case. We need energy is equal to 38.79 KW, so 38.79 KW x 3.10 x 20 hour per day x 300 days per year, so it is coming 7,21,494 rupees per year.

So total charge will be this plus this, so you are getting energy + demand charge, so it is

coming the demand chare is coming 8,19,627 rupees. So here we are getting this much in the standard, if you use the standard motor power charge is 8,73,621 and here 8,19,627. So the difference is 53,994 rupees. So this is our saving actually.

So payback period if I want to get the whole money back together that is 1,20,000 for the energy efficient motor then you have to divide, this divided by 53,994 so 2.3 years, but if I want to get the difference that is 1,20,000 – 100000, so 20,000/53.994, so 0.37 year, that is equal to 4.5 months. So that way, we can calculate the requirement of the demand, that you can calculate the demand in kVA, that is apparent energy and we can calculate energy charge and overall expenditure for this motor application.

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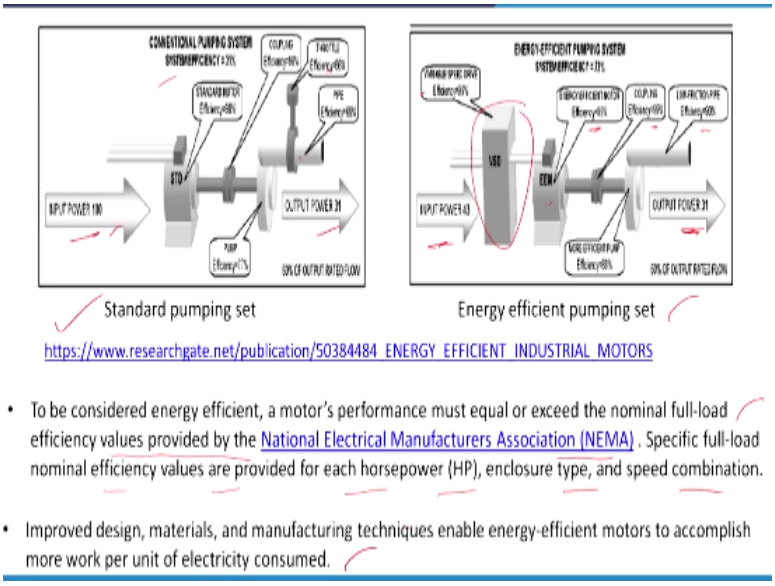

Now here we see the energy efficiency how can be improved in the pumping set. So this is the standard pumping set and here energy efficient pumping set. So here we have added one new device. So what was STD here standard input power we have 100 units, the same amount of work we can get here by using 43 unit, output is same, and this is made by the changes in the units which are used for the operation of this motor. So important is variable speed drive if it is used, so it is 99% efficient.

So here we have conventional pumping system, efficiency is 31%, so here it is 99% if it is used. Then this also energy efficient motor that is also giving us very high efficiency. So that way, this each part which are having less efficiencies here by the use of modified parts you are able to get more efficiency. As a whole, we can get the same amount of work by using less amount of energy with respect to standard motor.

So to be considered energy efficient a motor's performance must equal or exceed the nominal full-load efficiency values provided by the National Electrical Manufacturers Association. They have given a list that has specific full-load nominal efficiency values are provided for each horsepower, enclosure type, and speed combination. So by comparing that, we can get whether it is energy efficient or not. Improved design, materials, and manufacturing techniques enable energy efficient motors to accomplish more work for unit of electricity consumed that we have discussed.

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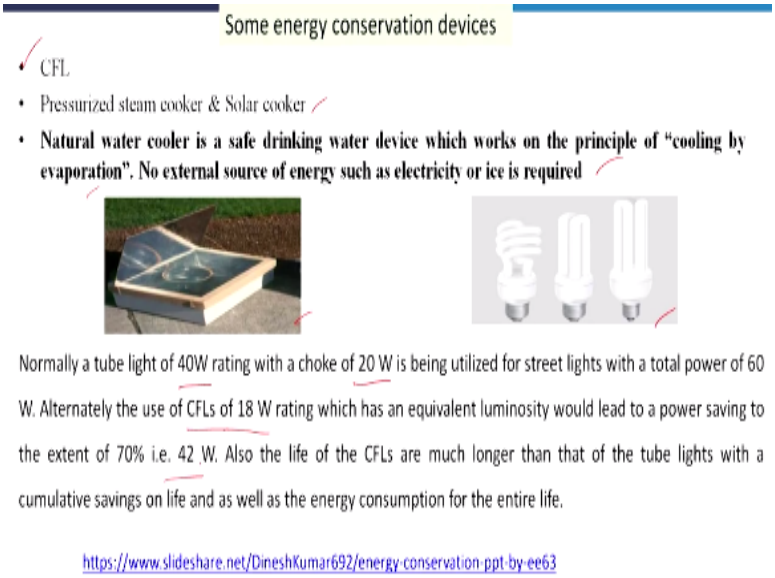

Now some energy consumption devices we will see. One is your CFL. So as you know that CFL uses less energy to give same luminescence to the conventional bulb and pressurized steam cooker and Solar Cooker another example. Natural water cooler is a safe drinking water device which works on the principle of cooling by evaporation. No external source of energy such as electricity or ice is required. This is cooler, this is our solar cooker, and this is our CFL.

So it has been shown that a tube light of 40 watt with a choke of 20 watt, that is total 60 watt, what luminescence they can give, the same amount of luminosity can be given by the CFLs of 18 watt. So there is a 60-18, 42 watt, a 70% saving in the electricity.

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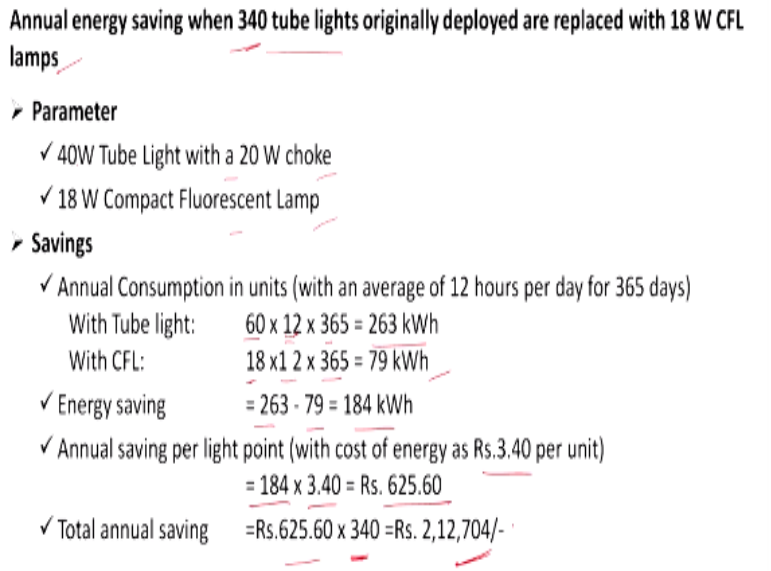

Now here are some calculations. The annual energy saving when 340 tube lights originally deployed are replaced with 18 watt CFL lamps. So 40 watt tube lights with 20 watt choke and 18 watt compact fluorescent lamp, CFL, that we have just discussed. So what would be the saving? Just is with tube light 60, 40+20, 60 x 12 x 365, that is 263 kilowatt hour and CFL is 18 x 12 x 365, when 12 is the average hour use per day, so that is equal to 79 kilowatt hour.

So the savings is 263-79 = 184 kilowatt hour. So the cost is 3.40 rupees per unit, so multiply this into this, rupees 625.60 per unit, so total unit we are using here 625.60 x 340, that is equal to this one. This is our annual saving. This 340 tube we have, so that is why this multiplied by 340, so we are getting this much of annual saving by this implementation of this project.

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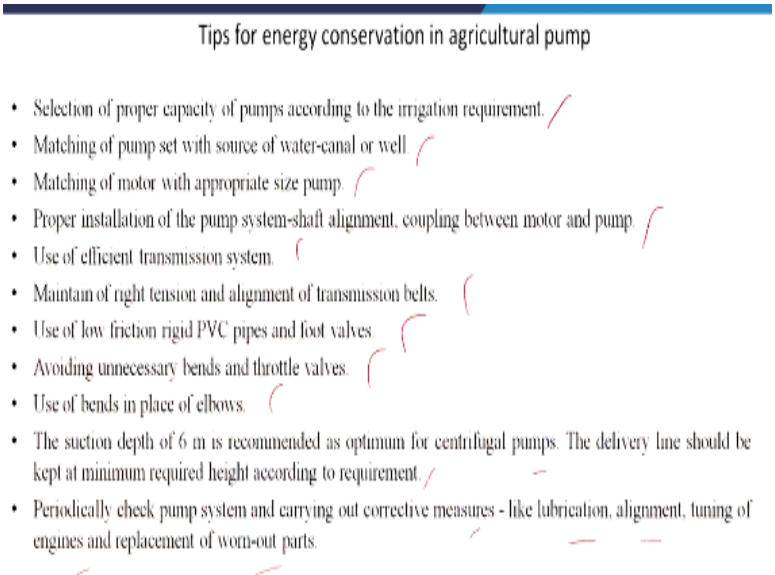

Now there are some tips for energy conservations in agricultural pump. So selection of proper capacity of pumps according to the irrigation requirement, then matching of pump set with source of water canal or well and matching of motor with appropriate size pump. Proper installation of the pump system-shaft alignment, coupling between motor and pump and use of efficient transmission system. Maintain of right tension and alignment of transmission belts. Use of low friction rigid PVC pipes and foot valves.

Avoiding unnecessary bends and throttle valves. Use of bends in place of elbows. The suction depth of 6 metre is recommended as optimum for centrifugal pumps. The delivery line should be kept at minimum required height according to requirement. Periodically check pump system and carrying out corrective measures likes say lubrication, alignment, and replacement of worn-out spares can help to improve the conservation of energy in agricultural pump because all of these are basically dedicated to reduce the loss of energy.

So these are some tips or some discussion on the energy conservation. Up to this in this class. Thank you very much for your patience.