Power System Generation, Transmission and Distribution

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Lecture No. 09

Air Pollutants

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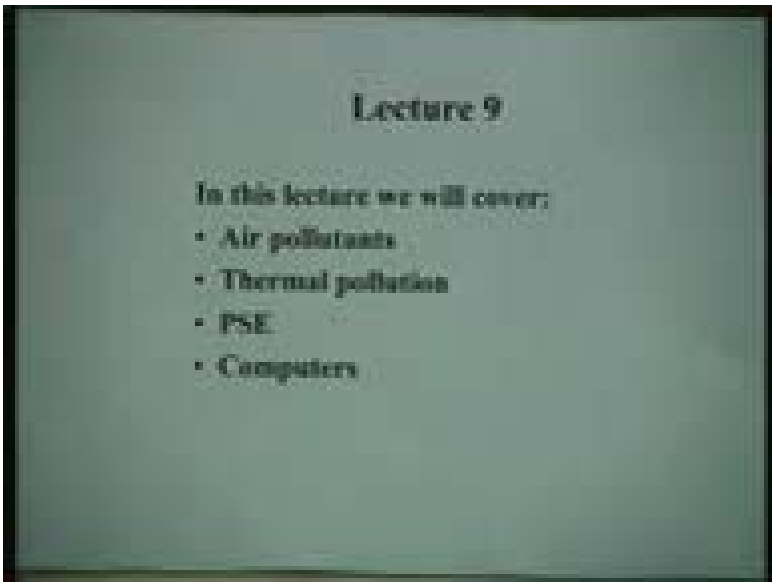

Good morning ladies gentlemen. Today is our ninth lecture, and the last before the first minor. In this lecture, we will cover air pollutants, thermal pollution, PSE, computers. What is air pollutant?

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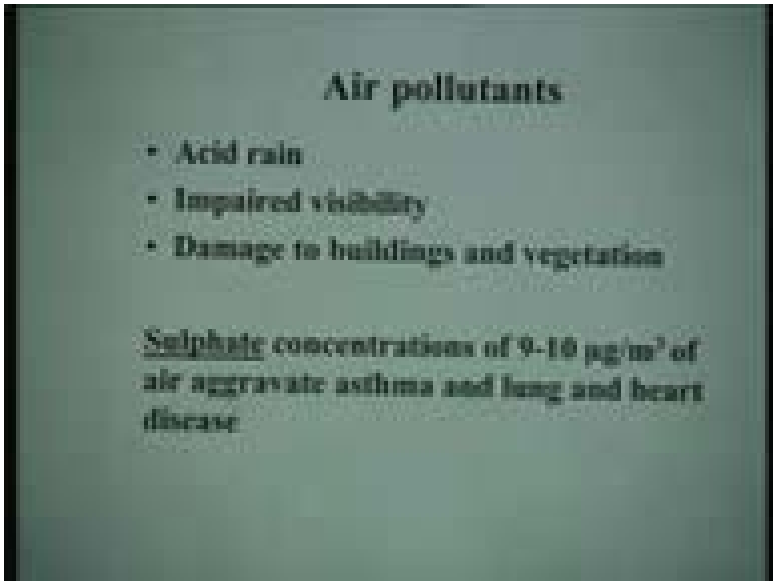

We already talked about acid rain earlier on, the sulphur content of coal luckily we do not have much sulphur in Indian coal, barring the coal from Assam that has sulphur, but coal from ariya, Jharkhand, Bihar, Chandrapur rest part of the country hardly contains any sulphur. But there are other acids like nitric acids and those acids can always fall back on the earth, and because of that there can be impaired visibility. As I told you whenever there is a pollution you always rub your eyes because that smoke, even the cooking, while cooking in olden days the ladies used to have problem with their eyes because of the smoke coming out of that cow dung or even those you know wooden things. The pollutions not only damage the human begins, the heart, the lungs, the brain, the eyes, but they even damage to buildings and vegetation. Even vegetation gets affected, buildings you know the famous incident of Taj Mahal getting, becoming yellow because of the Mathura refinery.

So, Mathura refinery is dangerously close to Taj Mahal. In fact, many of these small scale industries in Agra were ordered to be closed because they were threat to the beauty of Taj Mahal. Sulphate concentrations of 9 to 10 microgram per meter cube of air aggravate asthma and lung and heart disease. Of course we are lucky that we do not have much of sulphur, but then this is common for rest of the world, we are talking in general not just for India. I am sure those of you who are doing the various energy courses.

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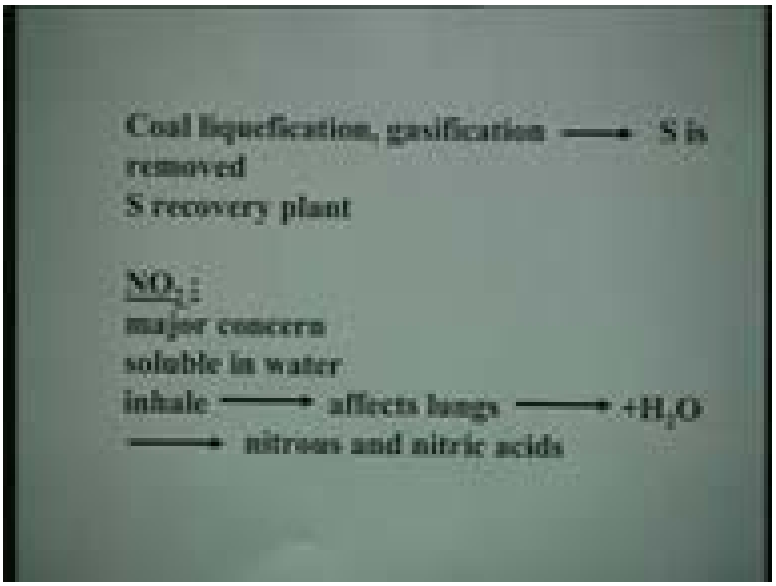

In fact, all of you must be doing barring the electives where you have a choice. The fuel group must have taught you or may be teaching you next time, next semester coal liquefaction and coal gasification. This is a separate area in itself, there is ph d thesis going on in those two areas specially for students belonging to chemistry and chemical background; what happens when you liquify or you gasify of course, there is a money for that. You have to have a liquefaction plant, the gasification plant you have to spend money, but the advantage is, the coal which comes out of this is a much better quality.

And the pollution gets reduced to a significant extent. In fact, sulphur is totally removed. Of course, as I said it may not be important for India, but then it is important for the world and who knows where you will be working after you get your degree here. So, sulphur recovery plant is very important to remove the sulphur. NO 2, that is there in India. It is also a problem for India, nitrous oxide In fact, it is NO x, it is a major concern as far as our country is concerned. Why? Because it is soluble in water and there is a water vapor everywhere in the atmosphere. Even you without its getting contaminated or contact with water you can always inhale that is why you must seeing now a day's many people even walk with a mask on; whether there is plaque or whether there is any problem in the city or not.

Specially on two wheelers, those who drive two wheelers you must be seeing the people having the mask and then driving. In fact, in Taiwan it is a must, it is like a helmet if you

do not have a mask they would not allow you on the roads because of to avoid pollution. So, if you inhale those gases it will affect your lungs and there is water inside the body as well and if the body that inhaled gas combines it, forms nitrous and nitric acids inside the body. And you can see how acid can play havoc with the various parts of the bodies. It can do anything and it can result even in death or permanent problems.

So, how fearful or how frightening is a prospect if you have increased pollutions because of the increased power generation and as I have been repeating we have to generate as much power in next 10 years as much we have already installed in last 50 years. That is 1,00,000 mega watt and if you want to install 1,00,000 mega watt look how much preparation we have to do to avoid the pollution because of this 1,00,000 mega watt.

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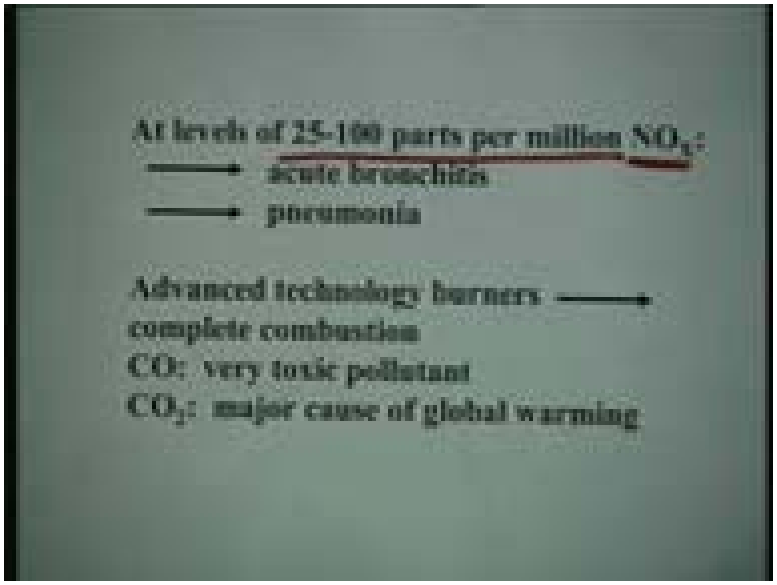

As you see at the levels of 25 to 100 parts per million this p p p. You know NO x at this levels suppose, you know must be seeing the pollution watch in several channels, TV, news programme they show you the pollution watch. So, that you get aware what are the different pollutants that can affect you. So, they show it every day on TV news channels.

It can cause you acute bronchitis and pneumonia, people die of pneumonia, people die of malaria do not think that these diseases you, nobody dies. So, pneumonia somebody can you know his life can be finished. There are advanced technology to tackle this problems. The man is also by nature adventurous and he wants always he or she wants to tackle the problems that they face. Here they are trying to develop the advanced burners,

as I told you on burner design there can be a major project, minor project or even the ph d thesis.

So, that there is a complete combustion takes place before emission, before exhaust. So, that at least there is no danger of CO or lower oxides of nitrogen because CO is more harmful than CO 2. And if you see the exhaust from the vehicle, if there are white fumes they are more dangerous than dangerously looking black fumes. Black fumes are not so dangerous because that is in to combustion, shows combustion is complete, but if there are white fumes coming out do not think they are harmless, they are more harmful.

So, very toxic also, these pollutants are very toxic and major cause of global warming and that is being seen in the world every day. This summer was very harsh in Europe they all remembered fans. In fact, the India was lucky or benefit beneficiary of getting an you know export order of fans because there were never fans in those countries, because this is not required. If you go to Jammu Kashmir even today you will see that there are no fans in the houses because they are not required, but Kashmir temperature this whole summer was above 30. Sometimes as high as Delhi temperature, it was never so in the past. This is all signs of increased global warming and this global warming will raise the level of sea also. There are some countries in the world, who are below sea level and then there can be problem, as I said few of the villages in Andhra coast already drowned because of the enhanced level of sea.

And as I told you there may not be any Sri Lanka, Mauritius, this small Malta, small islands may not be there if we continue like this for another 20 years, the whole geography will change.

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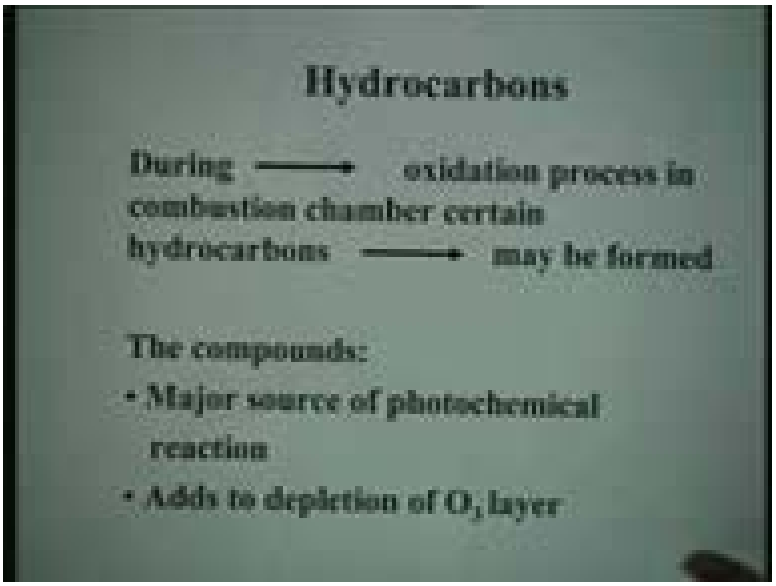

What is hydrocarbons? The oxidation processes take place inside the heat chamber, where the you know the steam is being prepared, whether by nuclear or by thermal or by anything and hydro certain in combustion chamber certain hydrocarbons may be formed.

These are the compounds which are major source of photochemical reaction. These are all bads and adds to depletion of ozone layer. I am sure this ozone layer keeps you safe from sun, the over global warming. When you go to Australia or new Zealand or all these countries, why that 35 degree centigrade is more harmful than our 40 degree centigrade. There in 30 degree they feel so awful you know because their ozone layer has already depleted, which has not happen in our country so far because our generation is hardly any 1,00,000 mega watt.

So, that is why in all these pollution conferences whether it is a Rio, whether it is you know what is called Japan in Kyoto conference, Kyoto resolution. It is the developed world which is creating this pollution and asking us giving us advice not to create one; whereas, it is they who are creating this problem. If you go by per capita we are hardly responsible for creating any type of pollution, including vehicular pollution because the number of vehicles, even today are much lower per person as compared to. You may always say that our population is so high, but these are the statistics which are always per capita, whether you like it or not.

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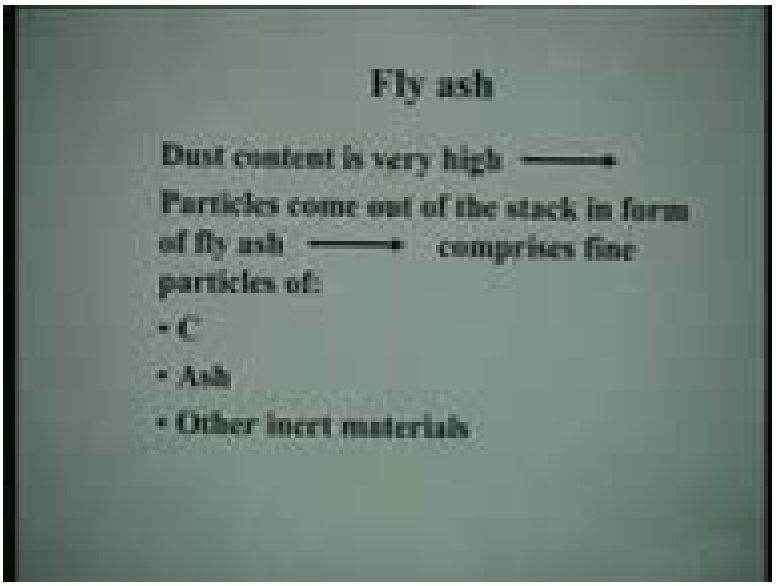

Fly ash, as I told you many mission projects are going on in India. What is mission project? Any project which has more than a crore funding and which has a mission, national mission is called a mission project. The funding is by DST department of science and technology. IIT Delhi has several such mission projects; one of them has the title of fly ash. This fly ash project is very important, very topical, very much concerned of today's population. What do you do with the fly ash? Which is this is definitely going to be I do not know whether you are aware our this head Avinash Chandra has left for US for 15 days. Is he teaching any course to you? No, he is just going to US to get training for 15 days to establish an ESP lab in energy center.

What is ESP? Electrostatic precipitator and that what does it do? It collects this fly ash. So, you will have good lab being developed, hopefully it will be developed before you people leave. Now dust content is very high, you go especially in semi arid zone Rajasthan, even in Delhi there was you know the black storm comes in summer time and there is a dust content goes up, visibility gets dropped during those storms. Particles come out of this stack, what is stack? Chimney. The taller the stack better it is, but taller means more money, maintenance is always a problem. How to reach there, how to clean it, the suit from inside, outside you know?

So, there is always a optimum height to which you can build your chimney, but higher the chimney better it is for locality living nearby because that machine will get dispersed

and it will be diversified, it will go on a long distance, it would not come down immediately. So, it will not affect the population living below so much as the smaller chimney would have affected. Now fly ash is nothing, but it comprises a fine particles of what, carbon, ash and other inert materials. what is inert? You must have heard the name in chemistry, inert gas. You know which has a no reaction with and it is bad in the sense you cannot remove it, if it does not react, if somebody does not talk how do I interact with him? If I want interact with you, you have to respond. If you remain like this whatever I may say then I have stop after some time.

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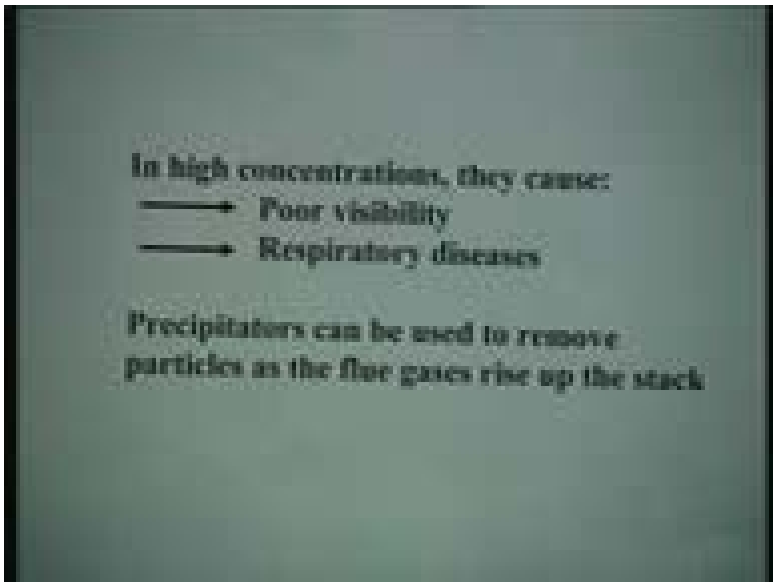

So, there are inert materials. Suppose such fly ash is in high concentrations, again it will reduce visibility. What poor visibility can cause? Accidents as it is there enough accidents and if visibility is poor, not only accidents it will delay your arrival at whatever place you are going, you will be delayed. You have to come out of your house sufficiently in advance. Suppose you are going to station you are going to airport you are likely to miss your flight, you are likely to miss your train, you are likely miss your interview, you are likely miss your class. Imagine an evening programme the students literally rush every day to reach here at 6:30 and sometimes they reach by 7, 6:45 and they lose class.

And then you do not get interested, once you have missed first 20 minutes you do not know what the teacher. As it is you people do not understand what teacher is talking and

if you miss them for 20 minutes, God only help them. Respiratory diseases very bad, I told you asthma 2 children out of 5 in Delhi are asthmatic. As any disease is bad for that matter, I will not agree that this disease is more worst than that this disease, no. Every disease has its own problems, it hampers your activities, your progress, your efficiency. Just a minor cold will put you a one hand busy all the time with your handkerchief or your tissue paper now days is a tissue culture.

So, you are always busy and your mind is pre occupied and you feel some things is bad today. So, you are not able to concentrate on whatever you do, just minor cold where people say if you take medicine it will get cured in a week, if you do not take medicine still it will get cured in a week. So, that disease harmless, diseases also creates problems. Precipitators can be used to remove particles as the flue gases raise up the stack. The main problem does not stop there, it starts. After collection what you have collected the ash and this is not one day job, its every day. Whenever you start your power plant you have to have ash.

And in olden days as I told you, they used to throw in the river, in pond and that river used to be spoiled were used to be you know as it is the rivers are dirty now everywhere. So, called sacred rivers are also become problematic because all these industries in the name of progress they leave their, you know, discharged there you know this harmful left over's into the river, that is the easiest thing to do. And this definitely spoils the quality of water, it is undrinkable, it is not useable even for taking bath, forget about taking into body. You cannot wash your clothes also, because if there is acid the clothes will get torn.

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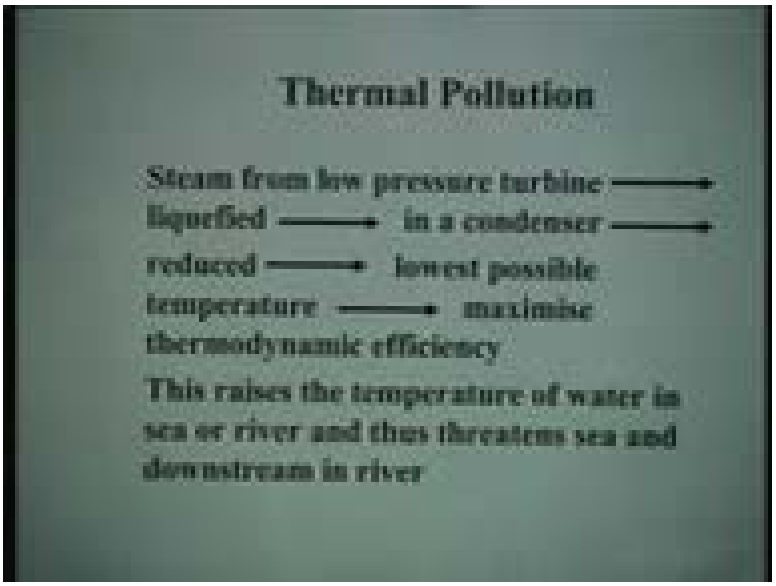

What is thermal pollution, any idea? Steam from low pressure turbine, you know there is a high pressure turbine and there is a low pressure turbine, there is a re heater. A time will come when you will say enough is enough, you would not again reheat, you would not again pass it through still lower pressure turbine. You will say now we have done enough like an exam you prepare 12 o clock, 1 o clock a time will come if you forget about it let us sleep now and who will see.

So, here also after you have taken work out of that steam, you say now let it go then it passes through a condenser, this is what is written here and there it is getting reduced to lowest possible temperature. Why? Why do you want to cool it? Why do not you just let it pass to the boiler again, why not to heat it because it has to further heated back to proper temperature and pressure. So, why cool and then heat?

Yeah.

(( ))

Right, wonderful, that is not one possibility that is the only answer. 1 minus T 2 by T 1. So, greater the difference between them better the efficiency that is the whole idea of having a condenser otherwise there was no need of condenser.

But when you pass it to this and when this is the outlet of condenser goes to a river you are spoiling the marine life of that whatever is there life is there in that river, there are

fishes, there are other things and they are not used to that temperature. They are used to a some given ambient temperature in the river. Now you are trying to interfere with the nature by externally putting a warmer, warm, hot water that too of bad quality. It is not Bisleri water that we are going to put into the river, it is a in already treated water.

So, in order to maximize the thermodynamic efficiency as much as possible may be to 40 percent that is a maximum we can have, we have to do this, but this raises the temperature of water. Anything you do in life there is a reaction and Newton's third law of motion still holds good, action and reaction equal and opposite. There is some reaction, reaction is a temperature water in the sea or river or pond goes up. This threatens sea and downstream water in the river and the marine life, the life of those who live in that sea or in that river or in that.

Even many people have their livelihood based on those fishes and if those fishes get becomes contaminated or sick someone is going to eat them and think what havoc you are causing and because there are persons whose main dish is fish or may be the Bengal, Kerala, coast people; anybody whose sea food is a very popular food overseas. Here we only talk of vegetarian, non vegetarian there is no another block. Any dinner or any social event you go there will be only vegetarian and non vegetarian. There is a sea food, there is Chinese food, there is a continental, there are all sorts of things, Mexican and so many varieties are there.

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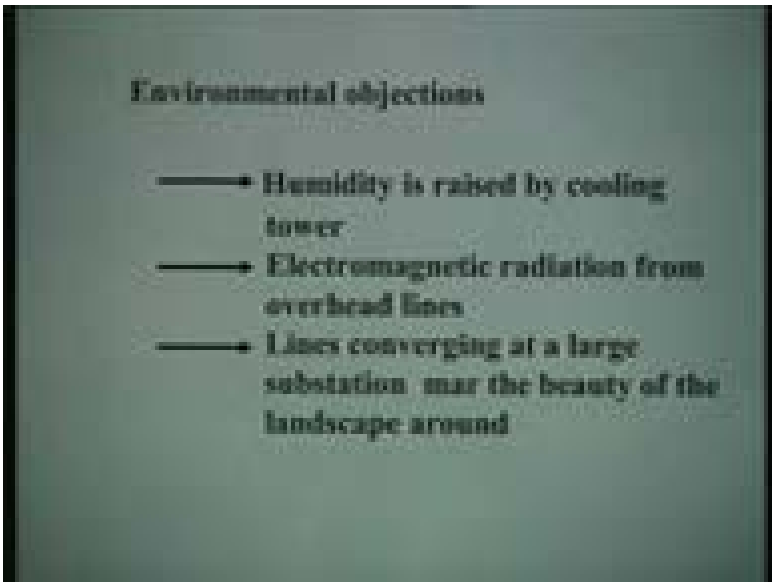

Now, those who take sea food, they will have a problem if they are living close to a thermal power plant. The story does not stop here, the missed fortunes never come alone as they say. You raise humidity also because those clothes you know cooling towers. the fountains or water coming in the air that will raise the humidity and humidity is not good. So you control humidity, what is AC and what is the difference between cooler and AC? Cooler is increasing humidity whereas AC is controlling humidity and now days they are claiming to be a hygiene air also coming out of AC. LG is having advertisement like that.

Now, do not think transmission lines which are looking harmless and which go for hundreds and thousands of kilometers. Kanyakumari to Srinagar and from Assam, Guwahati to may be Junagadh or Kutch whatever is furthest city in Pakistan on western border. There are thousands of kilometers of transmission lines, when current passes through them naturally they are live transmission lines. Electromagnetic radiation, you go to transformer I am sure you must have done experiments on transformer. There is a substation in IIT, I am not sure whether you have seen any substation in IIT. You should have visit there also, near bank, near hospital or subway whatever you are told that name and there are so many others. One is in block four side there is a entry or exist, the only entry or exist available now, block six, block four and its main blocks mechanical and electrical.

They make noise and this electromagnetic radiation coming out also spoils your health, even this mobile, though it is not true they say if you keep it on your this pocket your heart is affected, if you listen which the modern day youths goes on. I do not think even morning wash they cannot take without this. I am not sure while taking bath also they carry it with them, if it is water proof perhaps yes and that also has some, your TV. anything PC if you work for greater hours on personal computer and if you do not have these shield or security you know cover or whatever you call it even with that you cannot stop radiations that affect your eyes, It affects you by sitting posture, it may create back pain and above all you may become like me, me means obese, fat because you are not moving. You are hours and hours you are sitting, I am happy that in this class nobody is obese. So, otherwise obesity itself it is a disease. Lines converging at a large substation mar the beauty of the landscape around. These substations are not monuments where you to visit and you know see what is going on. It is an eye sore, it mar the natural beauty of

land, that is why there are under grounds substations, that is why there are underground you know parking, there are multi stored underground parking in US.

In fact, in US universities the hostels are connected to the institute by underground tunnels because there is any time snow fall is happening, it is raining or so to make it you know you immune to you. You can still come under your shorts and t shirts or whatever you want to wear and you can walk about a kilometer also, they are connected and you can straight go to your class rooms. Well the alternative is use underground cables. The New York city has no overhead line, it is all underground biggest underground cable network in the world, this question is asked normally in IAS and engineering services if you care to give that exam any electric with electrical this not with history or geography or psychology as a subject, which is a popular one.

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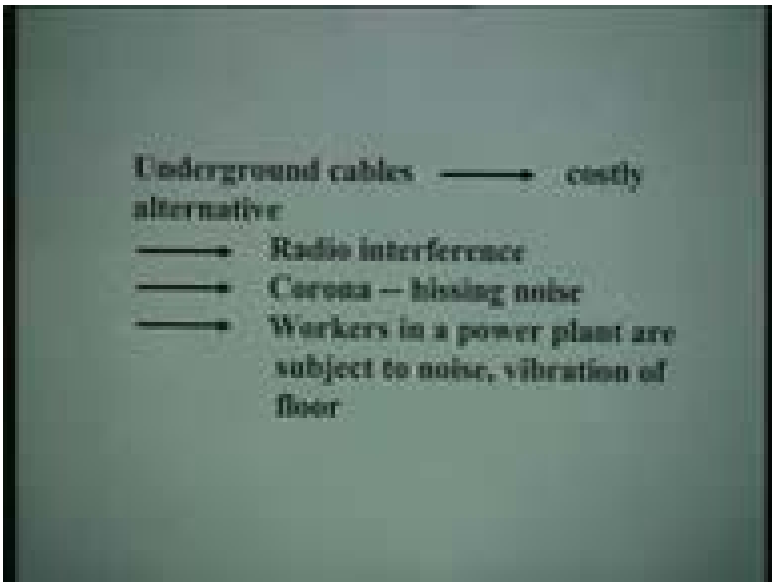

Then they will ask you which is the city, where is the most complicated involved cable network in the world? That is the New York, but where is the money, a poor country like India cannot afford underground cables. You also have a radio interference because of transmission line. Since it is pollution topic we are doing I thought let us cover in a comprehensive way radio interference or your telephone noise you must be hearing at times that is all due to several interference, radio interference, radio interference is one of them. Corona I do not know how many of you know Corona, you must have done in your undergraduate I am sure it using hissing noise it forms a glow visible, invisible you

know so, several types several verities. And it causes loss also, corona loss which is given by Peaks formula you must have solved some numerical based on that; though it is normally neglected especially in a fair weather condition.

If the weather is bad, if it is you know raining, there is a snow then it is it will form easily otherwise higher the voltage less is the chances of corona. That is one of the advantages you can say when somebody ask you why we should have a transmission at a higher voltage 800 k v, 765 k v, 400 k v one of the reason is the corona chance is becomes lower.

Workers in a power plant are subject to noise. Look at them versus look at those who are working in a corporate sector in air condition hall or rooms or chambers in a nice ambience, nice illumination compared to them versus those who work in field, those who work in power plants, imagine the noise. That is why I want to go to Badarpur to in the press, see so many things what are the service conditions there. Imagine those working in Satpura, there is nothing there, only jungle. Trains pass at the regular intervals at nearby railway line, nothing. You have to live there of course, they give you nominal field allowance or in accessible area allowance or difficult air allowance not allowance is ordinary thing.

And it can cause deafness or it can cause anything of course, definitely it is not a pleasant sort of ambience to work. Why people take jogging also with a walkman on. So, that they are in the world of music. So, the man is always trying to make the ambience as comfortable as possible. What is PSE power system engineering? This was one of the item in today's introductory in that sheet. You know what is coming in headlines and the news you get headlines similarly we introduce in the beginning and somebody tells you what we have covered.

Power system engineering or electric energy system engineering for you people because energy word should be brought in is a challenging task. In fact, you need a civil engineering, you need mechanical engineering, you need chemical engineering, you need physics, you need chemistry, may bio name a branch and it is required for energy. That is why perhaps there is no paper, forget for energy because everything is required.

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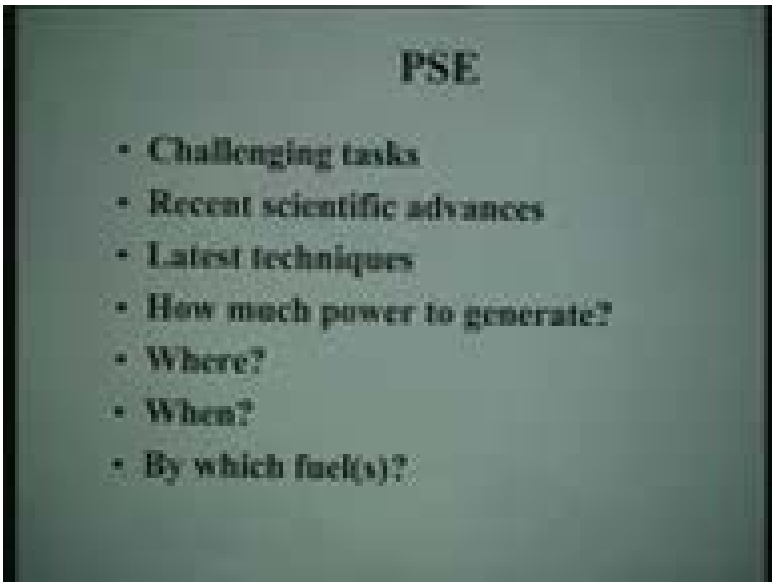

So, challenging task because all recent scientific advances you must be keep in track to improve the performance, you know your job should be always to see how you can improve the profits of the company in which you are serving, how you can in make consumers, your customers feel better by your actions, see that the gate proper quality power, proper voltage, proper frequency. So, that they do not have complaints, they do not want to switch as I told you there are various companies available. As you can change your toothpaste from Palmolive to Florence to Colgate to Neam to Babool or name a brand because there is a choice. Similarly, tomorrow you may like to change your electric company if the company is not good. Latest techniques, the smart control the intelligent control.

Now, you must have a course in intelligent techniques, if you do not take it outside the center, ann artificial neural network. You have. You already studied, but those who are not those you come from physics, chemistry would read more about them, genetically algorithm, evolutionary programming, (( )) logic, Nero (( )) you know all this techniques. Smart control, expert system, rule based, knowledge based and so on. If you are done it and then should apply it, when you do your major project otherwise there is no point in knowing them and studying them. You must try to apply in your major project then apply them in real life whatever you do. You will doing something after you graduate from here.

How much power to generate is a question an electrics system engineer has always to answer. Tomorrow, next day, next week, next month, next year, next movement, next hour depending on what you are trying to do, are you doing operation problem or planning problem or what. Where? Generate where? Is it a Bhadrapur, is it Indrapras are we going to take from WREB or north east, if they have excess, surplus or nearby country Pakistan, Nepal, Bangladesh if they have excess. It is a win-win situation they have a power which they do not need, we need power which we do not have.

So, it is a win-win situation. When? When you want to generate? Today, 3 pm, 6 pm, 12 midnight when, all this questions have to be answered by you for people and answered the adequately, optimally, economically, reliably etcetera etcetera with minimum pollution. By which fuels, what combination of fuels you want as I told you tomorrow bus may be available with diesel, with petrol, with CNG, with hydrogen, multiple fuel, multiple options and when which option should be exercised like you study four subjects.

Now, it is your genius which will tell you 8 to 9 which subject I should study, 9 to 10 which subject I should study, when you should start for preparing for first minor, the first day minor rather and when you should stop preparing for second day minor, third day minor how much you should prepare now, this every even in day today life you need to apply your knowledge or optimization, reliability etcetera etcetera knowingly, unknowingly, consciously, unconsciously you need it. You applied it also, you always feel which bus will take you early it should be 6:15 should be 6:20, again what is your objective function? If you have enough time you wants seat may be 6:20 every 5 minutes, 6:15 if you miss one next is only on after half an hour.

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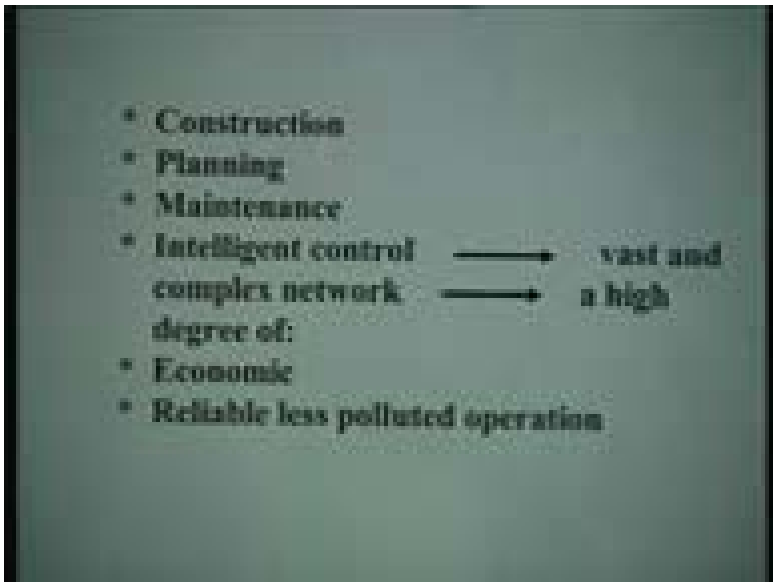

Construction; to construct power house is big job, construction of dam, the Tehri Garhwal still going on, the gujarat power plant still going on. It takes lot of time, needs lot of planning, you have to plan a lot, planning all the time, mid course correction. You know as time passes, maintenance if you do not maintain any beautiful fielding will get spoil any anything, if you do not study regularly you do not hope to get A grades. This maintenance here for you means study regularly, right from July to November or January to April not start studying only in March. We have already talk of intelligent control, this a vast and complex network. The electric network is very vast, it is spread throughout the country. Several hundred thousand miles of transmission lines, a thousand of substitutions, hundreds of power plants; imagine the man power working today in power industry, I do not know why people do not give first preference to electrical engineering and that to power systems. Look at BHEL how many people they employee, look at NTPC, look at power grid, look at NHPC, look at Damodar valley corporation, noted TATA electric companies, dairy and so on.

There are so many companies and what tremendous amount of man power is required with IT knowledge, with management knowledge that is why people prefer to do MBA now a days. If nothing else ignore MBA which can be done with minimum effort perhaps. You have to worry about economics, you have to worry about reliability and less pollute, this a multi objective function. Objective is not just one for example, here people they say come for PG education not forgetting M-tech, the simultaneously trying

for IAS simultaneously for IES, simultaneously trying for MBA, simultaneously going aboard anything wrong in it. After all you have 24 months to pass and if you have more than one objective, I do not think there is any problem unless until you fail in all then there is better to do one.

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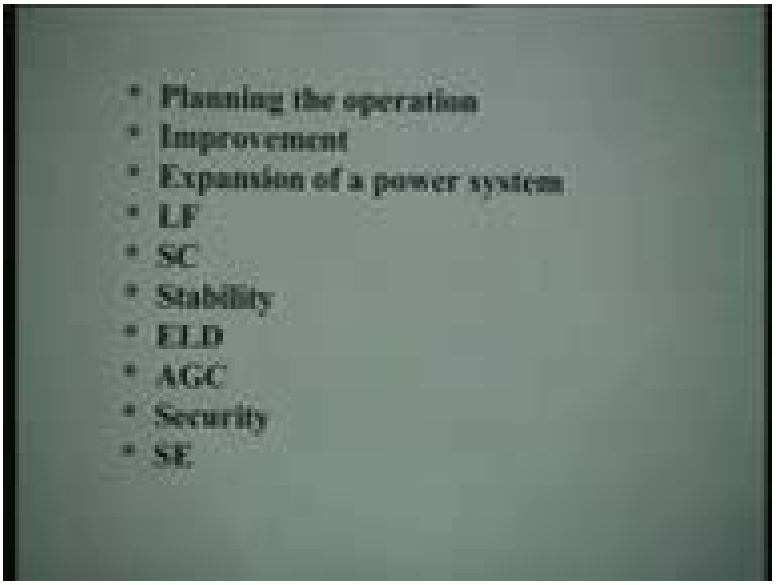

So, that you have to recognize your capability. Planning the operation, improving the operation and expansion all the time expansion, please remember 1000 mega watt to be added. If you do not expand, how do you generate more power, its old power plants are becoming old. They are going to generate less and less power with the your old car is going to give less and less mileage, it is not going to improve. Whatever you may send it to garage whatever you may do it you know maintenance, it can at best retain is performance. Ageing is natural thing, you would not become younger any day as the day is pass, but you can remain as young as you can depending, but maintenance that is.

But you would not become 8 year old, whatever means. What are the different studies that you have to continue to do round the clock in those load dispatch centers which I told you to visit. katawa I am sure you are not going to go anywhere whatever I am suggesting, but still this my job as a teacher to tell you, to guide you. Load flow studies, I am sure you must have done load flow studies in your undergraduate. Load flow studies is a bread and butter of a power system engineer or electric an instrument because it is tells you the pulse of the system. Whatever disease you may have when you go to doctor

what he or she does first, put your hand, may be you does not understand nothing still you have to do this to give a your confidence. Yes, doctor as started is our job you may not get pulse, where is pulse, still he will hold it and what is the problem.

In earlier days the they used to tell you the problem, now you have to tell them the problem. See the old doctors, old vydyas they used to tell you, I think you have taken Alvaa this morning please tell them and I have seen it my own eyes, in my own experience. Now they will ask you what you what are wrongs with you, what are the problems because they cannot find out and that they use the technology for that this x ray, this test, that test any way.

So, similarly you have do load flow which is bread butter of power system to know four men parameters of power systems. What are those four main parameters? The voltage, angle, real power and reactive power you need to know all this four guys all the time and there should be properly behaving all the time. If not, apply your controls real power control, reactive power control, voltage control, power factor angle control and bring them back to the required range, required zone. Short circuit studies, stability studies, ELD economic load dispatch, AGC automatic generation control, security, state estimation and so on there are so many. All these studies you have to continuously do all the time to understand the system, to control the system and it is called real time monitoring and control.

First you have monitor the system. What does doctor do? He will monitor, he will take your pulse rate, he will take your blood pressure, he will take your temperature if required, he will see your see your tongue, see your throat depending on what is wrong, ear or eyes or whatever and then he will control by writing medication or tests or x ray or MRI or whatever is required. I think with this we will stop today and now I will like you to ask me some questions on whatever we have done so far. If you have any questions even for your minor or anything, if you have any doubt, if not you always welcome to come to my this office or you can bring me take an appointment, 1705 is my number or at home it is 1958. I live near the main guest house, old campus and you are free to drop in any time, contact me any time for any problem, any issue.

Even now if you have anything you must yeah.

I have problem in load flow film?

Well, we have not done load flow studies in this course, but your most welcome to tell the problem.

I very understand what this control is required, but it I am just unable to understand my flat voltage profile is required.

Well, flat voltage profiles means 1 plus J 0 or 1 angle 0 that is an ideal thing, like your blood pressure should be 120, 80 right. Now, it is not exactly that you have to always maintain flat voltage, you can go within a narrow range of 0.95 per unit to 1.05 per unit. You should not cross 0.95 below or 1.05 above, but in India the real situation is it can go as low as 0.75 and we work with those sort of voltage, but the ideal thing is the flat voltage profile, that to 1 plus J 0. If not then best is within its zone. So, we try to do that you know, try to bring back by applying various techniques like fax, like SVS and SVC and. So, on which will study, we will do this load flow in detail in next semester in power system planning course 860.

Sir, this radiation for the transformer why they are. So, much making noise and what is the that is the.

Because of frequency and because of these you know the it goes friction magnetite magnetic read out machine board, if you want to know detail, even there is a book on transformers only written by BHEL engineers published by TATA Mcgraw hill the copies there in our center library, that will give you a whole chapter. Why there is an noise, when any you know instrument or equipment work based on electromagnetic.

Sir, rate also increasing.

Rate also increasing and it is harmful for human beings also, yes, anything else, if not then I thank you for today and wish you all the best for reminder.