Energy Resource and Technology
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Lecture - 36
Solar Distillation and Biomass Energy

Going to the next topic, let us quickly finish the remaining part of geothermal energy and we have seen yesterday that two types of sources one that emit dry steam or superheated steam and the type that emit saturated or a wet steam, these two we have already covered. There are a quite large number of other geothermal sources that either emits wet steam whose water proportion is quite large or it is simply hot water. In that case, what can you do? In that case, essentially the problem becomes similar to the problem that we encountered in OTEC, ocean thermal energy conversion, because there you, what you are getting is essentially hot water.

So, how did we tackle the problem in case of OTEC? We said, either we can have a flashing cycle or we can have a binary cycle. In case we are talking about the flashing cycle, it is easy to see that that is more efficient or effective, if you have relatively larger temperature, larger enthalpy in the fluid that is coming out. Why? Because, otherwise you will have to go to far lower pressure and if you go to far low pressure, then the size of the turbine becomes huge. So, in order to avoid that, for hot water cycles or where the source is saturated steam, but with relatively large water content, in those places it is better to have the binary cycle.

So, in case of the binary cycle, how it will look?

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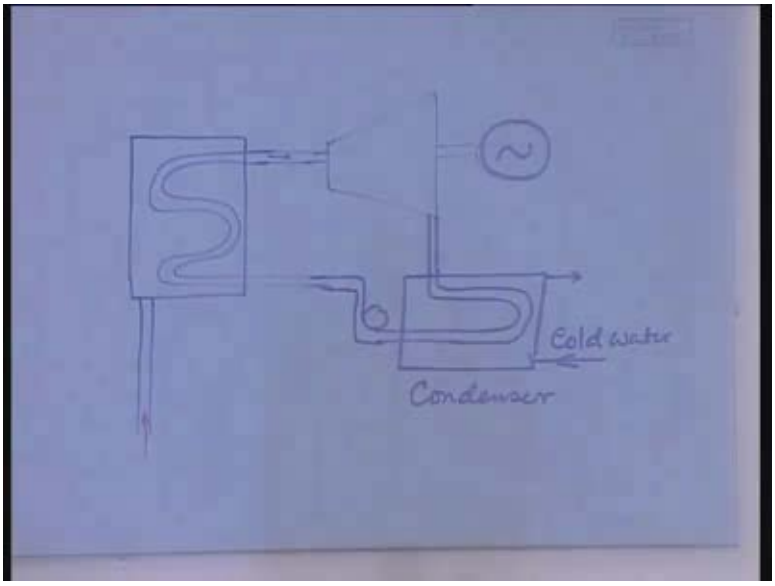

It will look as if you have a chamber which will act as the boiler in which your geothermal steam or hot water comes like this and then, you have the boiler for the binary fluid and in case of the OTEC cycle, we have learnt that earlier people used to consider freon as a suitable binary fluid, but nowadays with the problem of ozone hole, freon is no longer the favoured binary fluid. Now, most people are now considering either ammonia or some newer substance that does not have the ozone hole depletion characteristic.

So, after this it will go to a turbine. So, the direction is like this. It will go to a turbine that will run a generator and the turbine output goes to, it has to go to a condenser. So, the condenser will have something like this. I will draw schematically and it comes out and that has to be then pumped up to, so this will be the standard cycle. So, here is the turbine, turbine for the binary fluid and here is the condenser for the binary fluid and here you have to put in cold water and hot water comes out. So, this is essentially the cycle. So, in this case, the hot water comes up that gives the heat to the binary fluid and there is a binary fluid cycle and this, in the process of doing this, the hot water is relatively cooled down, but that water again has to be pushed back to the well. So, the cycle goes like that. There are quite many places where this binary cycle is actually installed.

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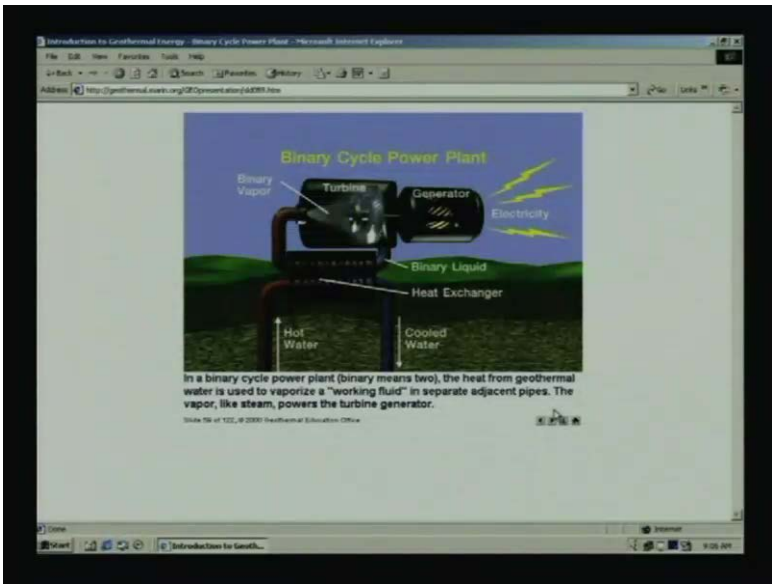

For example, if you go to the, this is again a very schematic way of drawing it, where the hot water is coming, it is giving the heat to a heat exchanger and the cold water is being pushed back to the well and the binary fluid is going through the cycle. But, this is, the one that I drew on the paper is the better way of representing it.

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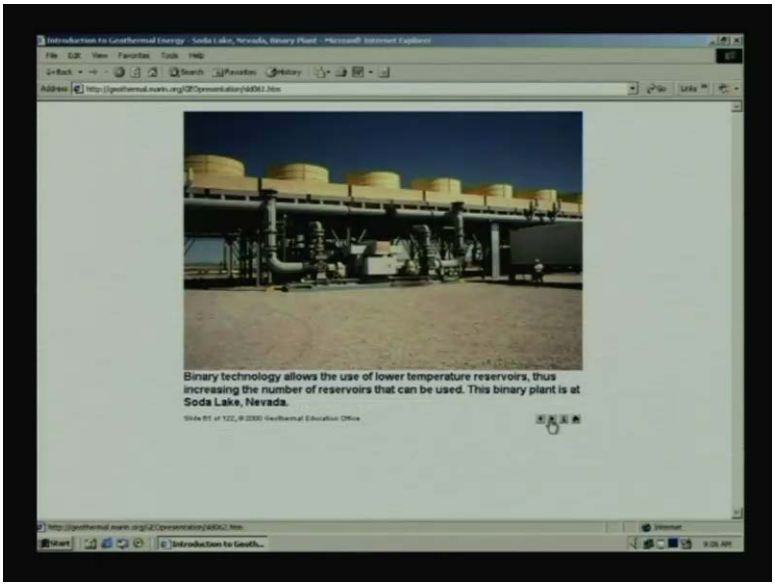

Here is a binary fluid cycle in the Soda Lake in Nevada in United States.

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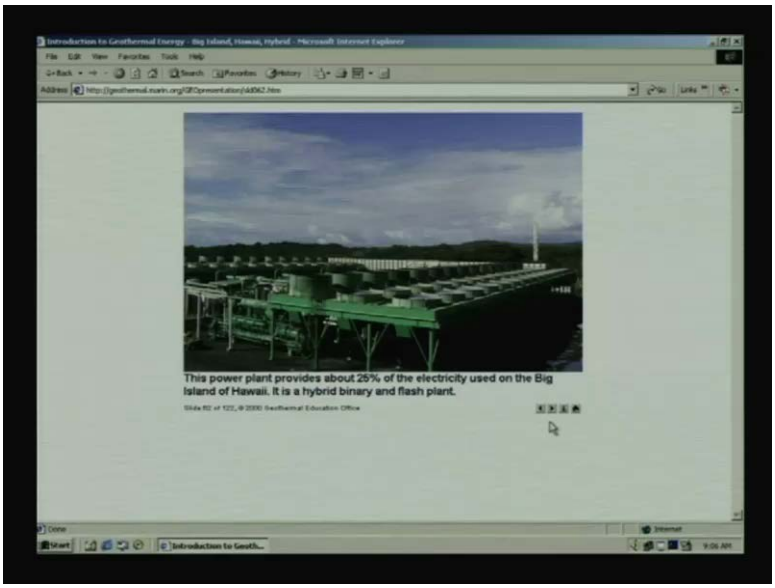

Here is one that is in the island of Hawaii. What are these exactly, these things?

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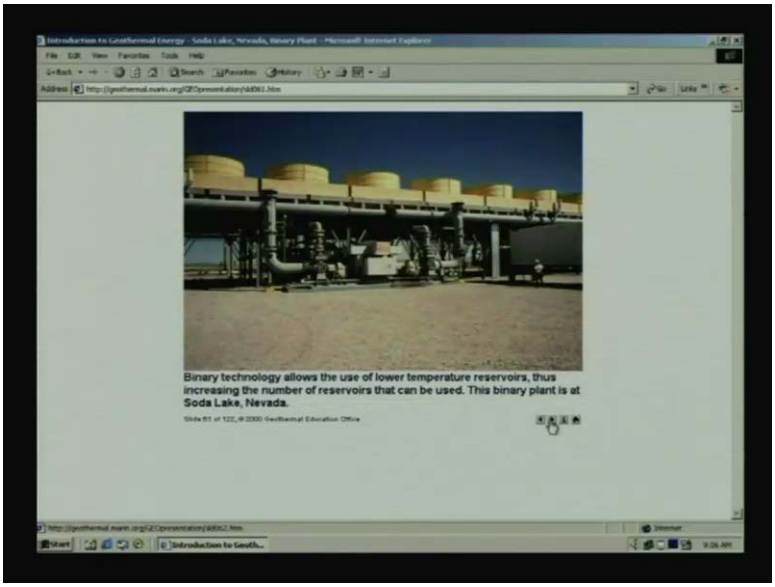

Or in this case what are these things? ……. So, you have to have the relatively large condensers, because of the relatively lower temperature there.

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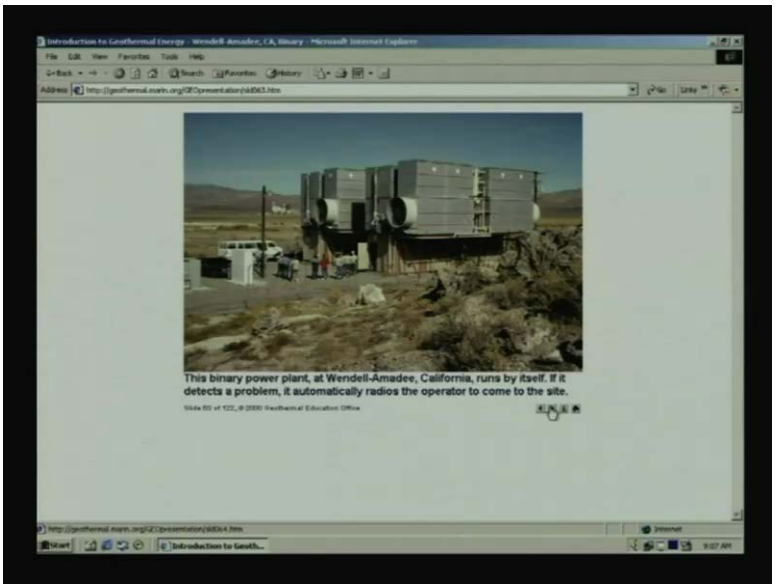

This is a very small, relatively small size plant in California which is designed to run by itself. That means there is no, no operator here. Only when there is some problem the system detects the problem and then it radios to the operator who comes and repairs the problem. So, you have a standalone geothermal system in California.

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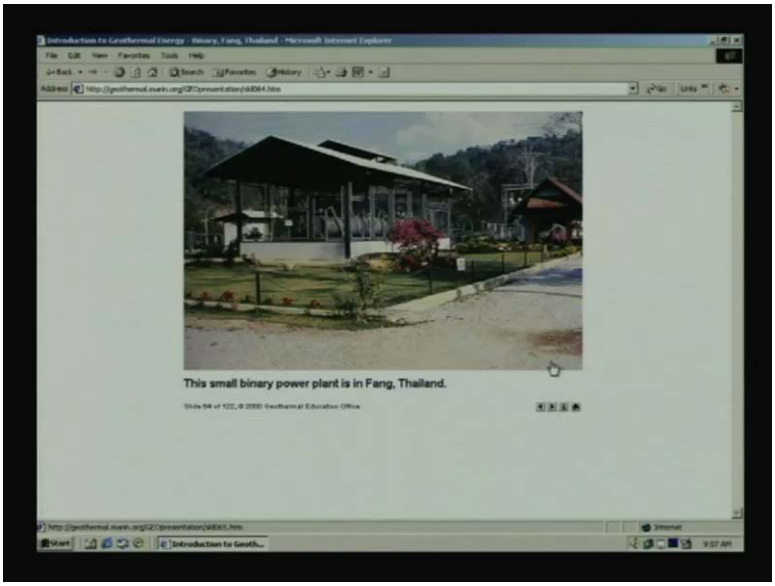

This is a very small plant in Thailand. You can see the size is of that of a shed only. So, you can have, depending on the location, depending on the availability of the fluid you can have various sizes of the plants. Let us, let us stop the geothermal energy part here. Is that understood?

So, in a nutshell what you have is there can be, the take home message is there can be three types of fluids that can come out; the superheated steam, the saturated steam or the hot water. You never use the actual surface manifestations that naturally occur. We always use, always do some geothermal prospecting to find the actual hotspot. We sink wells there, two wells, one for drawing the hot water, another for pushing in the cold water. So, there is a complete cycle established and that is how we do it.

In case of India, India has a reasonable, not, I should not say as large as the sites in Philippines or Italy or New Zealand or United States, but it has a reasonable prospect of harnessing geothermal energy, provided we can accurately locate the hotspots. As yet it has not been exploited to a large scale, because we have not yet been able to locate the actual hotspots. We have only sunk some wells and thereby reached temperatures like 100 degrees and we have running power plants, small size power plants from that water. So, there are a few topics in energy that are still to be covered. So, I will try to complete that within the next week two classes, today and the next class.

Student: ….

Oh, I ……, yes, what? What is the problem?

Student: ….

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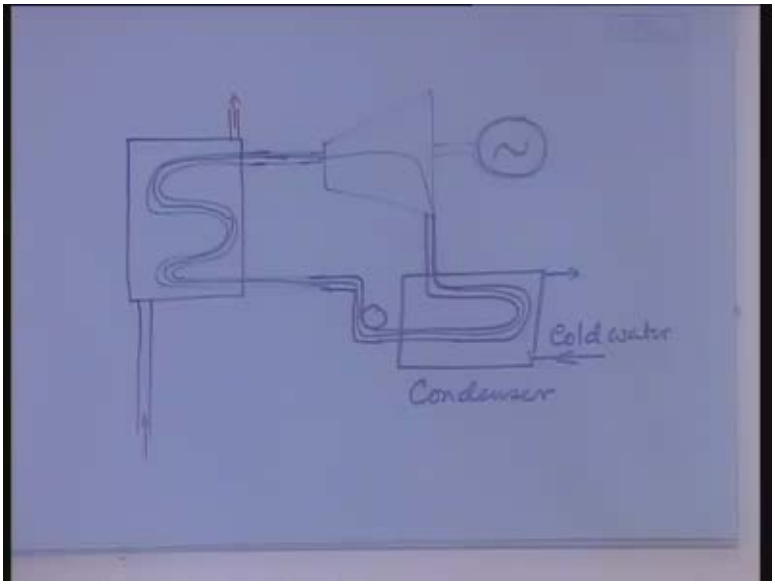

Yes, this is the place where the other fluid is flowing. I am drawing with green; this is the other fluid, so here it goes. This is the part through which the, binary fluid means two fluids; the primary fluid is the water that actually does the heating, but the secondary fluid is either ammonia or some substances like that. This cycle is essentially the same as what we covered under the ocean thermal energy conversion, OTEC. That is why I did not go into the details of it. These are already been covered under the other and you remember the same cycle is useful wherever there is any waste heat in the industrial processes. Any industrial process if it has waste heat, then the same cycle can be used to generate some amount of power out of it.

In the idea of use of solar energy, there is one other concept; probably I did not cover it, solar distillation, did I cover? No?

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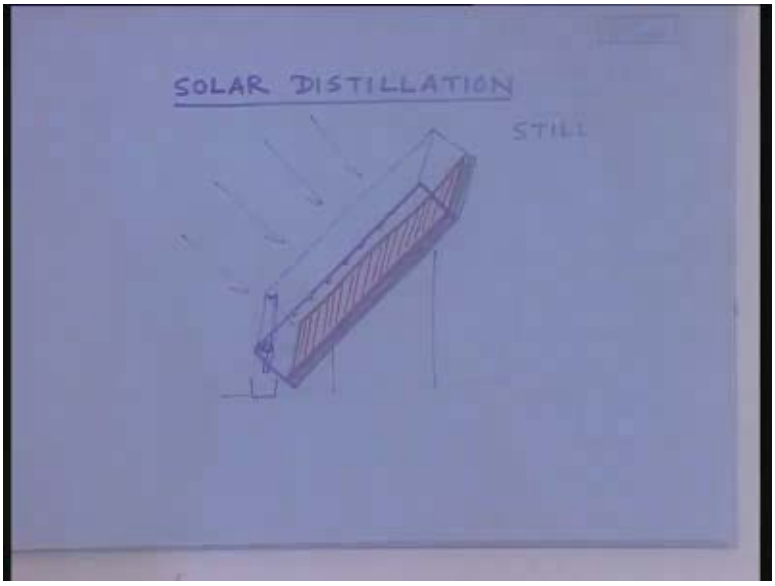

So, it is another form of harnessing solar energy, solar thermal energy and we have already seen the idea of the flat plate collector, we have already seen the idea of the concentrating collector, but solar steel is a modification of that. True, you can use the heat that is collected in a flat plate collector or a concentrating collector to run a distillation plant. So, in that case, the idea would be that you have a separate solar collector collecting the heat and that heat is used somewhere else to do the distillation and the distillation is a very large scale industrial process. Many industries need distillation, so the idea is that why not integrate the two. The place where the solar energy is collected would be the same place where the distillation takes place. How can that be? The idea is rather simple.

Suppose you have something similar to the solar flat plate collector which means this is the direction in which it is tilted. The top surface is glass and the bottom surface is an insulation, here there will be some insulation material and there would be one surface on which the actual collection is done that is the metal surface. Imagine, the standard structure of a flat plate collector, it is like this. In addition, in the flat plate collector you have the water tubes that go along this collecting the heat, rising up thereby and then it is, generally goes out and there is a process that is established which stores heat in a tank.

That is a standard thing in the solar collector, solar flat plate collector. So, we are talking about the …, the solar incident, solar radiation coming like this. So, you have a stand like this, something like this.

Now, imagine that instead of this surface being a normal metal surface, supposing this surface is a wet cloth here, so some kind of a wetting material, something that wets and that collects the solar energy, what will happen? Because it wets, it contains water and the water because it is absorbing the solar energy will evaporate. As it evaporates, what will happen to it? Here there was a glass which is allowing the heat through. Thereby the glass is not heated. This surface is heated which is taking part in the evaporation process, as a result of which the steam that is coming out will see only one relatively cooler surface available that is the glass, as a result of which it will condense on the glass.

So, small droplets will form on the glass and the since the glass, the whole thing is tilted, the droplets will flow down the glass surface and then if you have a small collector here, a pot like thing, not just a pot because it is actually extended like this if you draw it 3-D, so you will need to have a, you know, a half cylinder to collect the material and then you can have simply a tap, tap here to take it out. If you put a slight inclination here, then it will normally flow down the tap. As the water is collected, you can simply open the tap. It will collect in a pot or something, clear; simple structure. Essentially, the same structure as a flat plate collector.

Only thing is that in this bottom surface you have, in this bottom surface, the one that I am drawing with red, here you have something else. This is the insulation. Here, you have the absorber which is in the case of the normal flat plate collector simply a copper plate. In this case you have something that can be wetted, mostly wet cloth may be. So, as the water evaporates, there has to be some way of replenishing the water. So, there has to be some reservoir water here which continuously puts in some amount of water to the wet cloth. That is the essential idea. So, the same thing works as the collector as well as the distillation plant. Such things are often in short called solar still. Solar distillation plants

are also called solar still. If you come across this word, you will know that this is nothing but a distillation plant, all right.

Now, here we can see that there is one problem that you need to have some way of continuously replenishing the water so that the upper part does not dry up and water will have a natural tendency to flow down. So, before it flows down and reaches this part, it has to evaporate and if it does reach this part, then there will, water will accumulate here which will be somewhat inefficient. So, all these problems may be there. But, the advantage is that you can tilt the whole thing to face the solar energy, so that the yield may be high if you can make these things work. That means the rate at which the water is coming up should be equal to the rate at which it is evaporated. That means this has to be adjusted, because all the time the solar radiation changes.

There is a variant of this, which takes care of this problem which is in fact more popular as a standalone system.

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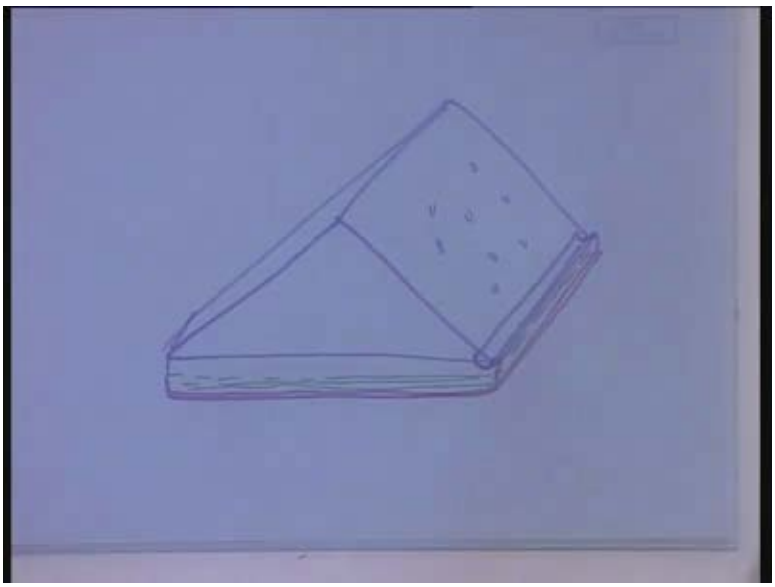

Here you have the collector horizontally, so that you have a collector system whose base would be something like this and you have the glass cover. The glass cover must be there

in order to act as both; the green house agent that means it has to allow the solar radiation in, but not the solar, the heat out. Glass is one substance, so glass has to be there and secondly glass is a substance on which the water collects. So, glass has to be provided, normally it is provided like this. That means if you want to look at it in 3-D, it will be something like this. It will be a structure something like this, you see.

Now, this is the, these two are the glass plates. This is one, this is another. This can be glass, but this can also be something else because this is not the direction from which the sun is coming. These are the directions from which the sun is coming and here you have, at the bottom now you can have a simple copper plate blackened in order to absorb it and water can be simply here flooding the floor. That means water can be here all over the floor which means that you do not need to do any adjustment or anything like that, you simply pour water there in the morning and as the day advances, the heat is collected and water is evaporated and that water will be collecting on the glass surface and it will also flow down like this.

It will flow down and naturally there has to be some way to collect which is done like this. You have to have a collecting mechanism here and there. It is just a half cylinder that collects it and which is inclined a bit in one direction, may be in this direction, so that it normally flows down in this direction and then you have to have simply a tap to take the water out. The advantage of this is that you do not need to have any finer adjustment. All you need to do is to put some water. You have a more or less a rough estimate of how much water evaporate within a day. So, that much water you simply put in and that is it, leave it. At the end of that day, you find water that has been distilled and accumulated in a bottle, very simple process really. What is there in this side? What should be there?

In case of the flat plate collector, the lower part, the bottom part has insulation. In this case, how do you do the insulation or in other words, do you need to do the insulation? If you do not have any insulation, simple, simply this is on the ground. This is a cement structure may be, no insulation. What will happen? During the day time, the heat will go in, all right, because heat will be conducted towards the ground. But, during the night

time the same heat will come out, as a result of which the heat is not lost really. Heat that is going in will come out during the night and that will take part in the evaporation. That also continues during the night.

So, you can have a relatively longer period of evaporation. So, it is not necessary to spend money in this kind of design on putting a proper insulation. If you do not have any insulation, then also it works as good.

Student: …

Because the dews are forming on the glasses, the glasses will not look exactly transparent; will not look exactly transparent in the sense of image formation. What is the problem if there are water droplets on your glass? Your image looks distorted. But other than that, what property do you expect out of this glass? Is it image formation? No. What do you expect? We expect only the green house property, nothing more. That is it should allow the solar radiation to come in. Does that stop because of the water droplets? No. The heat that is radiated, heat energy that is radiated from here will be stopped. Does that get jeopardized because of the water droplets? No. So, it really does not hamper. It only does not form the proper image. The glass will look as if it is a bit, it is non-image forming that is all, nothing more. Is that clear? So, that is how it works really.

You might argue that then the yield will be higher if you put say a fan here and blow it, because it will be, it will cool the glass surface further. No; a natural, natural line of thought, you put a fan and then cool the glass surface. No, it does not work. The reason is that you might, you might imagine the whole thing as an electrical circuit, some energy coming in like a battery and there are resistances. Why? Because the thing is going up and the heat that is absorbed is again, you know, fluid is evaporated and that reaches that. In between, the fluid experiences some resistance. So, there is a temperature here, there is a temperature here. The temperatures can be imagined as similar to voltages.

So, if you bring down this voltage, there is a finite resistance in between. So, it will result in the reduction of this voltage also that means this temperature also. So, it does not really increase the yield, so simply leave it. As it is, it works and in remote locations or places which are close to the sea, where you need water all the time, drinkable water or water for other purposes, this can be used. In remote locations, in villages, where you need distilled water for the purpose of the medication, where it is difficult to get the industrial distilled water, you can have local plant like this. So, it produces sufficiently. I have used such systems. I have seen that these things produce sufficiently to cater to even villages. So, this is the concept of the solar still.

As you have seen, there are two essential designs.

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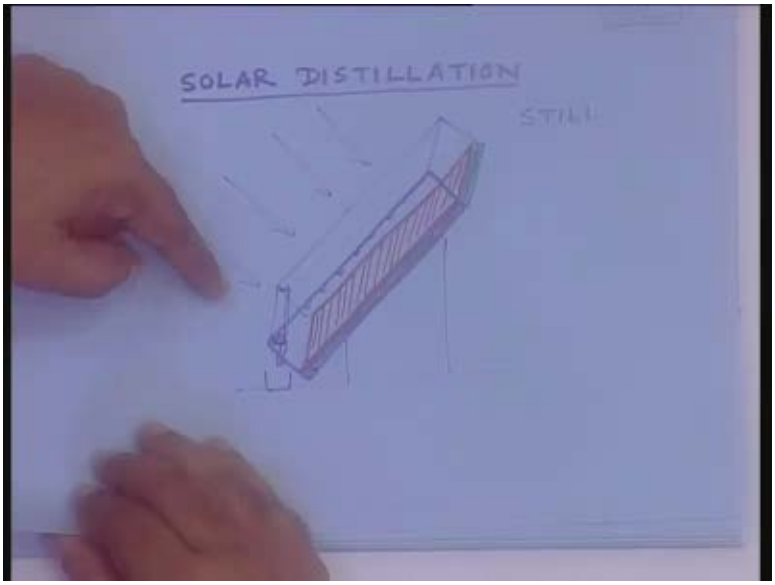

One, like the flat plate, which will have the advantage of, what is the advantage of this? That it can always face the sun which the horizontal design cannot, right. But, the disadvantage is that here you have to have some way of keeping the surface wet all the time, which may not be trivial and here you have the problem of keeping it wet is trivial, you simply have to pour, but it does not face the sun all the time. Obviously, that is the concept of the solar distillation, solar still.

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There is another type of energy source that I need to cover. That is the … Biomass is any kind of mass that is created in the biological process. Straw, bagasse, cow dung, all these are biomass and the essential idea is that it is a different form of solar energy, because solar energy is absorbed by the plants. Plants then increase in size. The increase in size is essentially owing to the absorption of the solar energy. So, you can cover a very large area simply by plants which grow in size, because they absorb solar energy and that energy you can use to generate energy for industrial use or for human purpose.

So, then the idea would be that you have a large area covered by plants that grow relatively fast. Forestry where the plants grow relatively fast, there are plants like that. For example, in India subabul is used for this purpose. There are other plants. Eucalyptus is now used, but eucalyptus has some problems that it does not allow other plants to grow in the vicinity, but nevertheless there are plants that have the property of growing very fast, absorbing the solar energy very efficiently. There are also plants that are considered to be pests. For example, water hyacinth. In water, the water hyacinth grows like, profusely, uncontrollably, but that can be used as an ideal absorber of the solar energy, right. It is still absorbing solar energy and that is how it is growing. So, the water hyacinth has another interesting property that it grows in water and it has the property of

absorbing all the toxic substances in the water. So, it can also be used as agents that can detoxify the industrial effluents.

In any case, the essential point is that we have to have some agent that can absorb solar energy and can bind it and the plants are the ideal things for that purpose. So, once you have the biomass collected that means if you are growing trees it is not necessary all the time to cut the trees. You can simply cut off the branches, leaves, collect the leaves that fall, there are hundreds of ways of collecting the solar energy that has been, accumulating the solar energy that has been collected and then that mass can be used in various processes in order to generate energy.

One simple idea is to, can you tell me how would you like to generate energy out of it? To burn it, as simple as that, burn it. As you burn it, then, have you ever burnt wood? Everybody has, right. Is it a pleasant process? No, it is a very dirty process, because smokes and other things go up. Why? Because, the wood normally contains a lot of volatiles; lot of volatiles are there. When you heat it, they go up and then finally what is left is carbon and naturally that carbon comes out at a later stage. First thing the volatiles go up and that is what produces the smoke.

So, one way of handling this problem would be first to allow the volatiles to be evaporated, to collect them, to use them separately for some purpose and then use the charcoal that remains as the fuel. That is possible. You can also have systems where the biomass, for example straw or bagasse, bagasse do you understand what it is? In the factories that produce sugar from the sugarcane, their byproduct would be the, that is called bagasse. That is called bagasse, the byproduct is called bagasse. So, that is an energy rich substance. It does not have the sugar anymore, but it has a lot of cellulose. So, essentially we are trying to use cellulose.

Now, so the bagasse can be used as one of the biomass materials; that can be used. Straw, huge amount of straw is produced, because of the agriculture. Now, how to efficiently use the whole thing? Say, we are considering straw, straw and material like that or material

like the body of the water hyacinth. Body of the water hyacinth contains a lot of water. So, they can be simply pressed, water goes out and then that material can be used as the available biomass. Now, they, if you simply burn them, as you have seen a lot of unwieldy things come out. So, that also results in some amount of pollution.

Instead, if they can be degraded, biodegraded, by means of the bacterial action, if you say leave some amount of straw on the ground, what will happen after sometime? After sometime what will happen? They will rot. They will rot and after sometime you will find there is no straw, because it has been mixed with the ground. What is that process? The process of where bacterial action broke the bonds of the cellulose and ultimately that became, cellulose is what? It is a polymer, right. It is a polymer of smaller molecules. So, those molecules were disengaged and thereby the whole thing was simply, whole thing rotted and mixed with the ground.

When that happens, it increases the fertility a lot. That means that increases the, that makes the nutrients go into the soil. That is how normally the forests are nutriated. The water collects at the bottom, they rot and that rotten material goes into the ground. So, if you can hasten that process that means by means of, there are now biotechnological processes available by which you can hasten the process. For example, if you now go to the step within the IIT campus, there is a plant that converts straw into manure. How does it do it?

They simply have one process in which, it is in the first stage biodegraded for some time and then it is mixed with worms that is called vermiculture and then that is left for some time, about a month or so and the whole thing is then rotten. The point is that through that process, again imagine you are considering cow dung. You can burn cow dung. You can dry the cow dung and burn it. That has been used for millennia in India. Obviously, that is a, that is a very inefficient process. Have you ever seen people burning? Lot of smoke come out, right.

A more efficient process would be to convert it into a, what should I say? The process by which you produce methane and the thing that remains is more easily used by plants, so that kind of process, which is called the biogas plants, that would be a more natural way of using it, more technically sound way of using it. Why? Because, you have produced a clean fuel, methane. So, when I talk about the biomass, all the biomass that are collected, they can be used in this form. For example, if you have collected large amount of water hyacinth, either you can have some bio digester that produces methane from the water hyacinth or you can simply have a cattle farm. They eat it, they produce a lot of cow dung and that cow dung can be used for the biogas plant.

So, essentially, ultimately we would not like to use the biomass in a very ugly way, polluting way. Rather you would like to use it in an environmentally benign way and the most environmentally benign way is to first use it in the animal process, produce relatively more degraded material, because all through this process you are essentially breaking the bonds. If you have the cellulose substance then it has a lot of bonds. If you degrade it by means of bacterial action the bonds are broken. If you feed it to some cow, in the gut you have, they have bacteria, it breaks the bonds. So, ultimately you have the relatively benign substance. So, there have been a few designs of the bio digesters which produce methane and that methane can be used for our purpose.

If you do not do that what happens? If you do not do that, say the cow dung is on the ground. The cow roams around and puts the cow dung on the, on the ground and that remains there. What happens? Things that we do not notice; what happens? After all the process that I am talking about will happen, slowly. The cow dung will rot and what is the process? What is the, what is the product of the rotting process? Methane and the methane will go into the atmosphere. What is the property of the methane? It is a greenhouse gas; it is a greenhouse gas. So, the point is that we have huge number of cows, huge, right and that huge number of cows are producing huge amount of cow dung and that huge amount of cow dung is contributing into a huge amount of greenhouse gas.

So, the natural way of using it is to do it in an organized way, to produce the methane, but then use it to run engines. Methane can be used to run engines. The whole of Delhi runs on methane. Do you understand? Do you know that? On natural gas, yeah, compressed natural gas, nothing but methane. So, you can then produce very large amounts of methane simply by using the biomass degradation process. There are a few designs of bio digesters now available, some you can see within IIT. For example, if you go to the Agricultural Engineering Department, there is one. If you go to the CEC guest house, near the CEC guest house within that campus there is one. No, it is not that cows reside there. It is not that there are cows there; that can also use human waste.

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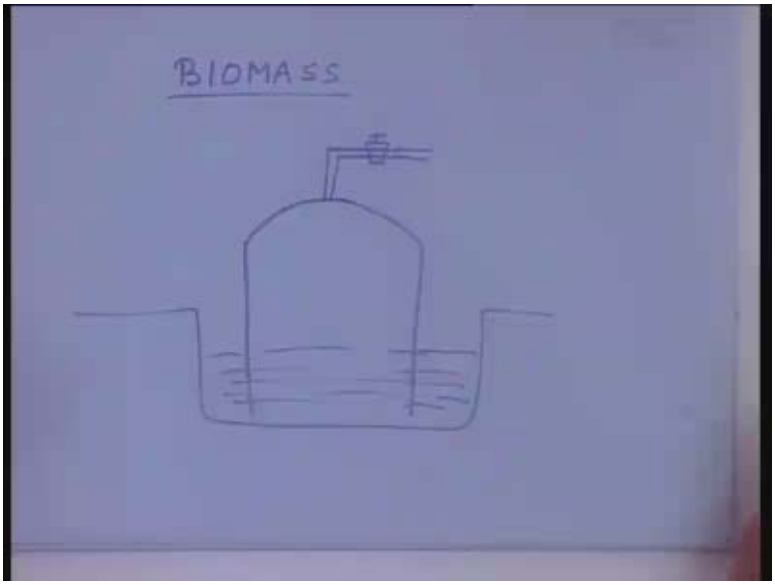

So, you have a cylindrical dome like structure made of iron and you have the ground something like this. This gap is actually very small, but this gap is necessary in order to put in the cow dung mixed with water. So, the cow dung is put, which is, which accumulates here in this part and you have this iron material that is upside down and normally it would sink to the bottom like this and as the cow dung that is normally mixed with some bacteria that means some bacteria has to be put into it and as the methane is formed what will happen?

It will push the cylinder up; it will push the cylinder up. So, the cylinder slowly goes up and because of the weight of the cylinder, the pressure inside is high. So, it is, it will be somewhat pressurized natural gas, pressurized methane. So, if you have an outlet here, with a stop cock if you keep it stopped, then the pressure will keep on increasing and if you open it, then that steam will normally flow, because there is a relatively higher pressure inside. So, this is simple construction of a biogas plant, which you see in many places. In some places you do not have this relatively movable thing. It is just one solid cement construction, but that is also possible where the gas accumulates and as the gas builds pressure that can be taken out. So, this is the essential design.

In case of the water hyacinth, in many countries they have water hyacinth farms. Where there is a large amount of solid waste or liquid waste from cities, but what you do normally with city waste? The sewage, what do you do with it? That contains a lot of nutrients, huge amount nutrients, what do people do with it? They normally release it into the river and you notice that the Ganga is so polluted, because all the towns and cities along the Ganga, they all release their sewage into the, into the Ganga and in fact, one of the purpose of the Ganga action plan was not to release the sewage into the river.

What do you do with it? In fact what can very efficiently be done is to collect it in a large pond in which you simply allow water hyacinth to grow. So, as the water hyacinth grows, it absorbs the nutrients, it absorbs solar energy, so that you have very concentrated amount of energy available in the form of the water hyacinth. That can be fed to livestock and their output can be used to produce methane. So, it is a complete integrated process and that is also true for much of the solid waste that is produced in the cities, in markets. Just go to the IIT market any day, you will find a huge amount of solid waste produced. The waste from the, from the fish market, from the, you know, vegetable market, huge amount; all this can be used in order to produce such biomass. They can be digested, they can be made to produce methane or they can be fed to livestock and their output can be used to produce methane. Is that point clear?

The amount of, earlier the creation of social forestry was not really considered. It has now become a possibility, where instead of cultivating anything else, there are places where cultivation of the normal agricultural products like paddy or wheat is not very good, there are places which are relatively infertile, in those places the larger trees can grow. So, the use of that kind of land to cultivate trees that are normally in a conventional sense unproductive, but which grow very fast and thereby you can use the biomass content of it, that can be used as a substitute. Their products can be used to produce paper as well as the leaf, leafy materials or the smaller tweeds can be used to produce energy. That is another source of energy.

Providing nutrients to those things is another issue and it has been found that if you simply take the city waste or the market waste and put it on the ground for some depth, simply put it on the ground, what happens? Due to the bacterial action they degrade and the results of the degradation seep through the ground, thereby increasing the fertility. Large amounts of land in the West Midnapore district, Purulia district and Bankura district, that were completely infertile earlier, only one crop used to grow that too very badly and nowadays many of these areas have been converted to very, very fertile land just by this process. You only have to allow it the time for the humus to grow in the soil and for that there are now technologies available.

For example, our rural development center, RDC here, has done this experiment on many tracks of land in the nearby areas. If you simply take a bicycle and go towards Salva, you will find huge tracks of completely infertile land. Have you seen that? Have you ever taken the bicycle and ventured that way? You will find large tracks of completely infertile lands and they can be turned fertile just by, by this method, by using the normal city waste. So, biomass is actually very large source of energy that can be harnessed in India, especially because India is a very large area, very large area, much of which is not really used, not really used in a productive way. The places which are used in a productive way where you have the solar energy collected, do you understand what I mean by this, where this solar energy is collected?

Not that solar thermal collector or solar still that are, yes, the places which are, yes, but let me accurately state my, put my statement, where the solar energy does not strike the barren ground, where it strikes a leaf, every place where it strikes the leaf is productive. Do you understand that? Forests are productive in the sense, any even the weeds where they grow they are also productive in that sense. Any place where the solar energy is not directly striking the ground thereby heating it up and making it completely useless, every place, every kind of plant is then productive. Why? Because, they are converting the solar energy into something that is usable.

So, the huge landmass that we have, a proper strategy of increasing the total yield of the country is simply to cover it as much as possible by some kind of vegetation, which unfortunately, this awareness unfortunately is not there in India, as a result of which, I do not know which part of the country you all come from, actually it is a fact that much of the countries landscape is uncovered. Forests are very small area, very small. It is normally estimated that in order to keep the environmental balance and to keep the weather cycle fixed, you need to have about 33% coverage. India has less than 15%, but even that is the forest cover.

Just imagine the area around Kharagpur. You will find that most of the places, sunlight is directly striking the ground. Not only the sunlight, if there is no vegetation cover, the rain also strikes the ground directly. If it is falling on the leaves and then dropping on to the ground, then it does not have the kinetic energy, but if it is directly striking the ground, it has a large amount of kinetic energy, as a result of which it unbinds the soil and makes it flow, as a result of which huge amount of silt is carried off from the fertile ground into the rivers. The rivers clog and the fertile grounds lose their soil cover. So, this is an effect that is very much there in India. That is again because we do not have the awareness to cover as much as possible with some kind of vegetation. Even weeds, no problem; has to be covered by some kind of vegetation.

The moment you cover, all that vegetation is biomass; whatever kind and that biomass can be collected and a very large amount of energy can be generated out of it. We only

have recently installed some energy converter out of the solid waste in the cities. For example, three or four cities in India, I should say towns, have installed such converters, even one is in progress in Calcutta. So, there is a, there are plants that produce energy, electrical energy out of solid waste that are produced in the cities, but then that has also not done to a large extent, because people talk about how economical it is. After all it is the question of using the material. So, it is actually beneficial for the society. So, the society should actually pay for it, but that awareness is not there.

So, the point is India has the major advantage that, much of the world does not have. It has a large area. Most of the area is coverable, it is not dessert. Dessert areas cannot be covered, but the other areas can be covered. But unfortunately, that awareness is not there. When you become somebody, I will expect you to work towards producing this awareness. Any kind of vegetation that allows the vegetation to absorb the sunlight is a resource. That awareness you should create. That is all for today. Tomorrow will be the last class and tomorrow we will talk about the energy storage.