Energy Conservation and Waste Heat Recovery
Prof. Anandaroop Bhattacharya
Department of Mechanical Engineering
Indian Institute of Technology, Kharagpur

Lecture - 50
Waste Heat Recovery from Incinerator Plants

Good morning, and welcome to the next lecture of Energy Conservation and Waste Heat Recovery. Today what we will do is, we will talk about at or we will take up a new topic which is Heat Recovery from Incineration Plants. So, that is what I have written here this is heat recovery from incineration plants.

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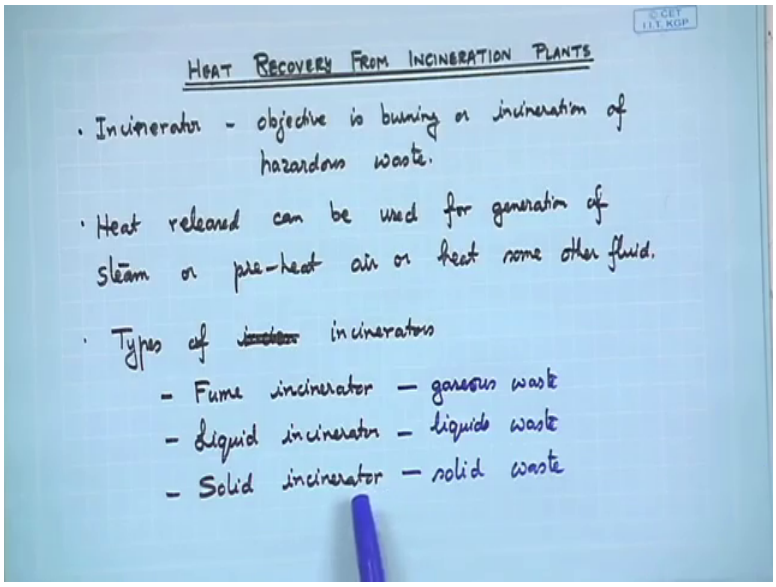

Now, what is an incinerator? So, incinerator is if you have waste products it can be household waste it can be municipal waste it can be industrial waste and so on. So, many a times what is done is or rather very commonly what is done is this household waste after whatever is extra whatever useful we can extract out of it is next burnt and it is burnt in an incinerator

So, incinerator; the basic functioning of an incinerator basic function of an incinerator or objective of an incinerator is burning or incineration. So, this is burned because finally, we have no other option burning is definitely not good, but we have not no other option because these materials that are incinerated if left, otherwise is going to have hazardous effects on the environment.

So, that is why incineration plants are exist and where this waste is burnt in these incinerators. So, let us write down that incinerator. So, objective is burning or incineration of hazardous waste and what we are going to look at from waste heat recovery point of view is when anything is burnt we are going to have a lot of waste heat that is or lot of heat that is being generated. So, instead of letting it go to waste can be utilized that heat for some useful purpose like you know for Addit for heating of another process or another stream or well as for heating the boiler in a power plant to generate electricity and so on.

So, our objective is that the heat released can be used for generation of steam or preheat air or heat some other fluid etcetera has let us say a central heating unit, we can use the heat release from an incinerator if we can if we can transport that heat efficiently. So, the incinerator is a; it is a piece of equipment which assists in the disposal of waste products that cannot be used in a processes or used for anything useful for or for any other useful purpose.

So, if you look at incinerators types of incinerators if you look at sorry. So, you know talk about fume incinerator liquid incinerator and solid incinerator. So, as the name suggests the fume incinerator is for incinerating gases liquid incinerator is for incinerating liquids and the solid incinerator that is the most common and commonly used is for incinerating solid waste. So, there are the gaseous waste liquid waste and solid waste. So, if you are burning solid waste it is a solid incinerator.

Similarly, for liquid and gas we call it liquid incinerator and fume incinerator. So, what we will do is in this lecture we are just going to look at 3 examples we are going to discuss 3 examples of fume incinerator liquid incinerator and solid incinerator. So, let us start with fume incinerator and I will just draw schematic first and then.

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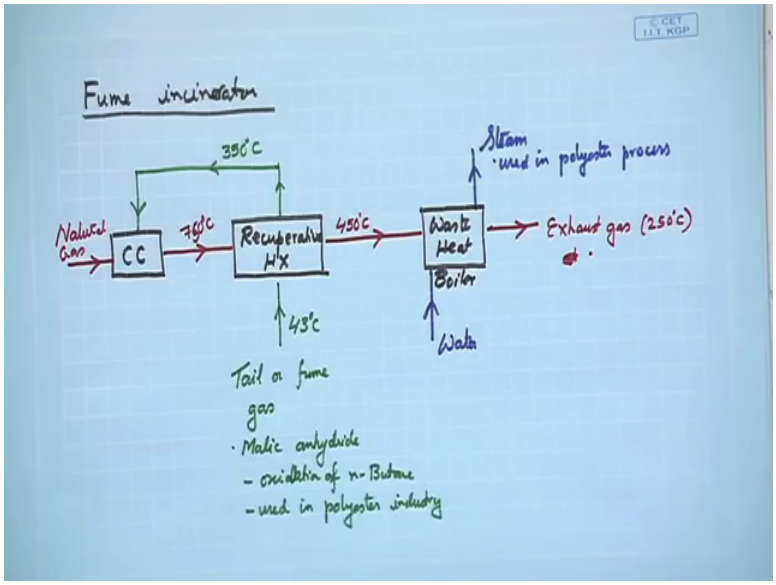

I will say what we are doing here incinerator. So, let me draw an example where have a combustion chamber then a recuperative heat exchanger which I believe you all know very well now that you have studied heat exchanger as part of this course then we have what we called a waste heat boiler.

So, let us look at this the first thing that I am going to do is I am going to use 3 different colours here to denote the fluid streams and then in the boiler. So, what are we having. So, in this example this is a Malic this is a gas I will I will let me call it you let me use the green ink and say this is the tail or fume gas, the particular example I am talking about is something called Malic anhydride which comes because of oxidation of n butane and is used in polyester industry clear.

So, let us say I am getting a tail of fume gas of this Malic anhydride we pass it through a recuperative heat exchanger I am going to show that example it goes through a recuperative heat exchanger where it picks up heat and comes to a combustion chamber where it is mixed with natural gas and its combusted . So, what comes out here is a hot gas and I am going to write down some temperatures over here this is 760 degree, 750 degree centigrade let us say this one is low temperature forty 3 degree centigrade.

So, this is a fume gas it is harmful which otherwise you would have kind of rejected to the environment, but I am using it to heat exchanger heating it up and then using mixing it with natural gas in a combustion chamber from the recuperative heat exchanger what

happens this hot gas coming out of the combustion chamber will lose heat to this fume gas and the temperature therefore, will come down to around 450 degree centigrade still hot enough.

So, this is passed through what we call a waste heat boiler where what comes in is water and what goes out is steam and this steam can be used in polyester process again right. So, you will see this in a polyester plant this is a steam that I am generating, but it is being heated up indirectly of course, with other things it is being heated up or it is the fact that we are generating the steam there is a contribution of the fume gas that is coming out of the polyester process and what comes out here is the exhaust gas at and I would say at 26; 250 degree centigrade. So, this is an example of a fume; fume incinerator what are we seeing here again what we are saying is Malic anhydride which is an intermediate and used in the polyester synthesis.

It is obtained by from oxidation of n butane catalytic oxidation of n butane. So, this one is around 43 degree centigrade is flows towards the recuperative heat exchanger where it gets heated up well it gets heated up to around, sorry, I did not forget to write that temperature this is around 350 degree centigrade then what happens this hot gas comes into the combustion chamber where it is combusted along with natural gas and mostly the prop by the product of combustion chamber coming out of the combustion chamber will be CO2 and water the gases. Then leave the combustion chamber and the same hot gas is used in this as the hot fluid in the recuperative heat exchanger and which is what actually is heating up the fume gas, right, what comes out is 450 degree centigrade and that 450 degrees gas at 450 degree centigrade is used in the waste heat boiler.

Where steam is generated which is indirectly used for the polyester process right. So, this steam goes to the polyester pro synthesis process and a by product of that is this tale of fume gas the Malic anhydride which indirectly also plays a role in generating the heat which is used for this production of steam required for the same process. So, what a wonderful configuration and not saying is the tail fume gas only that generated the steam because it is at a low temperature, but look at it and if you heat it up and pass it to a combustion chamber. Then it acts both as a source of heat which is finally, used for generation of steam and it also incinerates this harmful gas which otherwise cannot be let out into the environment. So, that is an example of a fume incinerator. So, the next what we are going to look at is a liquid waste incinerator.

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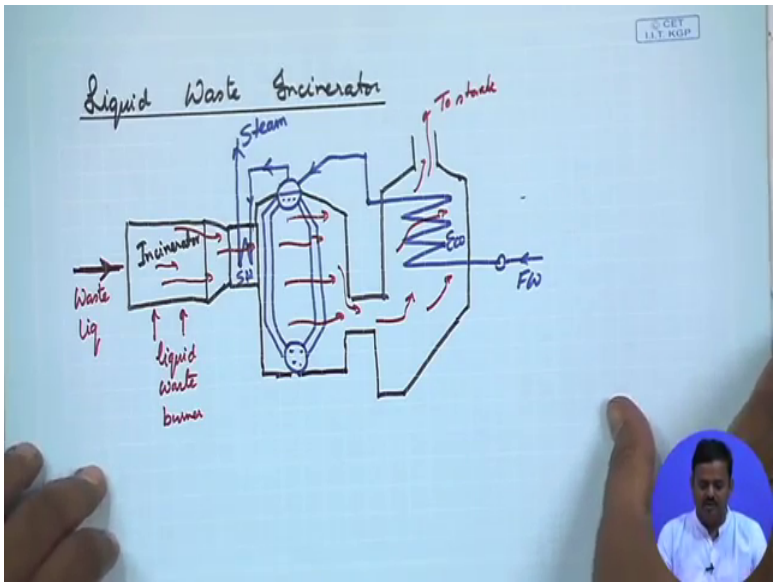

So, let us look at this a liquid waste incinerator this can be organic fluids hydrocarbons vinyl chloride methyl bromide lot of these which cannot be directly left into the or let or which cannot be directly released into the environ environment. So, what we will do here is this is a more or less a simple case. So, let us say here; I have the incinerator clear and then I will just draw this right now and this will look familiar to you. So, as you can see this is what we have seen in boiler. So, definitely I am talk I am talking about waste heat boiler here and then let me keep on drawing this.

So, this one is the incinerator. So, what comes into the incinerator is the gaseous liquid where it is burnt to generate the fumes and what do you have this is a boiler. So, essentially you have feed water coming through this is my economizer this is my boiler and this is my super heater clear. So, what comes out is steam. So, what is happening here the incinerator the hot gases are flowing over sorry I did not close this first flowing over the super heater then through the boiler supplying heat and then through the economizer and finally, escapes to the stack.

So, this is waste liquid which becomes gas and goes to the stack at a lower temperature definitely. So, what is happening here? So, I am using a liquid waste incinerator to generate hot gases which I am first using for. So, as things are burnt you know this is burnt because otherwise the waste is the liquid waste liquid is hazardous. So, when it is burnt it gives rise to some gases which can either be captured before it is leading to the

environment or by themselves, they are not that hazardous and can be left to the environment, but before that why not make use of the heat that is generated because I have expended energy. So, definitely, I have expended energy. So, I would say liquid waste burner.

So, our supplied heat; so, I am having temperature gases at elevated temperature. So, use it in a waste heat boiler to generate steam which can used for various purposes this can be used you know for heating purposes or if it is at sufficiently high temperature even for generation of electricity, so an example of a liquid waste incinerator. And finally, this one now that we know how an incinerator works.

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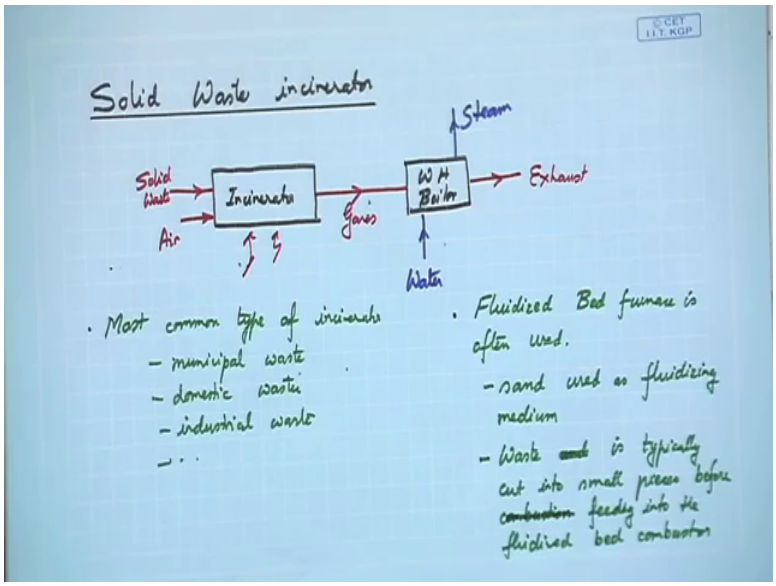

And what we are trying to use the last one is a solid waste incinerator, but essentially in terms of functioning there is really not much to talk about the functioning is pity much what we saw over here in a different configuration, but what is happen going to happen is in the incinerator the solid is going to be burnt and there will be some gases at elevated temperature and that gas can be used for generation of you know in a waste heat boiler for generation of steam or the gases can be used as a hot fluid in a heat exchanger to transfer heat to a colder fluid which can in turn can be used for some other heating application and so on.

So, I am not going to again heat this one I will just draw schematic what do I have this is my incinerator this is my waste heat boiler. So, again the same thing a solid waste and I

have air which is needed for combustion plus of course, the heat source and then I give rise to gases which pass through a waste heat boiler and then goes to exhaust and in the waste heat boiler I have water coming in and steam going out clear.

So, let me write a few words here this is most common type of incinerator you have you know municipal waste domestic waste industrial waste so on. So, lot of this can be used even we know the biogas plants etcetera that can be used to generate electricity essentially it is the same thing. Finally, we need some hot gases and from where we can; which we want to use as a heat source, right. So, there is rice there are gasifier plants, but the overall what we talked about biomass converter biomass gasifier rices; gasifier these are similar. I mean we are just generating hot gas by burning something, but in this case what we are trying to do is we are trying to get energy out of hazardous waste material.

So, when you burn this solid waste we generate hot gases which can be used for generation of steam now one may ask that you are supplying thermal energy or heat over here which you could have very well done in the boiler itself yes absolutely, but again remember we still need to incinerate the solid waste if we did not use it to use that energy for incineration and directly use it in the boiler yes definitely the boiler by itself would have been probably more efficient and all that stuff, but then what happens to the solid waste the incinerator anyway is required. So, what we are saying is you are burning solid waste and then you are letting the hot gases go to waste why it has a lot of trapped energy in it useful energy which can be extracted which can be recovered and used for something useful.

So, why not use that gas to heat up steam in a waste heat boiler so that the steam can be used for some useful purpose. So, here the other point I want to mention is in case of solid especially a fluidized bed furnace is often used. So, fluid as bed as you know is it is there, you have a; you know granular particle typically sand that is being used inside a furnace with refractory lining of bricks and the sides sand or this whatever the powdery or the particulate material is used as the fluidizing medium. So, I would let me write sand used as fluidizing medium right and what we typically do is the waste and not I would say the waste is typically cut into small pieces before combustion.

It increases combustion efficiency ok before feeding into before combustion or before or I would say before feeding into the fluidized bed combustor along with combustion gases

definitely. So, this is how a solid waste incinerator works I mean you can draw a similar diagram what we will do for liquid waste incinerator, but what we have shown is here is a schematic of course, the waste heat boiler will have its super heater the gas will first fly through flow across the super heater then the boiler and then the economizer. And then probably even you can make the same gas flow through the air pre heater as well so, that that air comes in into the incinerator right; so, same thing; so, same way as it is done in a boiler plan; a boiler or oh sorry; in a power plant; in a boiler in the power plant.

But except that here the source of hot gas is actually combustion of waste solid or solid waste in an incinerator plant clear so, that kind of wraps up the; our small discussion on incineration that we discussed in this module. So, once again to summarize, we started by saying that incineration is a process by which waste is burnt this waste can be primarily its mostly the most commonly one is solid waste incinerator, but there can be liquid waste they can be gaseous waste because these waste products do not have cannot be recycled do not have any other useful value to it. For example, it is not organic waste which you can composed to give rise to manure. So, these are not that type of these are waste otherwise which if left which has no other value it is not useful and if it left if it is left in the environment can have hazardous effects . So, therefore, they have to be burnt. So, when you burn of course, you spend energy.

But you have to otherwise you cannot compromise with the quality of our environment. So, we say that you know if you have to incinerate it in an incinerator I am going to give rise to hot gases and instead of just letting releasing these hot gases into the atmosphere granted they are not hazardous or even if they are hazardous their first treated and then left into the atmosphere what we are saying is let us try to recover the thermal energy that is contained in this waste gases in these hot gases that is coming out of the incinerator where the waste products have been burnt and use it for something useful. So, we saw 3 examples; one was for a fume incinerator which was kind of a very nice embodiment of where the waste fume gas from a polyester in the or from the polyester synthesis plant was being used first in a recuperative heat exchanger to heat it up and.

Then being used in an incinerator and the hot gases then used in a waste heat boiler and the steam that was coming out of the waste heat boiler is actually used in the polyester synthesis process. So, then the example of fume incinerator the fume in that case the gaseous phase was Malic anhydride which is a harmful gas comes out of catalytic

oxidation of n butane in a polyester synthesis process the next we saw liquid waste incinerator and the solid waste incinerator also again the overall you know the overall principle over here is burn it in an incinerator and use the hot gases for generation of steam.

So, steam is what we saw here we are stop talking about waste heat boiler, but it does not necessarily have to be boiler you can use it for heating up any other stream that can be used for any other purpose not just water to steam, but any may be use it for heating up air and the heated air can used for heating of a factory floor or heating of let us say these classrooms that is there in this academic building. So, it is a source of heat that can be used for various purposes.

So, in summary; what we discussed in this lecture is incineration plants and the waste heat that is obtained from incineration plants can be used and has been used at different places to recover the waste heat to recover thermal energy and use it for some useful purpose be it for generation of steam for additional electricity generation or be it for heating up some other fluid stream being be it heating of heating of air and so on and so forth.

So, thank you very much and that kinds of brings us to the end of our discussion on waste heat recovery from incineration plants the next class. We will take up a different topic and learn something new.

Thank you very much.