Fundamentals of Combustion (Part 2)
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Lecture – 77
Combustion and Effects on Environment

Let us start this lecture with a thought process by Gordon Brown.

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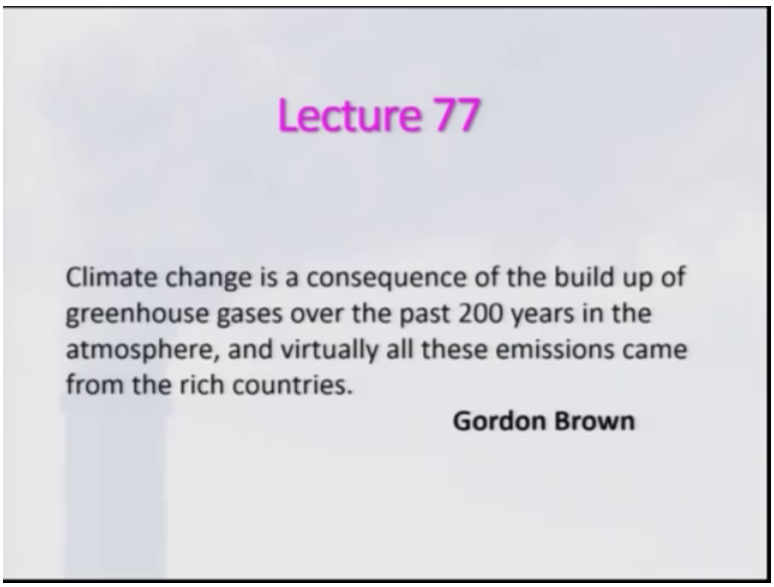

Who says, 'the climate change is a consequence of the build of greenhouse gases over the past 200 years in the atmosphere, and virtually all these emissions came from the rich countries'. And it is really very profound statement, so far our health of atmosphere is concerned which was basically cause after the industrial revolution begins around 1800 century. So, let us recall what we learnt in the last lectures, last few lectures or let us recall that what we learnt till date so far about combustion.

We basically looked at various aspects of the combustion and what are the mechanism in it, but and also how it can be applied for the welfare of human beings. But today we will be looking at how this environment is getting spoiled due to the exorbitant or due to the excess uses of combustion devices.

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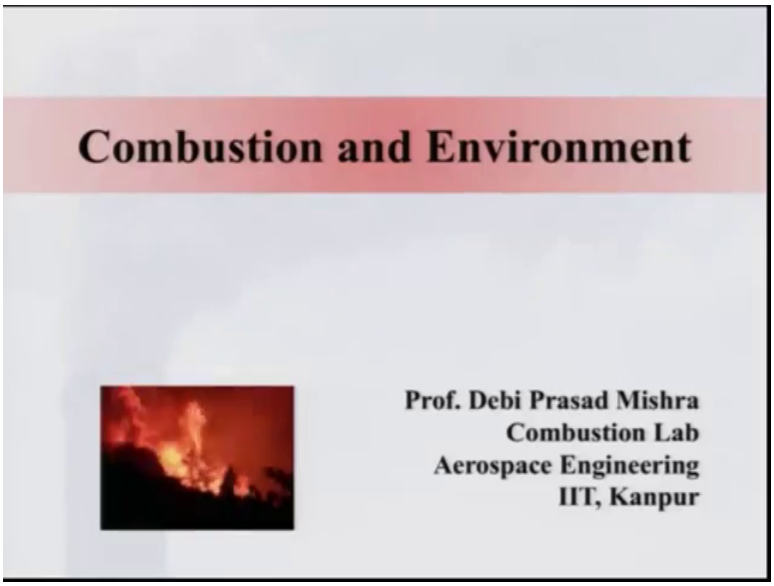

And we will be looking at basically the combustion and environment. And I will be looking at, we will be discussing about basically in a brief manner what are the pollutants comes from the combustion sources, and what are it is ill effect on the environment.

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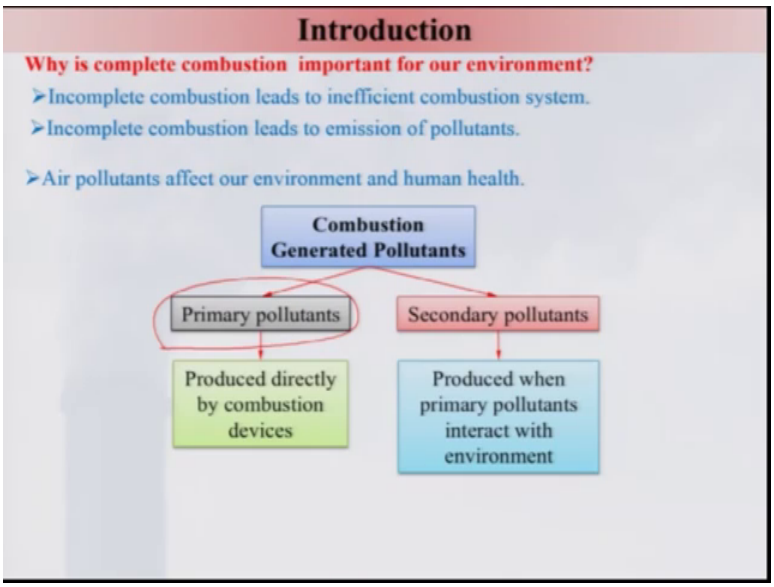

So, if you look at any combustion device we always try to have complete combustion. Question arise a why is complete combustion important right. And of course, that is important for our environment, because incomplete combustion leads to inefficient

combustion system. That means the combustion efficiency of the combustion device will be lower if the incomplete combustion is taking place. As a result, lot of fuel will be going unburnt out from the combustion system. As a result, that overall efficiency of the combustion system will be low, and the energy utilization will be also reduced considerably if the incomplete combustion will be taking place in the combustion device.

Incomplete combustion leads to emission of pollutants; which affects the environment adversely, and air pollutants basically are caused due to the combustion products coming out from the combustion devices. And incomplete combustion means more unburnt hydrocarbons which will be emitted from the system apart from the other constituents of the flue gases coming from the combustion system. And therefore, it affects the air quality, and air pollutants affect our environment and also the human health. It is not only affecting the human health also the health of the all living beings and non-living beings as well.

So, question arises there are various kinds of combustion products or combustion pollutants which will be emitted from the combustion systems and those pollutants basically can be broadly divided into 2 categories. In other words, the combustion generated pollutants can be classified into 2 categories. One is the primary pollutants; that means, the pollutant which are formed inside the combustion system and that are being basically existed out to the atmosphere. Others are secondary pollutants; which is being formed in due to the constituents of the combustion products, which will be undergoing a changes reacting in the atmosphere.

And then you will (Refer Time: 05:08) so, therefore, primary pollutants are basically produced directly by the combustion devices. As I told that it is basically several kinds of pollutants will be formed in the combustion device; namely, the carbon monoxide, carbon dioxide, unburnt hydrocarbon NO x, SO x several of them. And of course, some of these will be reacting with the atmosphere constituents. And then as a result these primary pollutants will be undergoing changes and into secondary pollutants after being interacting with the environment. And that is a basically for that purposes we will have to look at atmospheric chemistry which will not be talking about in this lectures.

We will be mostly concerned with the primary pollutants which will be basically formed inside the combustion device during combustion. So, let us look at what are the emissions comes due to the burning of fossil fuels.

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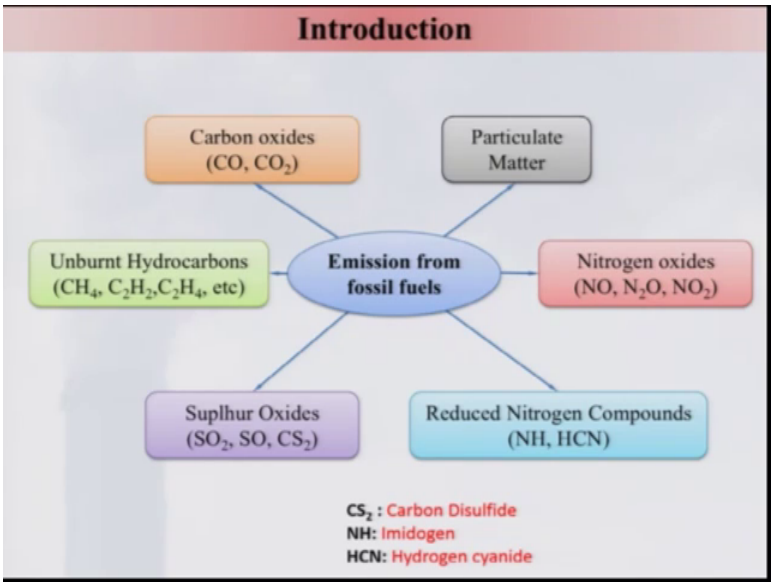

One is of course, I have told you carbon oxides, it can be carbon monoxide, it can be carbon dioxide. And there is also if the incomplete combustion takes place, mostly it will be taking place due to various reasons.

Particularly in engines where the combustion takes place in a very complex environment, like if you look at automobile engine, the piston will be moving up and down; and also there will be coolant; which will be cooling the piston, and also the casing or the body of the engine. And therefore, there will be a unburnt hydrocarbons; like a methane C 2 H 2, C 2 H 4 and several other things which will be a coming out from the combustion system. And these will be are very dangerous from various reasons, and they will be also reacting with the radicals present in the atmosphere. So, therefore, it will be creating imbalance in the atmosphere.

Beside this if the fuels contains sulphur then of course, there will be generation of sulphur oxides; like, sulphur dioxide, sulphur oxide and also the sulphur carbon disulphide, C also the CS 2. And the reduced nitrogen compounds will be formed during the combustion of fossil fuel with air, because air contains nitrogen and also some of the fuels which will containing some nitrogen that is known as fuel NO will be formed NH,

HCN and also other components; like a will be formed like hydrogen cyanide NH is basically radical which is reactive in nature. And beside this of course, the nitrogen oxides will which will be formed, nitrous oxide, nitrogen dioxide, nitric oxides all will be formed.

Due to the basically the presence of nitrogen in air in a very large quantities;so beside this the particle matters are been formed. Most of you will be aware that hydrocarbon basically produces suit; which is a carbon particulates being formed during the combustion. And beside this like other particulates particularly when you are handling the solid and liquid fuels; each will be getting as a part of the fuel itself. For example, (Refer Time: 09:35) other minerals and other things oxides will be formed. And which are being emitted from the combustion devices. So, these are the major pollutants which will be formed during the combustion of fossil fuels and also the biomass fuels.

And we will be looking at some of them, and also will be learning; how to control them and what are the ways to reduce or minimise the emission label from the combustion system. So, as I told that NH if you look at the CS 2 is your carbon disulphide; which is a very poisonous a substance. And like NH is imidogein, which is also a very reactive and it will be acting HCN is the hydrogen cyanide which is also a very, very poisonous gas, and also the other things which will be affecting the health and also the structure.

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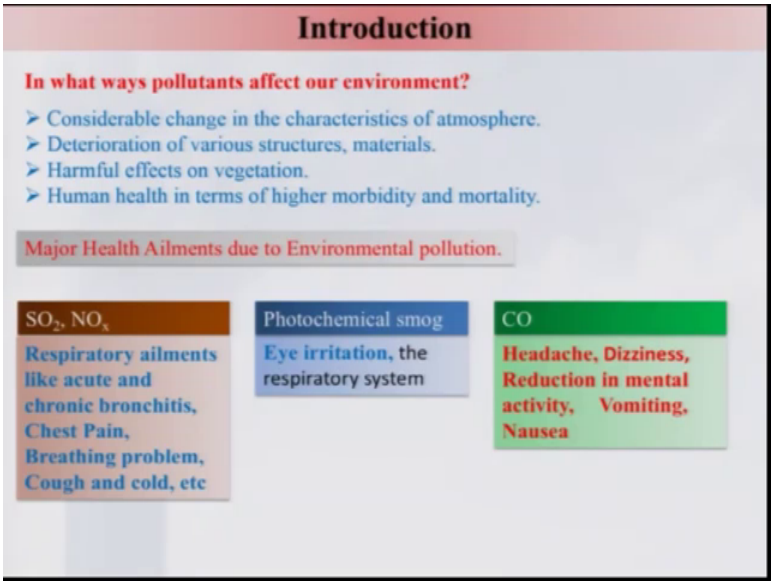

So, let us see that in what ways pollutants affect our environment. And environment plays a very important role, because we breathe air it is not only we, but also the other living beings breathe air for their survival. And if it is being affected by the combustion products emitted from the combustion devices, and naturally it is a great concern. And a considerable change being observed by various researchers while they are characterize in the atmosphere over the years. And it is you might be knowing most of the cities particularly the metros in India are really having high pollution levels, and which are affecting not only the health also the structure health of the structures.

Like a buildings and then bridges and other things, and also the several materials which are getting affected due to the pollutants emitted by the combustion sources. And also it affects the water pollution; for example, in power plants the water being used as a scrubbing the product gases or the flue gases. So therefore, that also gets affected and then the water of the river and other water bodies are getting affected due to that. And the pollutant is having harmful effects on the vegetation. And the whole chain food chain is being affected by the combustion pollutants and also the other pollutants from other industrial activities.

Of course, the human health in terms of higher morbidity and mortality is being increasing day by day due to the pollutants formed by the combustion system. And it is not only the human health, but also the animals and other insects and other things are getting affected; keep in mind that all are connected with each other. One cannot really think of leaving a loop of the system. So, therefore, this man made pollution which is really creating havoc in breaking the chain which was proven by the our mother nature. And it may happen that we will be in the trouble.

Or we are heading toward the catastrophic situation; where the living beings will be at take on this beautiful planet. And let us look at major health elements which are cause due to the environmental pollution. And as we already learnt that SO x and NO x are being emitted by the combustion systems.

SO 2 and NO x are basically NO x means NO; NO 2, N 2 O all those oxide gases nitrogen oxide gases. Those are really cause the respiratory elements like acute and chronic bronchitis. So, therefore, you might be seeing that these are all increasing. In

order even there lot of youth are suffering because of this forget about the old people, who are always suffer.

And beside this pollutants can cause the chest pain, breathing problem cough and cold and several other elements being caused by these pollutants. And the photochemical smog if look at it is a big problems like in China during the winter season, they had forced to close down the activities in cities. So, also in Delhi and other adjacent areas are affected adversely by the smog particularly during the winter season; and these causes, basically eye irritation and affects the respiratory system and also visibility and other activities are being reduced.

And some other cities in like Kanpur and other places we are facing the problem are small. Beside this is carbon monoxide level pollutants carbon monoxide causes basically headache, dizziness, reduction in mental activity and can have a vomiting or nausea tendencies provided. If human being is exposed to higher level of carbon monoxide for a little longer period, and which I am going to show you how it can lead to the death or a termination of life.

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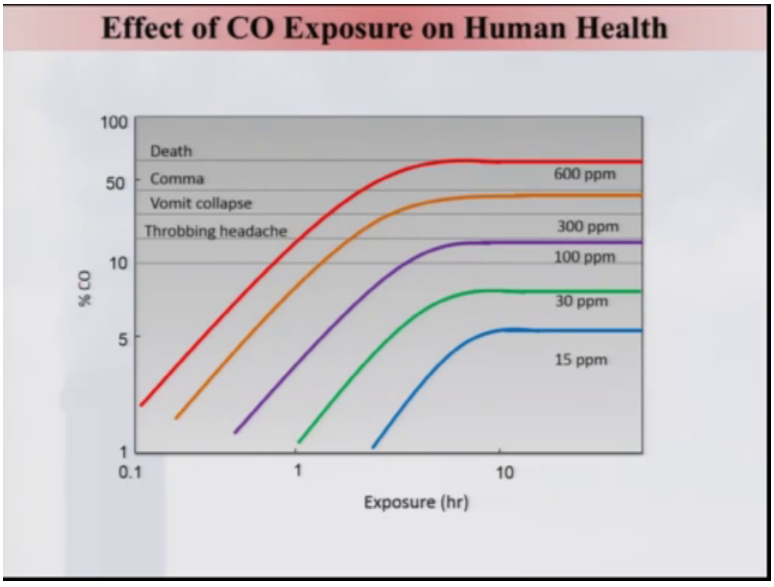

So, if you look at if you consider this figure, percentage of carbon monoxide, you can see that if it is time period is given exposure hour it is an log plot one and 10 hours.

If the label is a 15 ppm, that is the not much problem. And if of course, the exposure even if it is longer period, if it is 30 period there is no problem it is a green one, but; however, if you look at this is a 300 ppm level, and if you go for maybe 1 or 2-hour exposure you may get throbbing headache, and this is basically could have been hear. And 100 ppm if you get then 300 ppm, you will get vomiting or collapse kind of things and if you go to little higher level, you know, it can go to the comma, and then if you are go beyond 600 ppm, then what will happen? Even very small amount of time it may lead to that kind of things.

So therefore, one has to really worry about the effect of the carbon monoxide on the human health, because it is causing a lot of other disease these are of course, the things what people are talking about. But therefore the ppm; therefore, the problem; so, we will have to look at how to minimise the.

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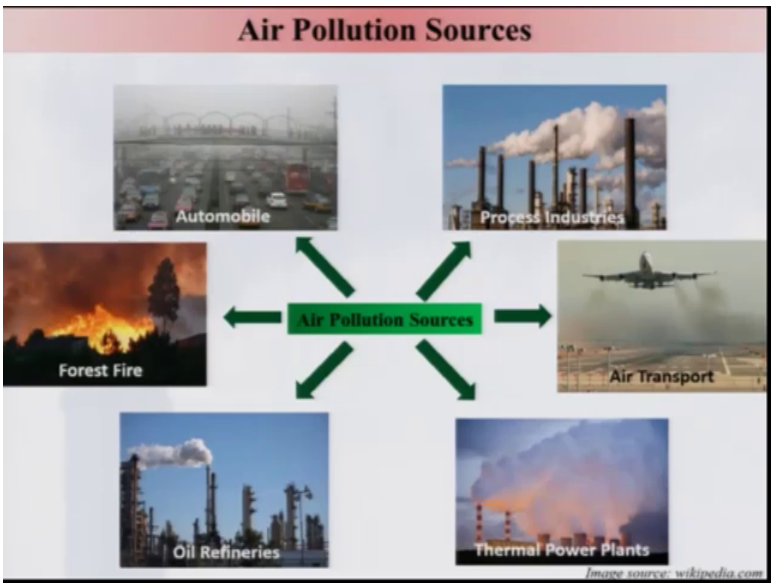

So, air pollution sources if you look at as I told earlier, that we are using the automobiles for our transportation. Now the cities are being studded with basically the cars and then bus buses and several other motorcycles.

Now, as a result that it is causing a lot of pollution, you can see it is a daytime, but the smog you can see from this because very difficult to see the cars under the visibility is quite poor in this picture. And automobiles really causing a lot of havoc for that of course, although a lot of researcher being going on to improve the quality of combustion

in the internal combustion engine. However, with the increased number of uses the pollutants accumulated by this emitted upon this automobiles are quite high. Beside these the process industries which really emits a large amount of combustion generated pollutants and also the other chemical pollutants which are really of great concern, because it is affecting the quality of air adversely.

Beside this, there is a increase in transport air transport which is really causing not only the low atmospheric pollutants, but also the in stratosphere where ozone layer and other things other layers which should have protected us is getting affected, because of air transport, because of increase in air transport or uses of planes. And it also causes a lot of other disturbances like noise pollutions and other things even in the ground level. And thermal power plant is also one of the major contributor of the air pollutants emitted from the combustion system.

And oil refinery because of we are living in a petroleum driven economy system so that the oils are being used very much petroleum products on is become a part and parcel of human activities. And as a result that also causes a lot of pollutants being emitted to the atmosphere directly, and that is causing havoc across the globe. And we are using more amount of petroleum products and also the petroleum fossil fuels for our day to day activities. And beside this the forest fire, which is cause of great concern, because it is a uncontrolled combustion and that really emits large amount of combustion generated pollutants. And of course, the forest is being resident.

So, therefore, the forest fire might be getting reduced. But however, that is a concern for that that this pollution must be awaited or the forest fire must be really minimise, such that you can reduce the emission from the forest fire.

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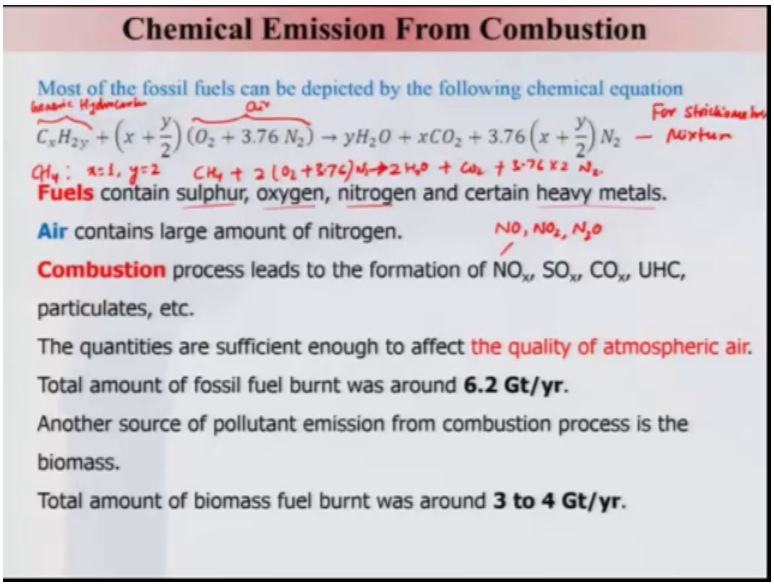

And, let us look at how we can really see this chemical emission from the combustion sources right. And most of the fossil fuel can be depicted by the following chemical equation. Like, you can see that I can represent the hydrocarbon in terms of C x and H 2 y and which can react with the air, this is your air oxygen, and 3.77 n 2.

And if you look at balance this one you will get, basically this is y of water and x of CO 2 carbon monoxide, and you will get 3.76 x plus y divided by 2 nitrogen. So, this is basically balanced expression for a generic hydrocarbon this you can call and generic hydrocarbon. For example, if I say this is CH 4; that means, CH 4 what it would be? Basically this will be C 1 H 2 into 2 basically it is a, x is 1 in this case and y will be, if I take this one for methane, then x is equal to 1 and y is equal to 2.

So, if I consider basically methane, then what I will do? I can write down CH 4 x is equal to 1 1 plus y is equal to 2; that means, 2 oxygen plus 3.76 nitrogen is equal to 2 water, plus x is 1 CO 2 plus 3.76 into that is 2 into 2 nitrogen, right. So, therefore, this can be genetic you can go for propane, you can go for methane, you can go for any other hydrocarbons; of course the unsaturated hydrocarbons. Then you can keep that what is (Refer Time: 24:06) this is of course, a stoichemetric mixtures right. This is for mixture and it is balanced.

Therefore, you are getting carbon monoxide and water, there is no unburnt hydrocarbon and there is no carbon monoxides. And other of course, NO x are the things we are not

considering. Therefore, it is quite clean and a very nice look at it. But however, the fuel contain sulphur and also some percent of oxygen if you look at alcohol, nitrogen and certain heavy metals like a coal and other fuels and air. Also contains large amount of nitrogen that we know NO x. We have already seen that there will be 3 gases like NO, NO 2, N 2 O right and SO x also sulphur dioxide sulphur oxide.

And similarly CO x you will get carbon monoxide carbon dioxide urburnt hydrocarbon particulate matters. And the quantities of these pollutants are sufficient enough to affect the quality of atmospheric air because the amount of fossil fuel is being used is increasing day by day. So, let me give some number which may not be very accurate; but however, you can say the total amount of fossil fuel burnt was around 6.2 Giga ton per year. Now if you look at for one kg of methane, you get something around large amount of carbon dioxide.

So, therefore, the carbon dioxide being formed due to the burning of 6.2 Giga ton per year will be at least much higher level. So, another source of pollutant emission from combustion is the biomass, because as I told there is a forest fire, and beside this in agricultural products they burnt in the field itself particularly in Northern India. As a result, that causes a large amount of emissions from the field. And total amount of biomass fuel burnt was around some 3 to 4 Giga ton per year across the globe.

So therefore, the amount of carbon monoxide, carbon dioxide and then unburnt hydrocarbon NO x released due to the fossil fuel and also the biomass are quite enormous in nature. So therefore, we will be looking at more aspect of this chemical emission from combustion in the next lecture.

We will stop over here.

Thank you very much.