Environmental Air Pollution

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Lecture No. 36

Air Pollution Control Devices – 2

You will recall that we just started discussing about electrostatic precipitators and which you see it from inside but before we go inside, let us talk a little bit about the theory that why ESP – why talk about ESP. You will also remember that I showed you how the difficulty in removing the particle was related to the diameter of the particle and we said if you just apply the gravitational force or cyclonic force, the difficulty will be the diameter square. So when the particle reduces, we want remove the smaller particles and with the forces that we had studied – that was the gravitational force and centrifugal force, those were not enough, those will not remove the smaller particles, so we thought why not utilize the surface characteristics and use the electrostatic forces and utilize that one because that driving force will be proportional to the d rather than d square – that we showed you. One of the ways to use electrostatic forces is to charge the particles.

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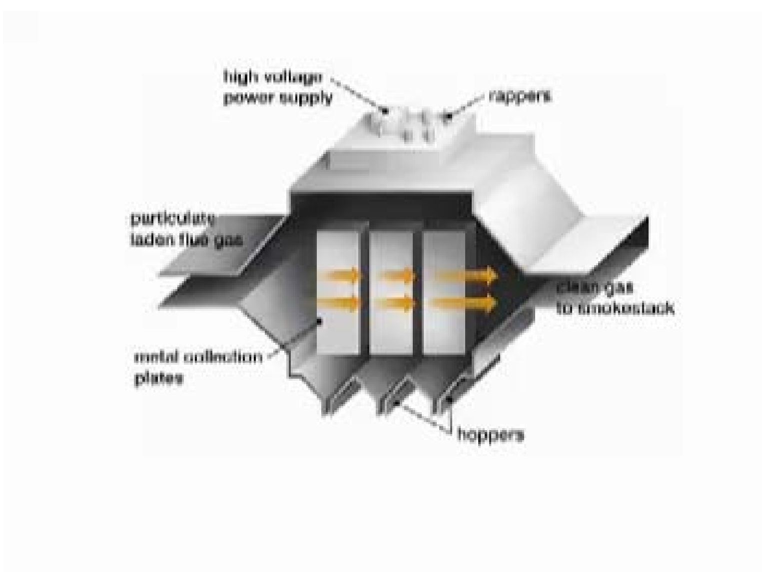

But before we go into that, I was just showing you if these are the plates, they are parallel plates, there are many plates and in between the plates, there is something and that will be used for charging the particles.

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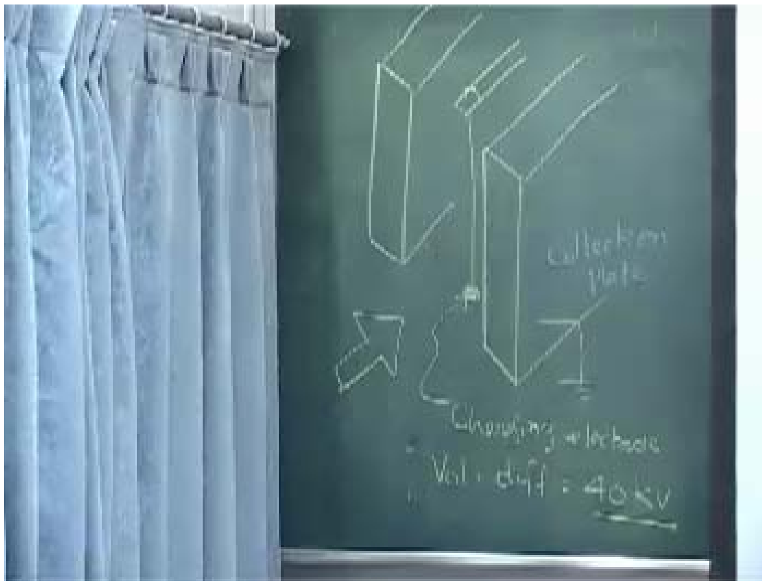

I will draw little a blow-up picture of the tubes and the picture looks…. These plates as we said are grounded and in between these plates, let us say that we draw some kind of beam through which I can hang the wires. One wire I am hanging is this and I put some solid bob or a pendulum – it does not move it cannot move. I can have several of these plates in parallel, several hanging wires with bobs. This is what we called as the collection plate and that is what you see in the picture – you are really looking at the collection plate but you are not seeing inside. If you see from inside then there is a… this is called a charging electrode or something, your dirty gas is entering in between these two parallel plates.

What will happen? The voltage difference between the plate and this electrode is about 40,000 Volts, so the voltage difference is 40 kV and this is negatively charged generally – it could be positively charged also but generally it is negatively charged – and the kind of distance we are talking about is about 3 to 4 inches, if I can say, between these two plates. Now what happens is your thing is filled by the dirty gas with particles and everything.

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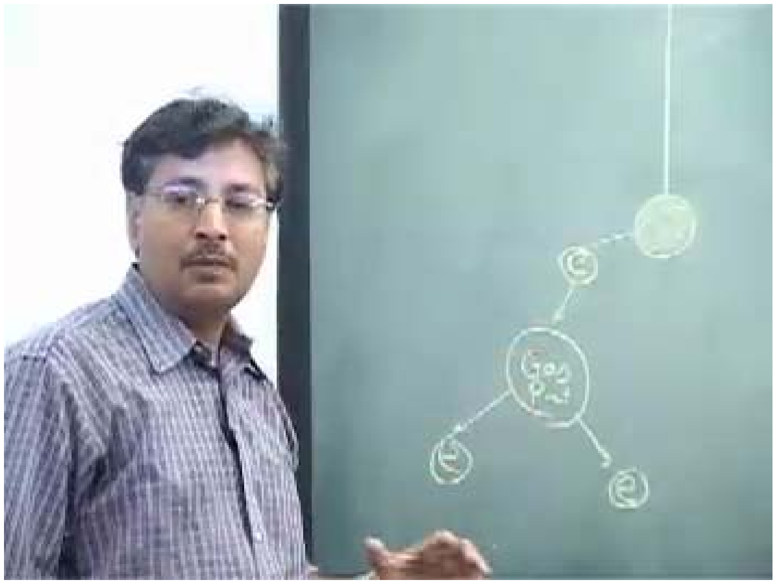

There may be some electron that will… or as I was trying to show you yesterday, there will be some stray electrons in the gas stream – you will always find some electrons in there. Once these stray electrons see the negative charge, they will be accelerated away from the electrode – they want to run away because they are of the same charge. In the process, this acceleration is so much that these things hit to the gas particles and remember that is this happening very very close to the electrode – only thing is we are showing a bigger picture. This thing in the process can knock off some more electrons from the gas as we are going away. Again, they can knock off more but as they go away, they also lose their energy because they are getting far from there and the numbers will reduce, but this can be very significant, very close to your electrode.

These gas particles will become positively charged and what they will do is they will rush towards the electrode and get discharged, but the electrons that have got free will continue to move away from this one but their energy will reduce. Once their energy is reduced, they cannot do more charging and knocking off of the electrons from the gas particles as we go away but in this area (Refer Slide Time: 07:04), they will do a lot. Once these electrons become freely travelling and once they encounter your… they are particle or dust, then they can sit on the dust particles, so these electrons can sit on your dust, which you want to remove. So in the process, what happened is that the dust particles have become charged because the electrons are piggyback onto them – they are just sitting on back of them. Now what will happen because these are there – your dust particles – then these dust particles will also start travelling in the direction opposite to the discharged electrode and go towards the plate because they were going towards the plate anyway. The electrons have to go towards the plate but on the way, more electrons have become available and then they sit on the particles and then the drive is continued towards the plate. As a result, all the particles start moving from wherever they are back to the plates.

They will go and the moment they hit the plate, they will discharge and they will stick to the wall. So this is the mechanism, this is how this happens. Remember that ionization is taking place only for gases, because sometimes people get confused and think they are hit to the solid particles or dust particles and particles become charged. Where are the electrons coming from? But that is not the case. The thing getting charged is the gas, which is the air generally or the flue gas and then more of the electrons come out and these electrons sit on the dust particles and then these dust particles continue to travel because of the charge they are carrying towards the collection plate and then they go and sit on the collection plate. Is that part clear?

What happens if you recall is there are lots of electrons emerging out, so there is something called if you will remember a word called ‘corona effect’. There will be some kind of corona effect that will take place, so more and more electrons are coming out and suppose in this one you had a little glass this thing and you can see a dim light because of the corona effect on this one and you can really see some kind of dim light across this one – it means electrons are being discharged very quickly and that is what you call as the corona effect.

If you can see some of the ESPs, they do have this kind of thing that you can see through the glass – at least some of the experimental ones – and you can see the corona being generated and that corona is key; if the corona is not being generated, it means your ESP will not work because you are not producing enough electrons that will sit on the particle and drive those particles towards the plate. This is the mechanism or this is the physics, if you like. Then, there is the mathematics for this one – that we will see or probably we will not see so much in detail, but I want you to get the sense of the thing. Once these particles come this one or to this one and as they travel, they will sit on the plate.

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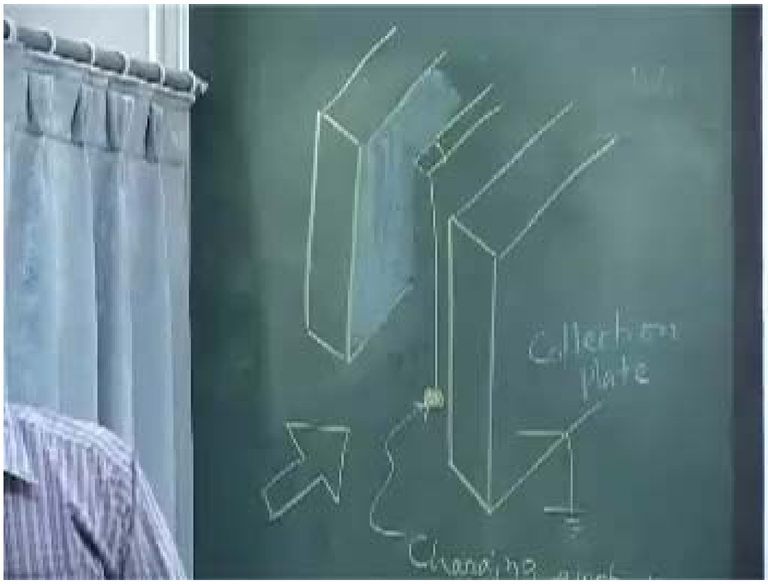

You will see very quickly these particles form a cake on the plate.

[Conversation between student and professor - Not Audible (11:16 min)]

It does not need to be positively charged. Why should it be charged?

[Conversation between student and professor - Not Audible (11:25 min)]

As they are moving away from there, the electrons have lost more or less their energy, they are travelling slowly and as they encounter the particles, they get stuck – just physical sticking, they are not necessarily knocking off anything from the particle, they do not have that kind of energy that they can knock off something from the particle and sit there. So simply what you will see here as the particles or your dust they are going, they will look something like this.

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Your dust and some electrons sitting there, simply attached. Now in the sense that electrons are sitting, it becomes negatively charged – nothing from the inside or nothing at the atomic level, but then they are just sitting on this one and as a result, these particles that were otherwise going straight they tend to have a migration velocity towards the plate, so this is what happens.

Now, this effect you see the corona effect very close to this thing and then, these particles will form a little cake on this one and as we go a little away, the gas becomes more and more clean – we will see this one. Then, what they do is after this one, once this is there… one plate and the charging electron is in between – this thing is called one field; it is very common to have five fields, six fields, four fields to remove the particles – we will see that one because in the successive thing. Once these are there, underneath this one, there will be a hopper and then there is some operation called rapping operation. What we do in the rapping operation is there are some kind of hammers, which with some mechanical movement can come and hit the plate – very hard hit to the plate, then again they can come and round hit to the plate and once they hit the plate, the dust will fall in the hopper; otherwise, dust can be sticky and it is not falling. What happens in the rapping operation is just again the inertia fundamentals because this plate is stationary, the particles want be stationary – they are dislodged and they continue to fall in this one. So when there is a rapping operation, this is a good chance that your emission at that moment will increase because these are all continuous processes – as the rapping operation is going on and then but that will be for few minutes – maybe you may need to do the rapping operation once in 24 hours, once in 8 hours but that time, the emissions can be a little bit large because you are dedusting the whole ESP in a sense. When the rapping operation is going on, you can hear the sound – the hammer hitting this one, for example an ESP even for a, let us say, 50 megawatt power plant can be the size of this room and then the huge plates are put in side and you can think of it as if the fans are the discharging electrodes – the fan I hang there and then this goes on.

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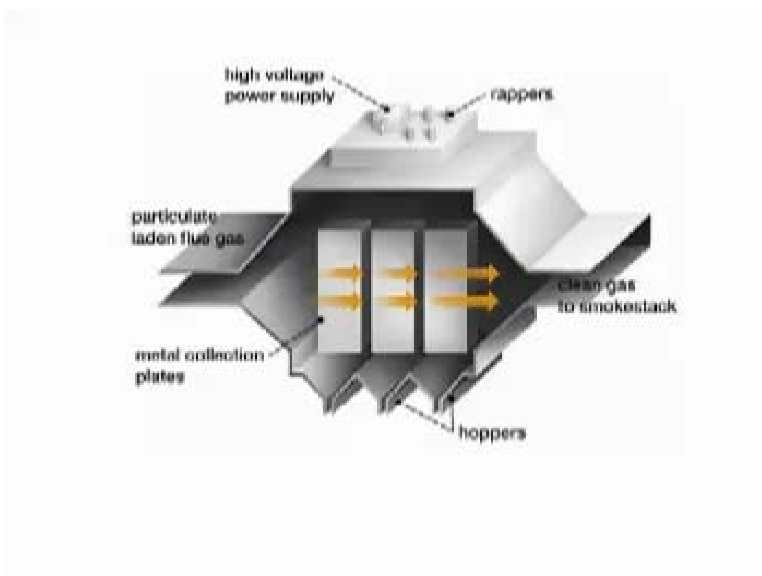

The few things we have talked about more in terms of the physics is that these are the metal collection plates. The particulate-laden gas goes in there, then the gas that is smoke-free comes out, there is a high-voltage power supply for the charging electrode as you see there – it is 40 Kilowatt, there are rectifiers, there is a DC voltage that is supplied here and then you see the rappers – the mechanism that will hit the plates and these are called field number one, field number two, field number three, but once they do the operation – and it is all computerized – when they are doing the rapping operation in this one, the rapping operation in this and this cannot start at the same time, you cannot put the whole thing under rapping – you will see emission being very large, so once rapping operation is going on in this one, these are fully operational, 99 percent of dust that is emitted here will fall in the hopper and whatever little is entering back into the system will be collected here and here.

So most of the emission you only see when the last field or last plate is being rapped, but then you will see that because most of the collection will be here followed by this one, there will be a minimum collection here, so then that part is not so significant, so that part when you do the last rapping operation this requires very rare once in, let us say, 24 hours. At that moment, you can see… sometimes you see a very good plant, you see chimneys working fantastically but you can see that there are some emissions on some stray occasion – that emission could be either because of rapping operation or something going wrong, but then it could largely be because of the rapping operation because the entire process is very robust, it works very fine, it does not work under certain conditions – that we will see in a moment – but by and large, it works.

The application is so good that you have large power plants where you have six fields, so you can see six rooms of this size and things are going on continuously and it can be so small that it can be fitted into an air conditioner. In the air–conditioner advertisements you see all over –clean air, bacteria-free air, they may have some device and ESP is one of the devices they use inside, there could be a filter or some of these things they use in the ESP. So if you see the common air conditioner, it might be fitted with a very small but not the same kind – different kind of this thing. Not only can you remove the particles but you can also remove let us say mist or liquid particles in this one – then it is called wet ESPs, but mostly it is used for this one. What I will do is that I downloaded a picture for you, let us see if you can see that one. This is what a typical ESP will look like with four fields.

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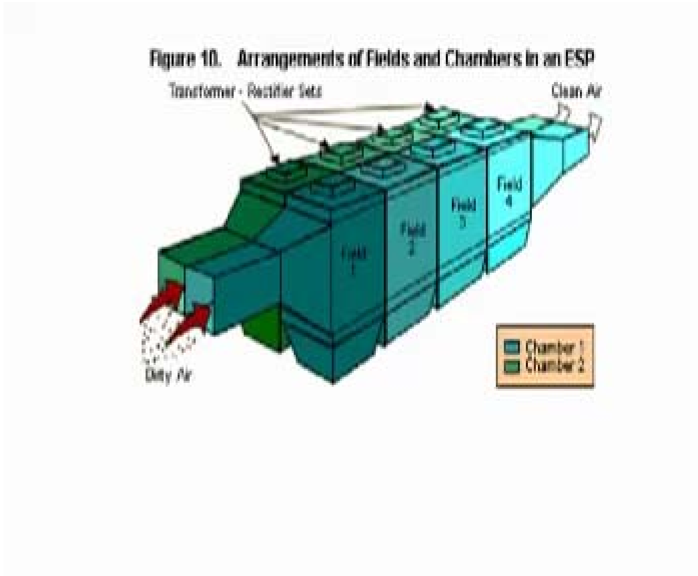

You have transformers and rectifiers fitted onto the top, field number one, field number two, field three, field four and generally they run in parallel because the gas quantity may be very large, you do not want to have too much things – one large thing rather than divide into two. The idea of dividing into a parallel process is that it will always have higher efficiency; if something goes wrong in this stream – things go wrong and things can go wrong – you continue to operate this way. That is why generally you will see there are two ducts from the same let us say generator, they will divide into two streams – absolutely identical but one will go in this one, the other will go in this one and there will be two ducts coming out and that will go and will be connected to a large chimney part. That is how your ESP looks like. They are huge in size and a very interesting thing I can say in India is that almost 99 percent of the power plants have ESPs, 99 percent of your power plants have ESPs, so it is a very widely used process for dust removal. Let us see if we have anything more here. This is a better picture from inside.

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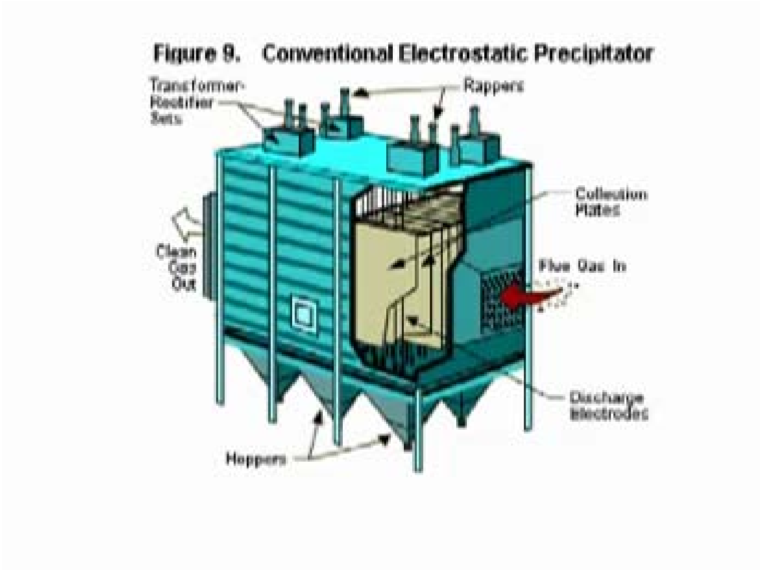

The picture color here is different than it is here. This gas flue gas is in from here and you see here the plates, this is one field, there is one hopper and then what you see here are the rappers that will hit the plate to make it fall and then you have the transformers and rectifiers to supply the order of 40 kV voltage to your electrodes – so this is how it looks. Once the things fall onto this ESP, then either it is pneumatically collected or I do not know if you recall – have you heard about fly ash ponds? What they do is they put it here and they bring a water pipe from here to here and the water is mixed with the fly ash and there is a flue wall that rotates and the fly ash keeps on falling down – you will collect it dry or make it a wet slurry. Nowadays, we only collect it dry because the dry fly ash is used in cement and you will be surprised that we can almost use… about 30 percent content of cement could be fly ash, so fly ash was a huge problem for the country because we are using coal with 45 percent fly ash and all that will show up in your hoppers, there was a huge problem. DST come up… whenever there is a huge problem, the government comes up with a mission, so DST made a mission called Fly Ash Mission and then they said that fly ash has to be utilized, otherwise it is a problem, so fly ash is being utilized in cement making and cement people are very happy because they can still maintain the same quality of cement –we can discuss that because we have also done some work on that and then fly ash.

So to some extent, we are able to resolve the problem of fly ash because we are almost generating about 85,000 to 90,000 Megawatt of power based on coal, which is huge. That is all I have in this picture and then I want to talk a little bit of something else now. Again, we are not talking mathematics – a great deal of maths involved in the collection and migration velocity and efficiency, but I want you to know qualitatively and understand the physics, which we have partly done. One thing I must tell you is the concept of resistivity and the performance of the ESP because this is important. If you talk a little bit that is fine, but if you slightly go on to the details of the working of the ESP, people talk about the resistivity.

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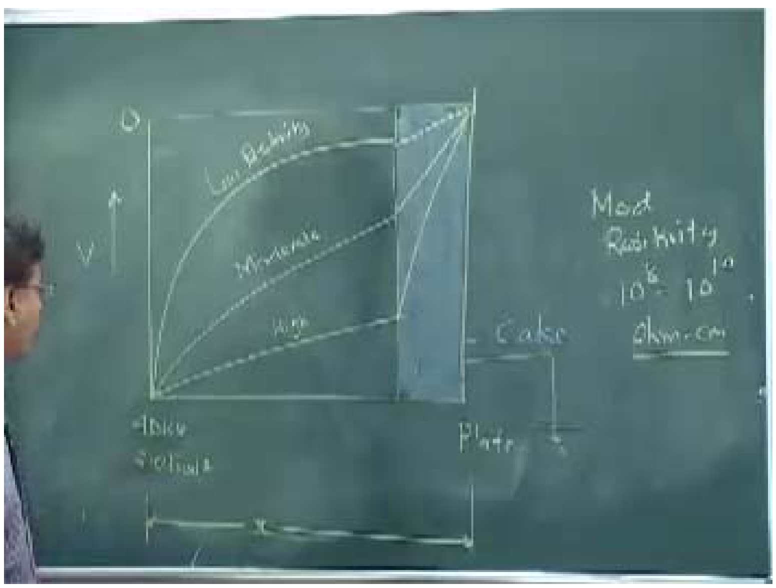

We will show you the concept of resistivity here. You have here an electrode, you have your plate, let us say I just call this as x. We have talked about how big is the x – about 3 to 4 inches. Then, what is the voltage at my plate? It is grounded, so 0, this plate is…. Then you see here at the plate, there will be some cake formation that will take place. These are the particles let us say that are deposited, so let us call this is the cake.

Suppose I am dealing with dust, which has low resistivity. Then, because the resistivity is low – and this is the voltage here – resistivity is low, then I have a picture like this, the voltage will not drop so easily. If my resistivity is moderate – I will explain to you what is the meaning of moderate – it will be like this. If resistivity is too high, I get the picture like this. We are talking about low resistivity, moderate and high and then to complete the picture, I must go because here it has to be 0 (Refer Slide Time: 25:47) and this is my 0 here, this also should become 0, this should also be 0.

In your opinion, which kind of dust will collect best? The higher one – that is what generally people feel but this is not correct. Moderate resistivity: I will give the idea about moderate resistivity, what this number really this. When low resistivity is very low, see here (Refer Slide Time: 26:49), there is not much of… between here to here, there is no difference of the voltage and as a result even if the particles are trapped, there is not enough force for them because things are about the same at this point to this point, so they do not have enough force to get stuck onto this one. When your medium is the same, similar kind of voltage difference is there, so as a result, they become re-entrained into the system because they do not have enough force, you have the similar condition here to here – there is not much of difference here. As a result, they do not find enough force to be attached to this one. Then as a result, they can simply very easily get re-entrained; even if they have deposited, it is very easy for them to re-entrain.

Let us talk about the high resistivity. The problem with the high resistivity is that… one thing is that the particles are… the gas may not have enough charge, the electrons may not be able to flow because of the resistivity [27:53] and when the electrons are not flowing, they are not likely to hit the particles and they will not be able to go through quickly from the medium and go and stick to this one. The larger problem with high resistivity is you see here the voltage difference, because of this voltage difference there is a possibility of generating back corona because of the huge difference you see here and here; the corona we developed there at the discharge electrode – that phenomena can occur here and if that occurs, there is a fear that the particles will not only dislodge themselves but then there is another fear that it can catch fire, because they if you know like at that point, that can catch fire, so the ESPs work best under the moderate conditions and that condition is generally this one.

Low resistivity. To give you a little feel of what is low resistivity and what kind of particle has this one, for example, carbon particles and there is an industry called carbon black industry I do not know if you have heard about that – they make the very fine carbon and that carbon is used largely in making tires, the carbon is used a lot in the tires. The carbon black industry is to give you a little feel that these carbon particles will have very low resistivity. Example for moderate resistivity: ash. Very high resistivity: suppose there is sulfur dust and I want to remove the sulfur, it is just extreme examples that I am giving you, so if you are dealing with carbon black… if you go to the carbon black industry, they will not talk to you about ESP – they will talk something about back filters, which we have not talked about. You go to other things where the s one is there, suppose sulfur is there in your ore or in your process, they will say we are not going to use this one – they do not use this one; for ash or ash kind of substances, it works very well but unfortunately, Indian ash has a low resistivity, so that will fall somewhere in between.

Therefore, the ESPs we need in India or that have been designed largely by BHEL and Thermax, largely by BHEL, the size of the ESPs in India is very large. Some of the difficulties we had in India was in 1970s and '80s when we were importing the ESPs. The Americans will make ESPs based on their this thing and science has really grown after that one. A rare ESP is what we see with the old power plants – very small ESPs, those never worked. Slowly, people realized that we need larger ESPs. Now, you will see very large ESPs wherever they have and BHEL is the leading manufacturer of ESPs.

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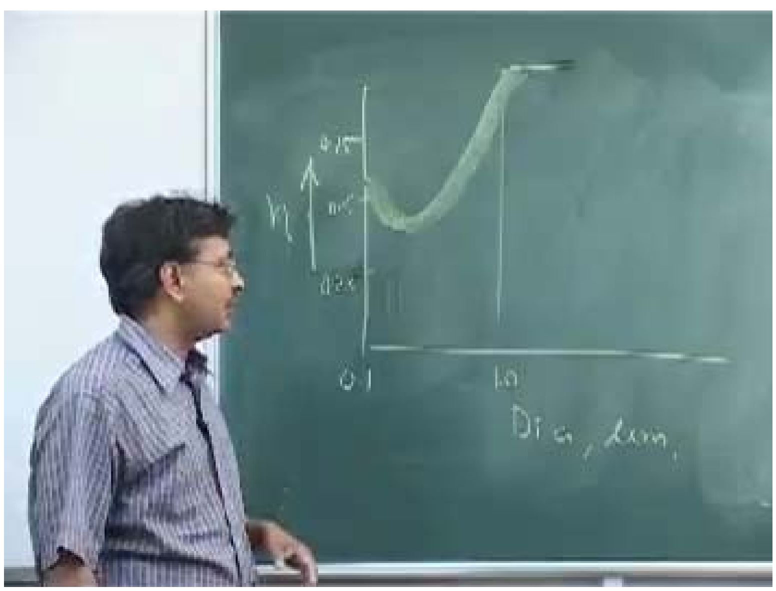

If you want me to show the removal, dia, efficiency of removal as function of diameter, 0.25, they are the particles that we are trying to move, so this efficiency looks something this, this is a band, some particles between 0.1 and 1, they have the minimum efficiency, the particles smaller will have this thing and then you see almost any particle of the size of 1 micron and above will removed 100 percent in your ESP but some particle may have some lower efficiency.

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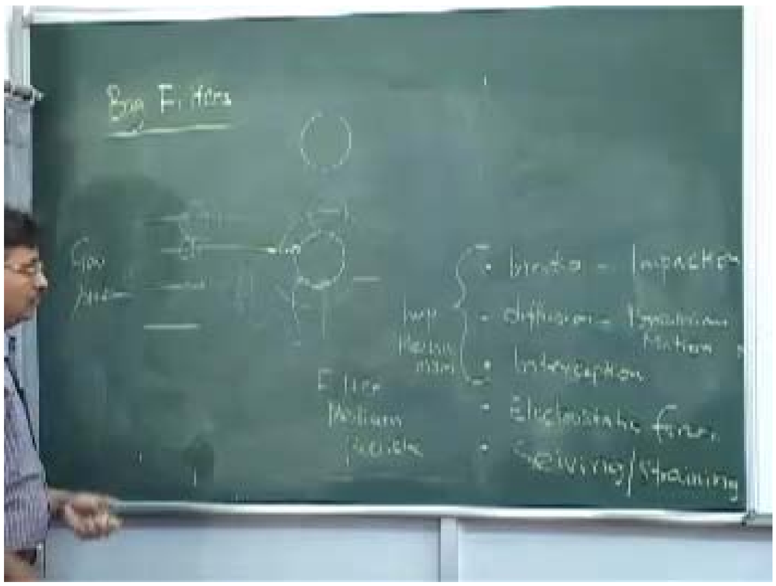

The next thing on the line is the most widely used process to remove very fine particles. After the ESP which is something which is used when application can vary from ESP to this thing. Again, the physics part of the bag filter is something very similar to this. The bag is there made of cloth and the air passes through this one and the particles will be retained or something like the filter as you have learned in the water and wastewater treatment. What is the physics? Suppose this is fabric or my bag filter particle, one of the particles on this one, so this is my filter medium particle. What are the mechanisms we are operating? Suppose the particle is here. It travels, it will change the path, the streams will… the gas stream, the gas stream. Then this particle because of the inertia will leave the path of the gas and get stuck onto the fabric filter and the clean air stream will continue to be like this.

What is this? We call as 602, 603… particle is moving and because of this inertia, the gas will react to the disturbance, the gas stream will move up, because of the inertia, the particle will continue to go – that is called impaction if you recall. So the first mechanism is because of inertia – this is impaction, which I have talked to you about. The second thing is let us say a particle is very small, a very small particle. It will it will hardly have any inertia, so the gas stream will go like this and this particle being very small – submicron size, 0.1 or something like this – this will have some kind of what motion is that? Brownian motion – very small particle will have Brownian motion, so they can go like this, there is a possibility that the small particle can get stuck. So the second mechanism is removal by diffusion or Brownian motion of very small particles.

You may have a particle that is fairly large, a large particle, but the density may be low and so its inertia will be low, so the gases are going like this. I will make it little more bigger just to…. This particle because of the low inertia it does not want to leave the gas stream, but you will see the particle that is still with the gas stream may come in contact of the filter medium. I am saying the inertia is low, so it will not leave the gas stream – it goes along with the gas stream but then it might hit the filter particle and then it might just get stopped onto this one – that is what we call as interception.

Another thing that is a possibility but a low possibility is that these particles may be slightly charged with respect to this one, so there may be some electrostatic force that might be working between them and the particle as it is approaching this one, even if it is somewhere here, it just goes there. Three things are important and the fourth, which is not so effective in this case because we are not imparting any charge, is the electrostatic forces.

You have to tell me the last one, which is simply sieving as we filter tea – you pour the tea, the pores are smaller than the size of the particle. So if there is another filter medium that is sitting here and the particle is much bigger, then it is just stuck between these two particles. So another mechanism, which is not of great importance, is the sieving or straining if you like – sieving or straining. These are the… and the most important being these three things, important mechanisms.

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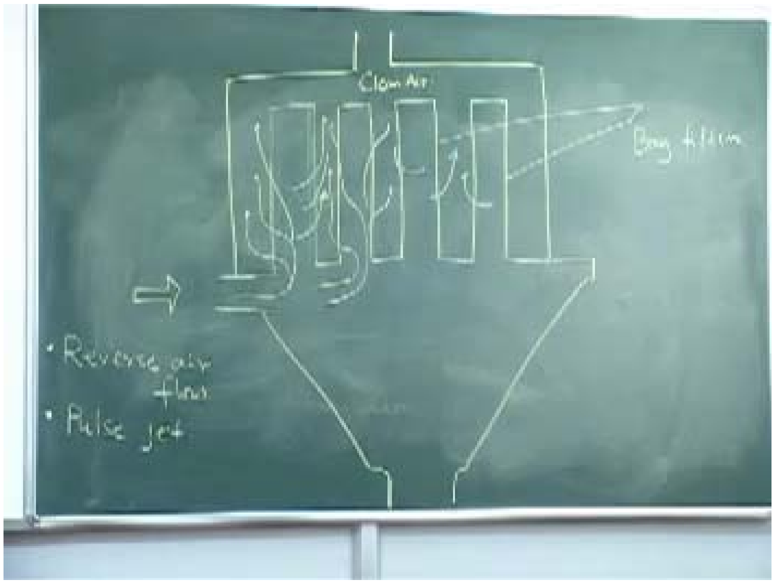

How does the filter look like? Just giving some… your dirty gas goes in from here and then these are your bag filters. This gas and these particles make a little cake on this surface and the gas that has to pass through, same way from here, same way from here, this gas goes on like this, similarly from here and here. So what will happen? This is your fabric filter – like cloth, special kind of cloth and the particles will be stopped here because of some of these mechanisms here and your clean air will come out of the… – simple thing. Again, we are just talking physics we are not talking mathematics here. Then finally, you will get the clean air that will go out from here.

What will happen sometimes is that when any filter mechanism is there, the pressure drop will slowly build up. When the pressure drop builds up, you will not be able to suck the air through and then the bags must be cleaned. The bags are cleaned by two mechanisms. One is reverse air flow: you stop this one from here, make the flow of the air reverse of the clean air – we will have some kind of compressed air, so you make the flow reverse – and now the flow is from the outside to inside, so that will dislodge your dust and the whole dust will fall into your hopper – that is what we call as the reverse air flow.

The second thing is also very common – pulse jet. The fabric filter as you will see here is put onto a little steel cage; otherwise, how will this stand? You can hang it up like this or you put a steel cage, put that thing onto that as if you are putting a cloth onto the cage, then you pass an electric pulse or some kind of pulse that will quickly shake the things very quickly and with a lot of energy; then in the process of the pulse jet, all the dust will fall and the bag will still again be erect, so it is further used. All things happen electronically and with computer controls and so you can just remove the dust as you will see and the rest will eventually will fall onto this one. What else should I tell you about this?

The dust falls into this one and that is [43:58] important thing. With the latest design, everything is basically in parallel, so if something is going wrong here, you will have to stop the whole thing. They can isolate each and every bag and they can go through when they are doing the reverse air flow jet or when they are cleaning the jet, cleaning the bag, they can isolate certain area so that your whole thing is not stopped, because the size of the filter bag may be the same size as this room; they can isolate the bags or the section of the bag because it is very common for the bags to get torn up, some kind of leakages may have happened or there may be some corrosion here, they can isolate certain sections so that the whole thing is not affected – that is a very important thing.

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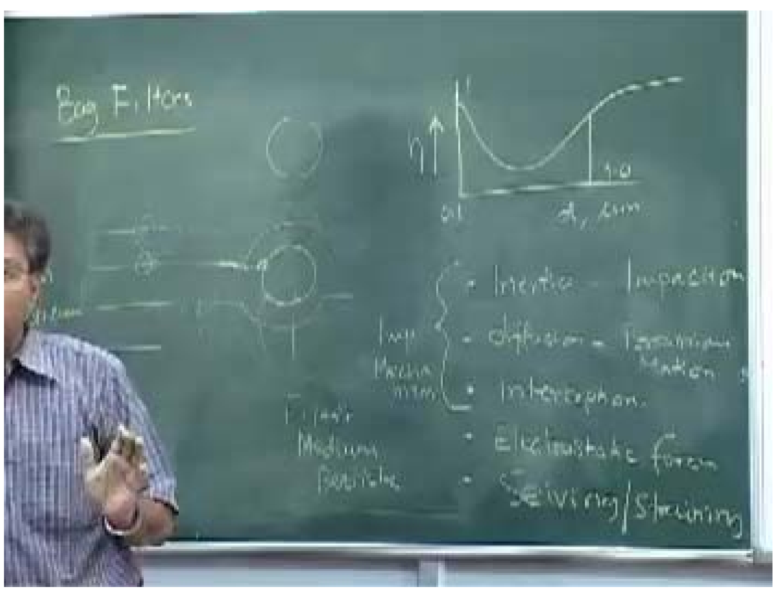

You have this particular idea and if you see here, if you look at the collection efficiency and the particle picture, efficiency of removal versus diameter, this picture also looks something like this. Particles with diameter 0.1 micron meter is removed with fairly good efficiency because of the Brownian motion, large particles will be removed either by impaction or by interception, but the particles in between 0.1 and this thing because neither is this force enough for them nor is the Brownian motion effective, so these particles within this range with little [45:44] will have the low efficiency for the control, so these particles are likely to escape. I will pass on the material to you from the email – you can have another look. Very quickly, let us do some comparison.

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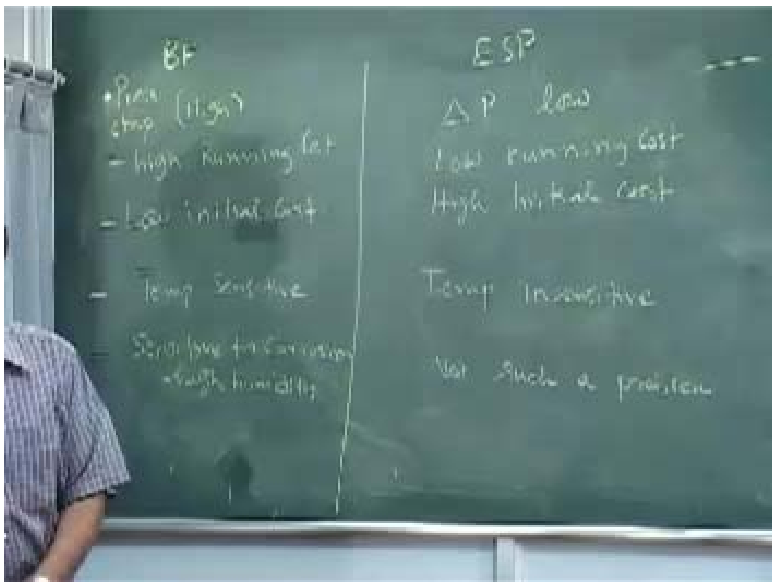

Bag filter and ESP. Let us talk about the most important thing we talked always about – the pressure drop. Now somebody tell me where is the pressure drop more – in the bag filters or in the ESPs? Bag filters. Bag filters, high, delta p is low. What it means in terms of the cost? High running cost because I have to put the blower, so we say high running cost – I have not talked to you about that but.… What about the installation cost or initial cost? Where do you see it more? In ESPs. We are talking in the relative sense, I do not say this is cheap – relatively between these two, low initial cost, high initial cost.

Given the type of the bag and the temperature, can all bags or fabrics resist all temperatures? No. If something is there, for example cotton, suppose the heat is very high, it may not be able to resist that, so bag filter is temperature sensitive; depending on the temperature of the gas you are dealing with, your fabric filter, quality of the filter medium and the fabric filter that we are using will change – we are not talking about this one. Temperature insensitive, if you like. What about the corrosive things? If you have corrosive or high humidity sensitive to because if you are not maintaining the temperature, the humidity, water is always there in the combustion process, flue gas will contain lot of water, so if the temperature is low, that water itself will sit on your fabric filter, making it non-operational, so it is sensitive to corrosion and high humidity; not such a problem.

[Conversation between student and professor - Not Audible (49:49 min)]

The [49:59] may contain the water but it is in the vapor form and it is the form of SO_2, it will not be in the form of sulfuric acid – it will in the form of SO_2 and to convert SO_2 into H_2SO_4 is very difficult.

[Conversation between student and professor - Not Audible (50:15 min)]

But then again where is the s?

[Conversation between student and professor - Not Audible (50:24 min)]

Some corrosion occurs but then again, the size of the plate you are talking about and the corrosion that occurs makes a hole in the fabric filter. Problems will happen but then you see the long-term thing – the plate, the huge plate steel plate will last compared to this thing, that is in the relative sense; huge plates are there but some corrosion is going on slowly, again there will be cake and how we stop the corrosion is by painting the things and the cake itself will act resistive to corrosion.

[Conversation between student and professor - Not Audible (51:05 min)]

Comparatively again, we have not given the number, the question is well taken, but the cost of running this one is not so high depending on the power plant you are dealing with – that cost is very small, but here the cost of blowers and the pressure drop which takes this thing is really very very high, very high and the order of the pressure drop difference is so high that – I do not remember the numbers – here in the ESP, there is no obstruction to the flow of the air, it just simply travels like in a duct as if it is travelling in a duct and you see here, every little thing has to go through the this thing, so pressure drop is enormous here.

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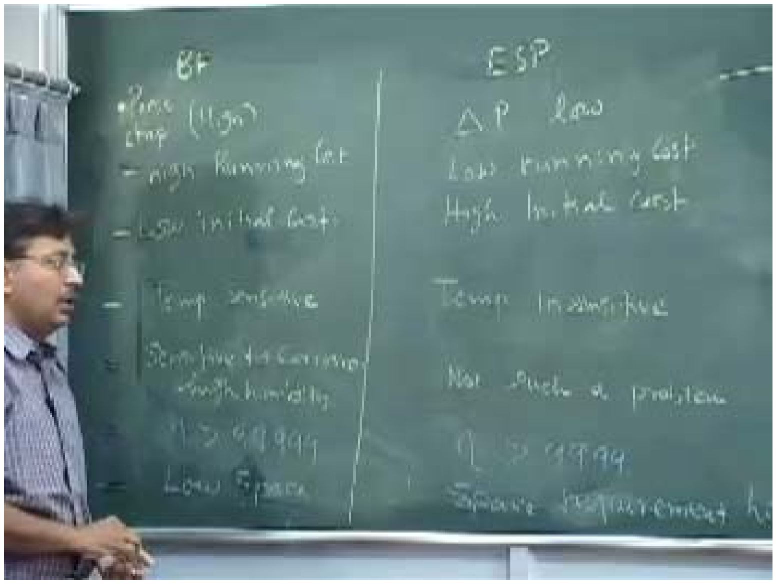

We talked about this thing, efficiency here almost exceeds 99.999 – very good, practically everything is stopped, efficiency of the removal is very high and so whenever you are dealing with something most valuable, you will always use bag filters. Suppose you are working in a gold processing unit and the gold is in the form of particles, you will not go for ESP, you will put the bag filter because these costs are insignificant for me, because if a little gold escapes, then I do not… I am just giving you an example that is a very coarse example but then if you… for example cement industry, because cement is a product, they will have this one because the efficiency of the bag filter is high.

Efficiency here is also high of the order of about 99 percent. Both are comparable if you see here, but depending on what situation you are in you have to use this one. It is temperature sensitive, sensitive to corrosion and high humidity. What people have done is they use different kind of fabric filter. For example if you use Teflon, what is the problem with the temperature the Teflon? Depending on where you are, these bag filters are there but ESP is still considered to be more robust because here within no time you have to do the operation, maintenance bag tearing off, the life of the bag for example the running cost, see bag filters have the life whereas in ESPs, once you install you forget about them for ten to fifteen years.

In the bag filters, the fabric filter will have the life of two years, three years, one year and then you have to always maintain the inventory so that you can quickly replace the bag whereas for ESPs, you make the ESP and forget about the ESP. But the other thing that we should not forget is low space – low space is required for this one because you are increasing surface area by putting n number of [54:24] and then you can go vertically up, you will have the bag filter on one floor, second floor, third floor and this thing and because the ESP sizes are very large, the space requirement is high, space requirement if you like.

These are the differences. I think we will have to stop here. If there is some point missing, I will that one. You can see the choice between the bag filters and ESP can be a little tricky for people – depending on what process they are dealing with, depending on what they want to remove, they have this one. Then for example, the other thing is this ESP as we have talked about can be a little bit prone to fire, because you are dealing with electrons and corona. Suppose there is a little bit more of carbon monoxide in the air and the temperature goes up at the corona, it can explode a little bit, so ESP has another problem.

If the gases are combustible or there is an explosion that is possible because of the nature of the gases, you will not go for ESP – you will always go for bag filter because there is no possibility of any chemical reaction as such happening inside bag filters, so that is another thing. People dealing with the air, the process where suppose the CO level is very high, hydrocarbon is very high, then they will not go for ESP due to the fear of some fire but nothing to fear about if you are dealing with the inert dust like ash.

All power plants in India have ESPs but trends are changing because of two things: efficiency is higher and some of the power plants in India that are very old do not have one enough space to put ESPs; the laws are changing and the government would say “We do not care whether you have the space or not – control the emissions or close down your plant”. Closing down of the plant is not an option, so now because of the low space requirement, power plants go for bag filters; countries like Japan even if they have ESPs, they might still go for bag filters because the land requirement, space requirement is very very important for them. We will stop it here.