Air pollution and Control
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Lecture 18
Determination of Concentration of Pollutants using Gaussian Dispersion Model

Hello friends. So, as you are aware, we have already discussed several kinds of models like point source model, line source model, area source model to estimate ambient air concentrations. Now, I think we should try to practice it otherwise the feeling the real feeling to solve those problems or illustrations will not be so clear.

So, today we will go for kind of tutorial exercise or practical exercise to solve certain numerical problems based on point source model, line source model and area source model. So, that we can use different input parameters to estimate ambient air concentration at a particular distance from the source. So, that practice session we will have today. So, there would be you know three different kinds of sources point source, line source, and area source.

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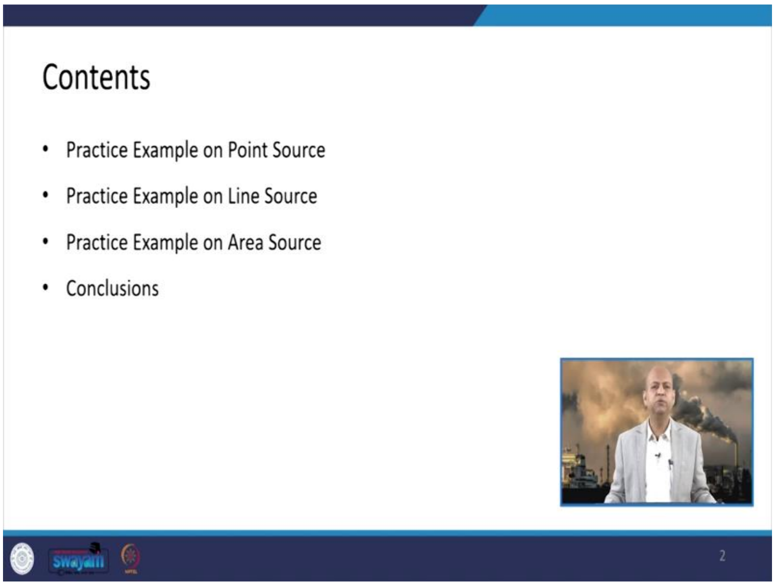

And accordingly, we will have a numerical problems or examples based on these points source dispersion modeling, line source dispersion modeling and area source dispersion modeling which we have already discussed and then we will conclude.

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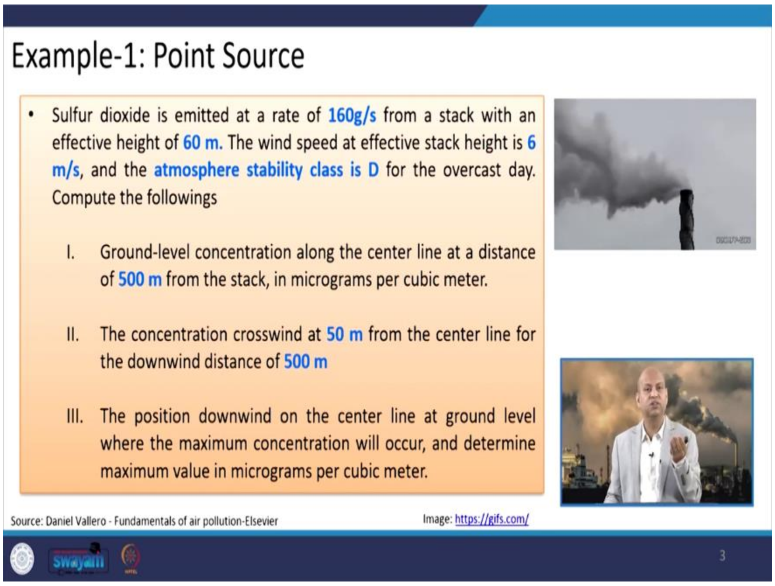

So, let us go for a point source dispersion modeling. So, first exercise is like there are certain things which are given for example, if it is given to us that sulphur dioxide is emitted at a rate of 160 grams per second from a stack with an effective height of 60 meter. Effective height you know, the physical stack height and then the plume rise.

So, the physical stack height plus plume rise that is the effective stack height, if it was not given only physically stack height was given then first of all we have to calculate plume rise then we have to add into physical stack height and then we use it as a effective stack height but it is already given. So, we will use this value 60 meter of the effective stack height. Then the wind speed at the effective stack height is 6 meter per second.

Again, it is very easy for us that the wind speed at the effective height, effective stack height is already given. Otherwise, what happens normally the wind speed at the ground level and that means, around 10 meter above the ground is normally given then we have to estimate the wind speed at the effective stack height then we use it, otherwise you know there will be error in the model calculations, but it is already given that the wind is speed at the stack height is 6 meter per second.

So, again we will use directly. And the atmospheric stability class is D for the overcast day. Again, you know sometimes situation is given, night time, cloud cover, daytime, solar insulation very, bright solar insulation or thin, lean or slide those kinds of things are given. And we have to assume, plus wind speed displayed related table we can visit and see what is the atmospheric activity classification, but again here it is already given D.

So, we will use it. Then what we have to compute or what we need to estimate? We need to estimate first ground level concentration along the central line. Look at the language, ground level concentration that means, if you remember that equation, so that Z = 0, because X, Y, Z coordinates we can calculate the ambient concentration at any point X, Y, Z. But when we are talking about the central line, so the X distance would be given which is here 500 meter, ground level concentration along the central line at the distance 500 meter from the stack in microgram per cubic meter.

So, the input value of the Q that is the exhaust rate whatever unit it is, so that unit is of the concentration but we can change it into microgram or gram or whatever unit you want. But here we have to concentrate there the distance is given from the stack, downwind distance at the central line that means again $\sigma_y = 0$ because it is at the central line, if it was away from the central line literal distance something like left or right, so that could be the σ_y.

But here again it is given that the central line and ground level so the Z = 0, Y = 0, so that is to be consider that x is only there. So, the coordinate of the point where we need to calculate the concentration in this first case (X, 0, 0), Y = 0, because lateral distance is 0 and Z = 0 because it is at the ground level concentration. Second is the concentration crosswind at 50 meter from the center line for the downwind distance which is same 500 meter. So, Y is given here.

So, that will be (X, Y, 0) because ground level concentration but center line it is away from the center line with 50 meter distance. So, Y is given. So, that means (500, 50, 0) that is the coordinates for which we have to compute the concentration of air pollutant. Then third condition is the position downwind on the central line at the ground level again Z = 0, where the maximum concentration will occur and determine maximum value in micrograms per cubic meter.

So, again you will use that empirical formula, you may recall I will let you know what is that where this maximum concentration occur. So, that is the relationship with σ_Z and from σ_Z we will calculate the X and then for our X we will calculate the concentration because we know other values.

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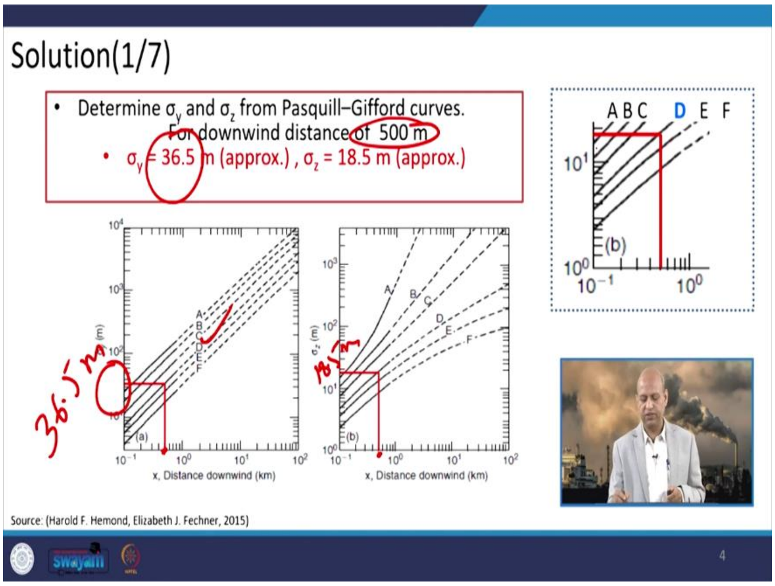

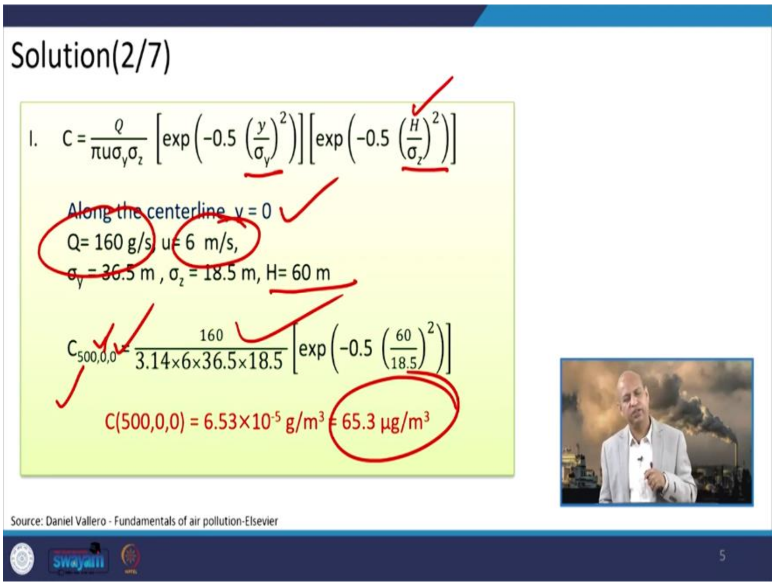

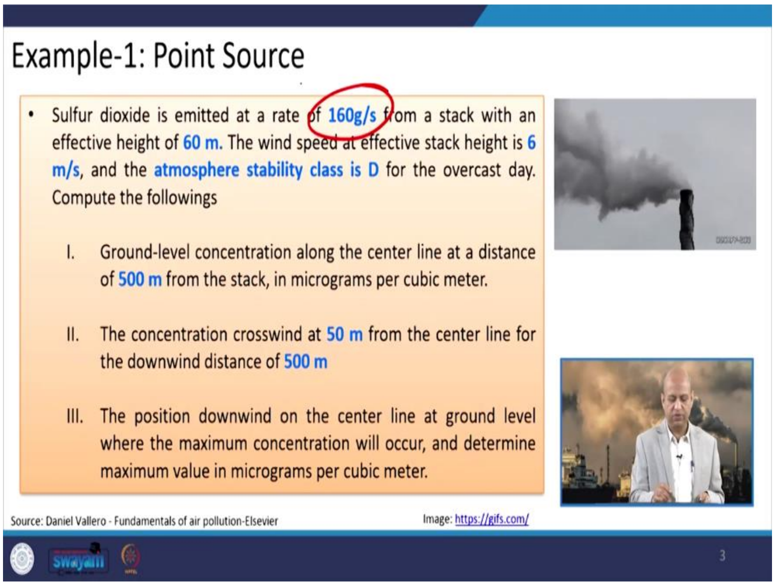

So, first of all the first exercise we have to calculate concentration, the air pollutant concentration at the ground level in the central line, 500 meter at the central line from the stack. So, for that σ_y and σ_Z we need to calculate because σ_y and σ_Z are used in that formula which is this equation, σ_y is used, σ_Z is used, effective height H is used, Y is used.

In this case Y = 0 because at the central line, σy σz here it is. Q is also we have to use that is given already 160 gram per second, Y wind velocity at effective stack. So, these values we need to have. So, σy σz is not given, but the horizontal distance is given where we need to calculate the concentration. So, with this the graph which we have this Pasquill Gifford curves, we can use that for particular classification of the stability.

So, that D classification is given. So, first of all we go to this 500 meter. So, these are not linear graphs, but logarithmic kind of, so you have to be careful where this distance this is in kilometre in X axis. So, we are given 500 meters. So, first of all you calculate like where is 500 meter in this particular graph, then you go up, up to the D, this is the D.

Then you go to the left where σy value will be there and this is around 36.5 meter here, this is 36.5 meter. So, that is σy. Similarly, for σz again 500 meter this is here, you go up, up to the D, this is the D, then go to the left and you calculate σz which is 18.5. So, you got σy and σz. You can, this exemplified you can see this is kind of thing.

Now, we put these values σy σz, Y = 0 because central line concentration not away from the central line, H is given that is the effective stack height 60 meter, u is given 6 meter per second at the effective stack height, Q is given that is sulphur dioxide is emitted at the rate of 160 gram per second. So, that rate exhaust velocity you can say that is given.

And σy σz you have estimated already from that curve. Now, you put those values and you get the concentration that is C (X, Y, Z), Y = 0, Z = 0, X = 500 meter. So, C (500, 0, 0). So, for that this calculation happens and we get this calculated concentration at 500 meter in the downwind direction at the centreline, at the ground level that is 65.3 micrograms per cubic meter.

$$C_{500,0,0} = \frac{160}{3.14\times6\times36.5\times18.5}\left[\exp\left(-0.5\ \left(\frac{60}{18.5}\right)^2\right)\right]$$

$$C(500,0,0) = 6.53\times10^{-5}\ g/m^3 = 65.3\ \mu g/m^3$$

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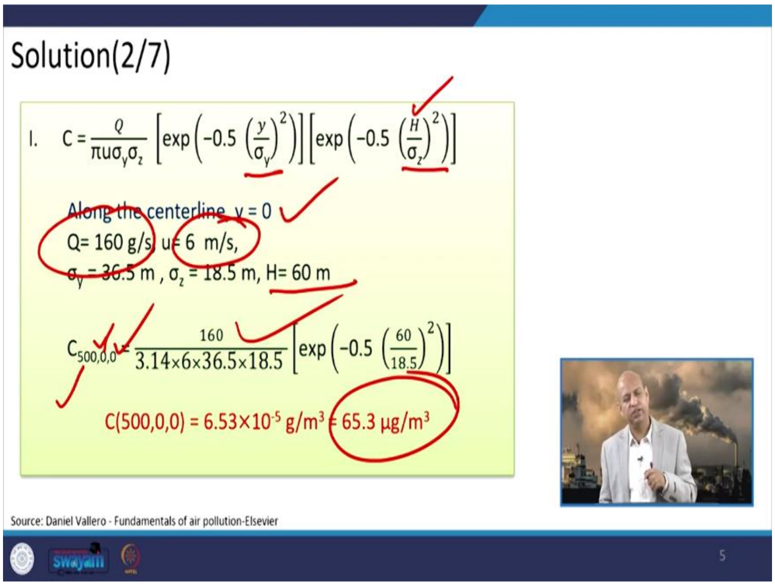

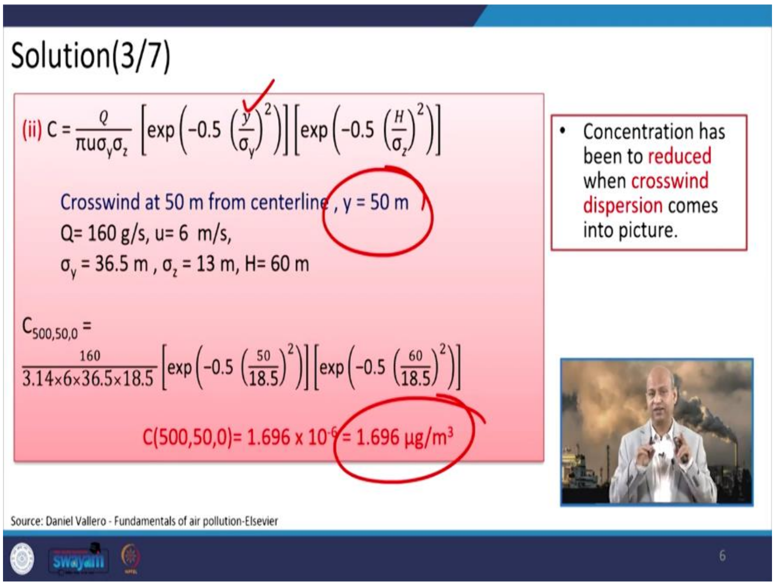

Now, we see the second, second exercises at the ground level, but not at the central line, 50 meter away from the central line whether left or right, does not matter. So, this Y is here 50 meter, that we have to put otherwise, all other values are same. So, you put those values and again calculate you get this 1.696. You can say 1.7 micrograms per cubic meter.

$$C_{500,50,0} = \frac{160}{3.14\times6\times36.5\times18.5}\left[\exp\left(-0.5\left(\frac{50}{18.5}\right)^2\right)\right]\left[\exp\left(-0.5\left(\frac{60}{18.5}\right)^2\right)\right]$$

C(500,50,0)= 1.696×10^{-6} = 1.696 μg/m^3

So, that means at the central line this is 65 around, 65 microgram. Here, it is around 1.69 or 2 micrograms per cubic meter that means, the concentration decreases when we go away from the central line. So, that is again it is your proved you can say. So, this is the concentration at the 50 meter away lateral distance from the central line.

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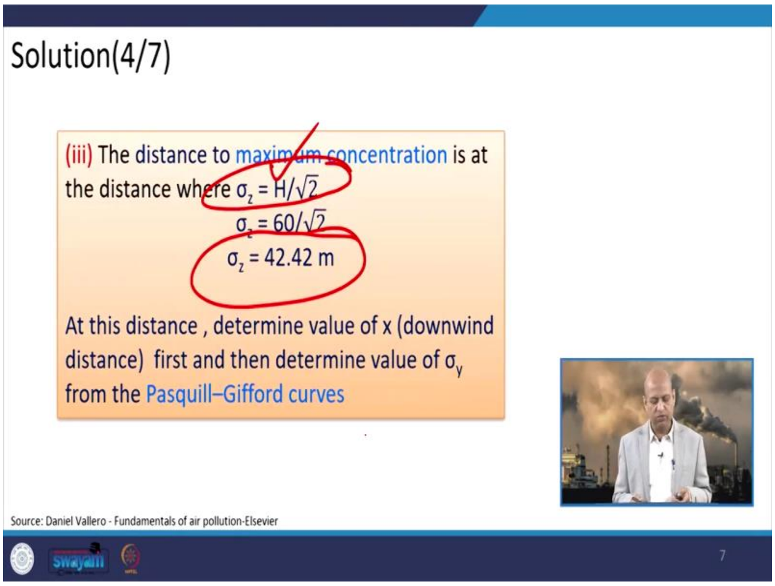

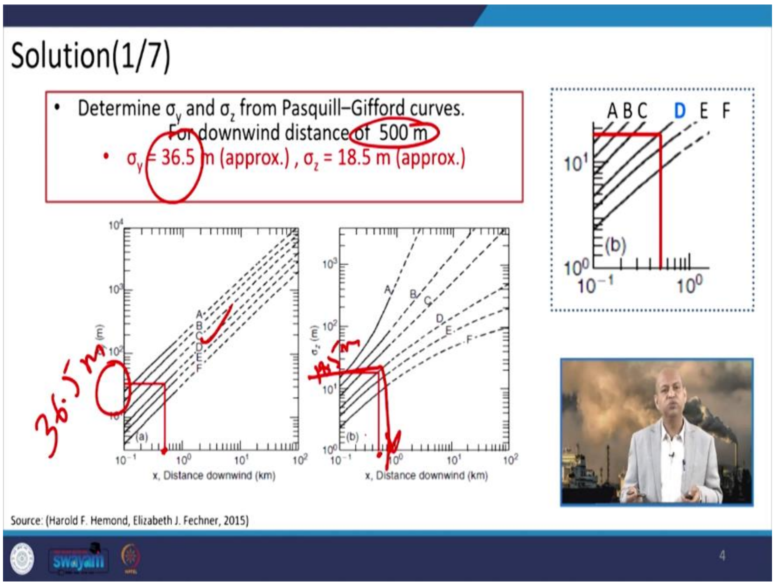

Now, the third exercise is that we need to calculate the distance where measuring concentration occurs and we know that particular relationship of σz is equal to H divided by square root of 2, this is the distance where maximum concentration occurs. This is the empirical relationship.

$\sigma_z = H/\sqrt{2}$

$\sigma_z = 60/\sqrt{2}$

σ_z = 42.42 m

So, H you know 60 meter effectively stack height under root 2. So, the σz is 42.42 that means, at a distance where the σz is 42 meter around there will be the maximum concentration. From σz, we can calculate X because you remember this we calculate it from the X, σz is given you can come back like this, you can come down, you can get the X value. So, that we will do here.

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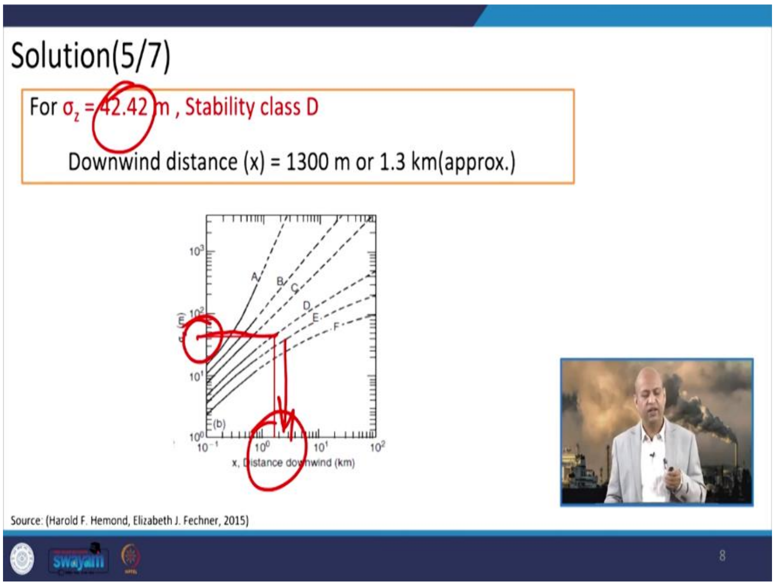

We have this σz value, we calculated 42.42 meter, this is here. We go to this D, you come down to calculate the X and X distance is around 1300 meter or 1.3 kilometre. So, this X you have calculated where maximum concentration will occur.

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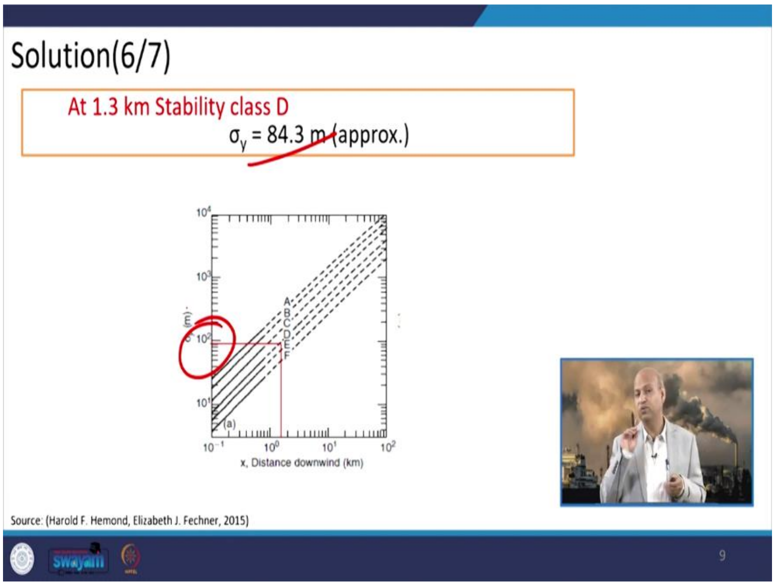

And for this you calculate the σy because σ is needed, σy and σz is needed for solving that point source dispersion model equation. So, you get this, for this X distance 1.3 kilometre you get σy which is 84.3 meter here from this particular curve. Now, you have both value σy and σz.

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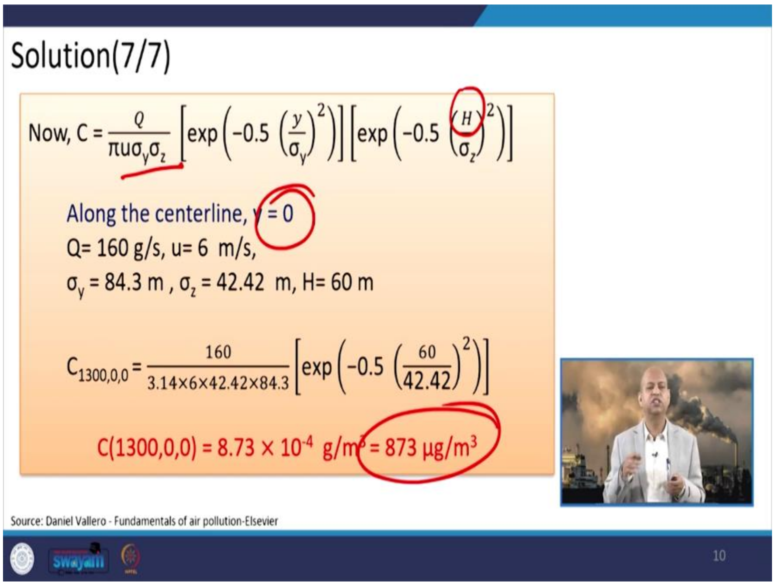

You put those values σy and σz, you have Y, how much, 0, why, because the concentration is to be calculated at the central line not away from the central line. So, Y = 0. H is again that same 60 meter effective stack height, σy σz values have changed basically and you get this maximum concentration that is 873 micrograms per cubic meter.

$$C_{1300,0,0} = \frac{160}{3.14 \times 6 \times 42.42 \times 84.3}\left[\exp\left(-0.5\left(\frac{60}{42.42}\right)^2\right)\right]$$

$$C(1300,0,0) = 8.73 \times 10^{-4}\ g/m^3 = 873\ \mu g/m^3$$

So, that is the maximum concentration and the distance we already know around 1.3 kilometre away from the stack height, from the stack position this maximum concentration will be there. So, this is the utilization or application of this point source this Gaussian dispersion model to calculate concentration at the downwind distance whatever it is given.

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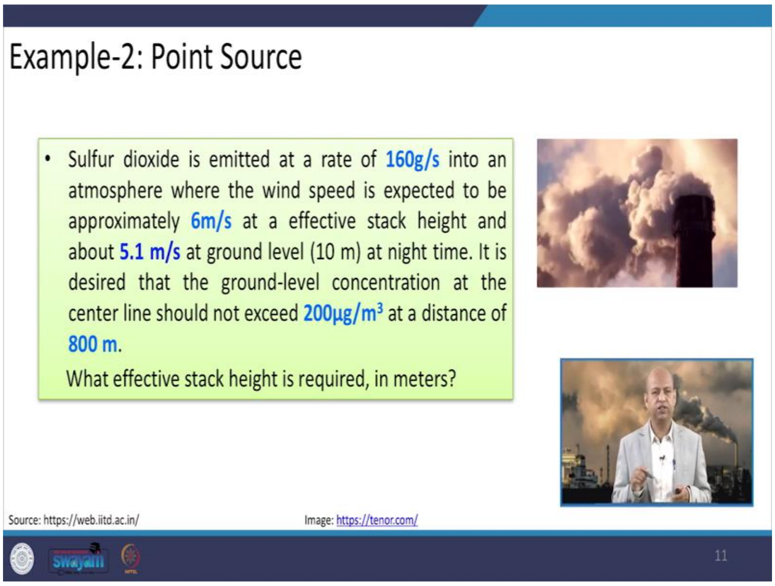

Now, we take second example of again point source in which little bit different calculation is to be done like here sulphur dioxide is emitted at a rate of 160 gram per second the same which was in earlier exercise from the stack. And the wind speed is to be approximately 6 meter per second at the effective stack height same value, new value is given like 5.1 meter per second wind speed at the ground level that is around 10 meter of the ground level which is we know it has a ground level in the night time. So, this is another value is given.

And it is desired that the ground level concentration at the central line should not exceed 200 micrograms per cubic meter at a distance in the center line downwind distance of under 800 meter. So, that means, for X = 800 meter one value of the concentration is given, ground level concentration. And for that we have to estimate the effective stack height.

That means, in this equation, this concentration earlier we calculated concentration because effective stack height was given and σy σz we had computed, u is given, Q is given. Now, what we will do the C is given, we have to calculate effective stack height. So, that is also possible for this particular example, we will do the next thing of calculating the effective stack height. So, how do we proceed.

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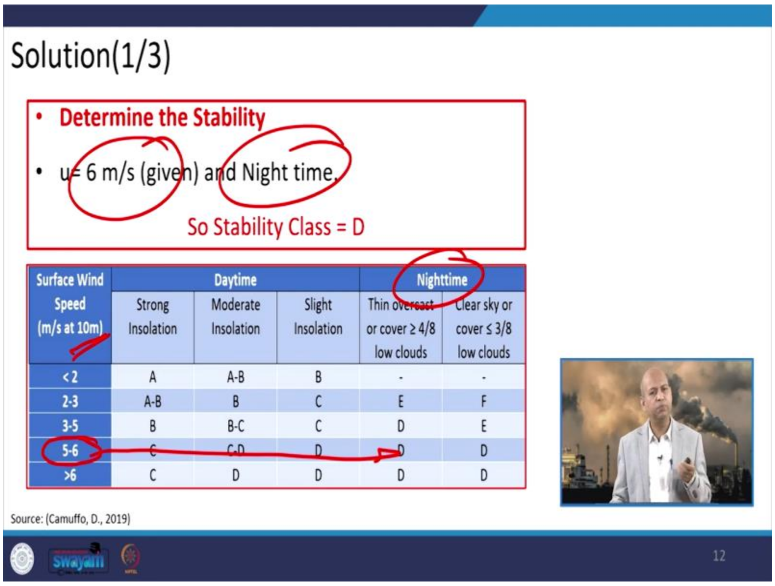

First of all, like for night time, you know the wind speed is given around 5.1. So, night time and the wind speed is 5.1 that is between 5 to 6 at the ground level. So, what will be, this is D, you can see here. So, the D is the stability classification. So, first of all we computed the stability classification because on this many things are dependent.

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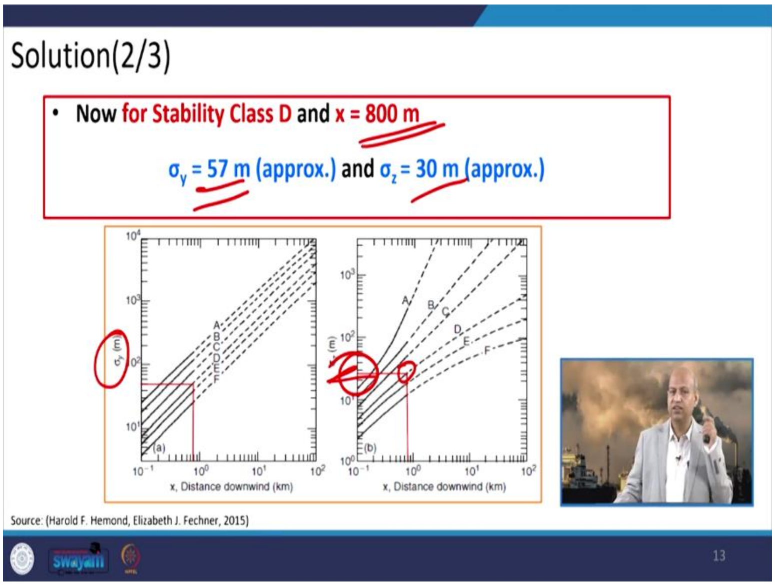

For example, we will calculate this σy and σz which curve is also divided into different stability classification, ABCDEF. So, now, we know for the D we have to compute. So, the distance is given 800 meter, concentration is given. For 800 meter we need to have σy and σz. So, 800 meter we selected on the X axis, we went up to the D and we went left side to calculate σy which is calculated around 57 meter.

Similarly, from the another curve, we went to 800 meter on the X axis and then we came to this particular point which is on the D and we went to left side to calculate the σz which is around 30 meter approximately. So now, we have σy and σz in the same equation of point source dispersion model.

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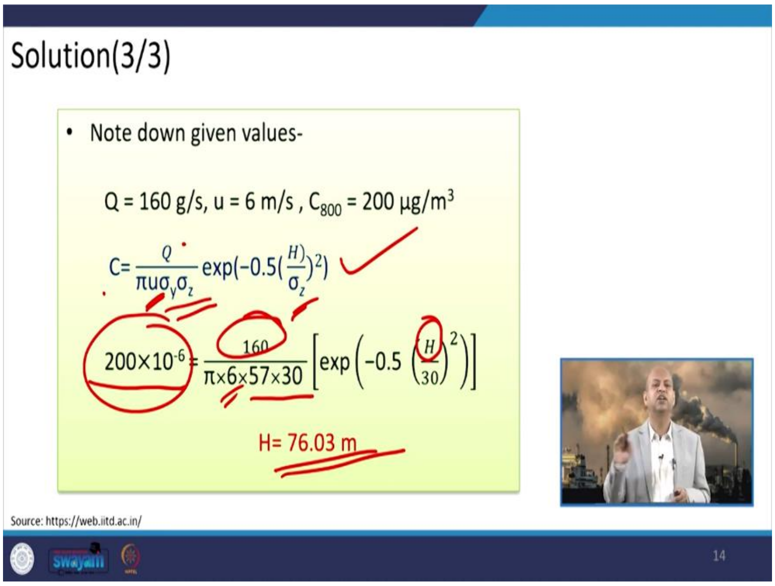

So, in point source dispersion model where Y = 0, this is the very simple relationship concentration is there, Q is there, σy, σz, u and H effective which take height σz is there. Now, value what do we have, concentration we have it is given for 800 meter 200 microgram per cubic meter this concentration is given.

So, this value we have to put here. Then this Q value which is exhaust speed you can say this is also given 160 gram per second. You calculated σy and σz. So, these are the values 57 and 30. u around 6 meter per second at the effective stack height which we have used here. Effectively stack height is not given, so H we will put.

$$200\times10^{-6} = \frac{160}{\pi\times6\times57\times30}\left[\exp\left(-0.5\,\left(\frac{H}{30}\right)^2\right)\right]$$

H= 76.03 m

Now, we can solve this equation, we can solve this equation because only unknown value is H. So, after solving this equation we got effectively stack height around 76 meter. So, for this effectively stack height the concentration will not exceed more than 200 micrograms per cubic meter at the distance of 800 m at the central line that is the ground level concentration.

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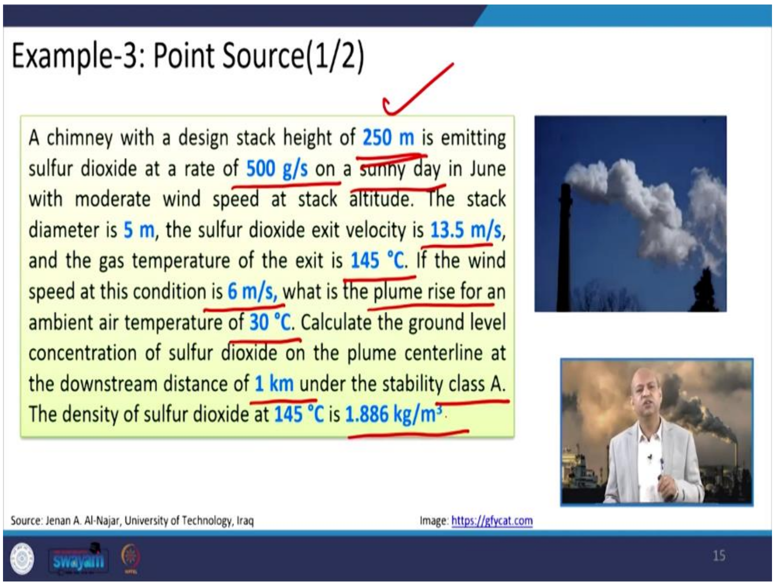

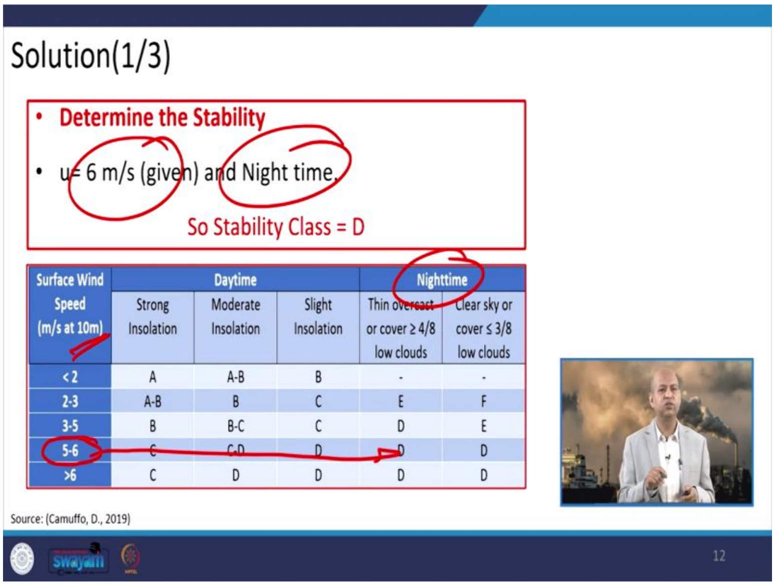

Now, the next example is of another point source. So, we will see like there is a chimney with a design a stack height of 250 meter. It is emitting sulphur dioxide at a rate of 500 gram per second on a sunny day. So, again, for that table remember were night and those insulation, let me show you, this table daytime, strong insulation, moderate insulation, slight insulation.

So, daytime these inner conditions will determine the stability according to the wind speed. Night time, overcast or cloud cover is more than 4 by 8 and it is less than 3 by 8 cloud covers, so though you know categories are there in night time. In daytime, there are three categories according to the sunlight strength. So, here it is given it is a sunny day in June with moderate wind speed at stack altitude, means stack height.

The stack diameter is 5 meter, the diameter is given. The sulphur dioxide exit velocity is given 13.5 meter per second and the gas temperature of the exit gas is around 145 °C. If the wind speed at this condition is 6 meter per second what is the plume rise for an ambient air temperature of 30 °C.

So, plume rise to be calculated. Stack height, physical stack height it is given 250 meter, but effective stack height is not given. For effective which take height we need to know ΔH, that is the plume rise. And here it is also given that we need to calculate plume rise. Now, calculate the ground level concentration of sulphur dioxide. On the plume centreline, plume centreline ground level concentrations Z = 0.

At the downwind distance of 1 kilometre under the stability class A. Here a stability class A is already given, you do not need to compute from the table. The density of sulphur dioxide at 145 °C is also given around 1.886 kilogram per cubic meter.

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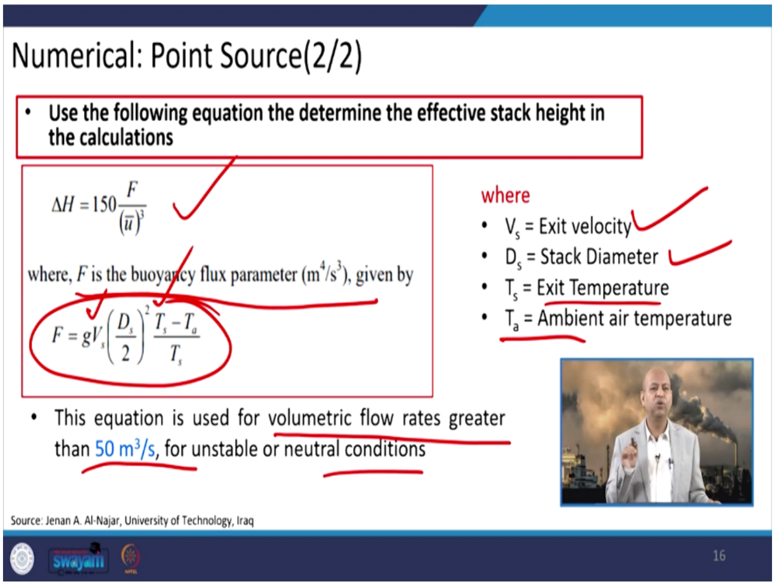

So, we use these equations like ΔH that is the plume rise equation in this terminology, F is the buoyancy flux parameter and this is to be calculated by using this particular relationship. So, we know this volumetric flow rate 50 cubic meter per second for unstable or neutral condition this equation is to be used basically. And we do not know how much volumetric flow rate is there.

$$\Delta H = 150\,\frac{F}{(u)^3}$$

Where, F is the buoyancy flux parameter (m^4/s^3), given by

$$F = gV_s\left(\frac{D_s}{2}\right)^2\frac{T_s - T_a}{T_s}$$

So, first of all we should calculate the volumetric flow rate, so that we can know whether this equation is applicable or not. Exit velocity V_s. diameter D_s, this D_s, V_s is exit velocity, D_s diameter of the stack, T_s exit temperature, T_s, Ta ambient air temperature. These are you know given, so we can easily apply this equation but before that we need to know whether the volumetric flow rate in this case is more or less than 50 cubic meter per second.

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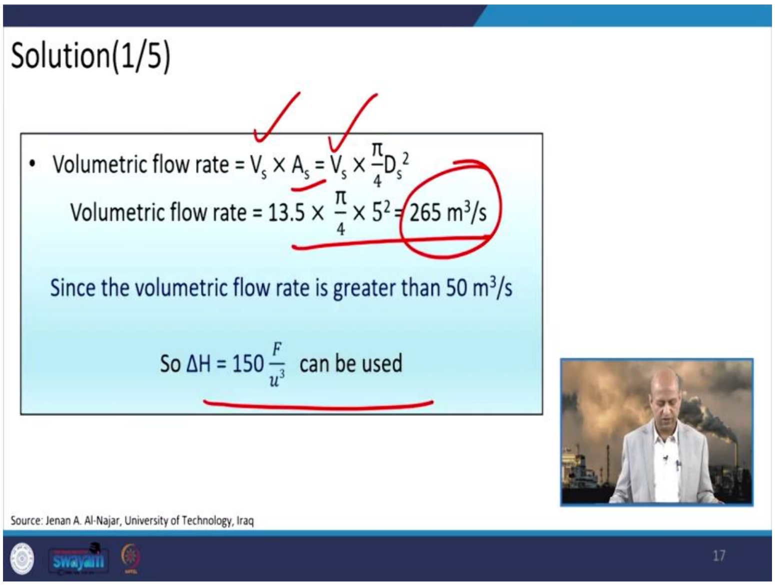

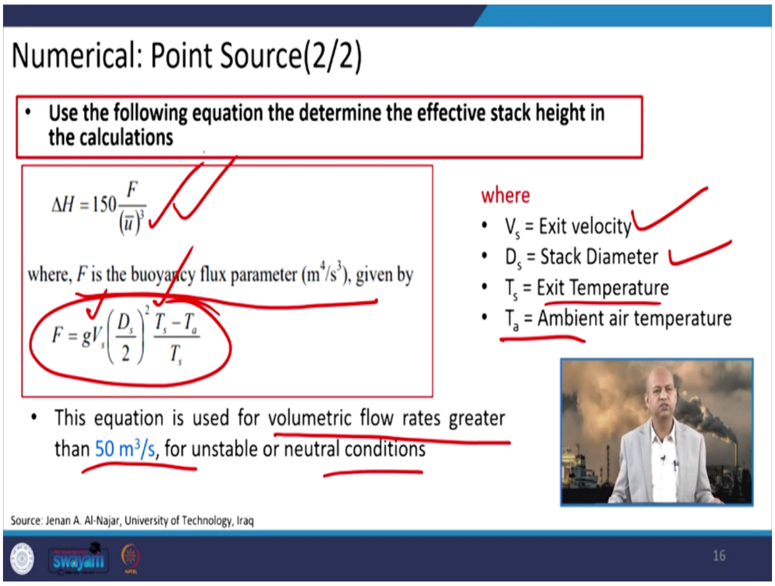

So, first of all let us calculate volumetric flow rate that is V_s into A_s, stack diameter that surface area, before the stack diameter that is this pi D square by 4. And V_s is the velocity with which this gas is being emitted through that exit velocity of V_s. So, we calculate this volumetric flow rate, this is around 265 cubic meters per second. So, that is more than 50 cubic meter per second. So, that is why this particular Δ H equation can easily be used. This Δ H, F by this u and then cubic of the u value that is the velocity, wind velocity.

Volumetric flow rate = $V_s \times A_s = V_s \times \frac{\pi}{4} D_s^2$

Volumetric flow rate = $13.5 \times \frac{\pi}{4} \times 5^2 = 265\ m^3/s$

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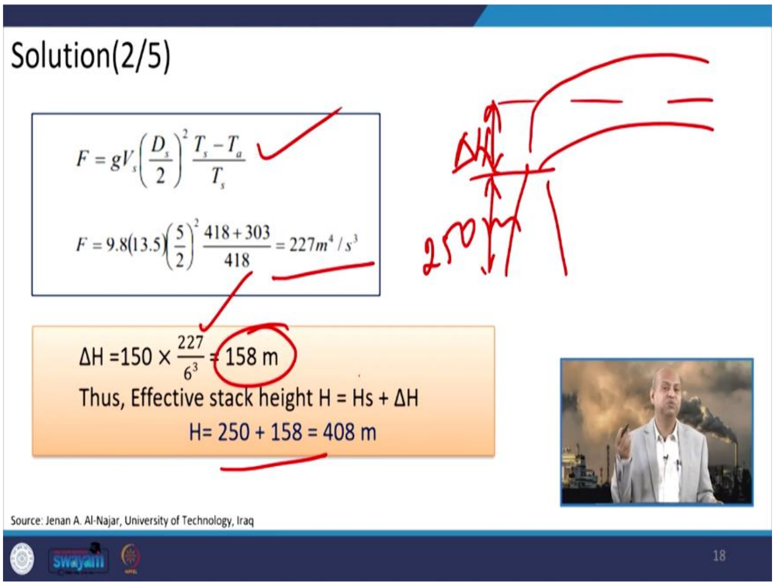

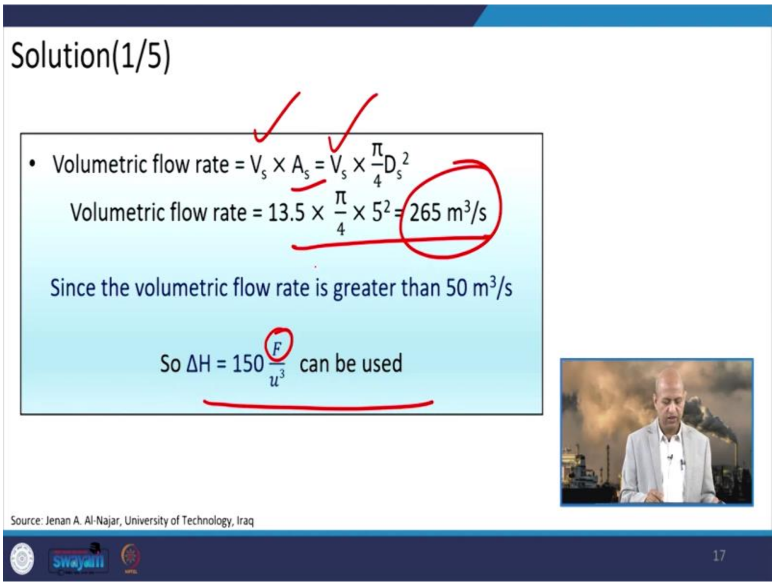

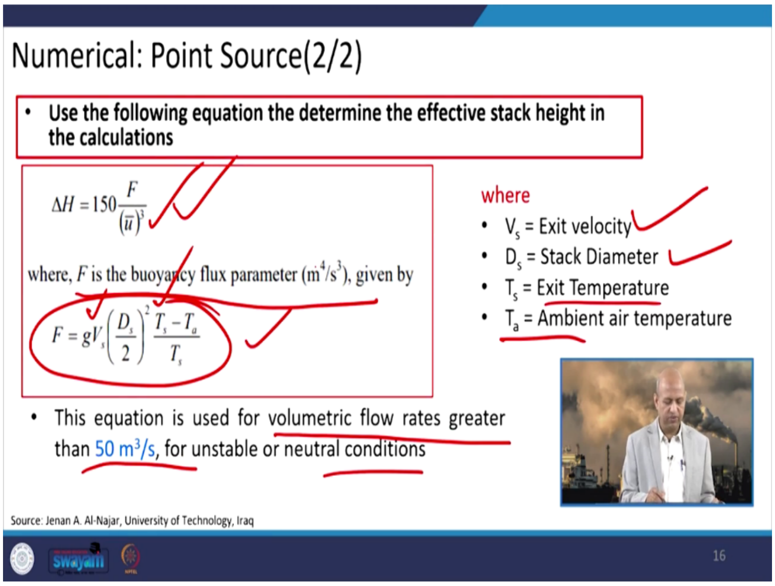

So, we can use this equation and for that F value we need to have first this and we can calculate F value from this equation. So, we first apply this equation and calculate the F value this is around 227. We put that value here and this 6 is there already wind velocity. So, cubic of that and we calculate this ΔH this is 158 meter that is the plume rise. Plume rise you know, this is stack height and then plume goes up and dispersed like this.

$\Delta H = 150 \times \frac{227}{63} = 158$ m

H = 250 + 158 = 408 m

So, at the centreline of this plume from the top of the physical stack this is the plume rise ΔH, we have calculated here, 158 meter. And 250 meter is already given the physical stack height. this is. this physical stack height is 250 meter. So, we add into 250 meter this 158. So, this is 408 meter that is the effective stack height which we will use for calculation purpose.

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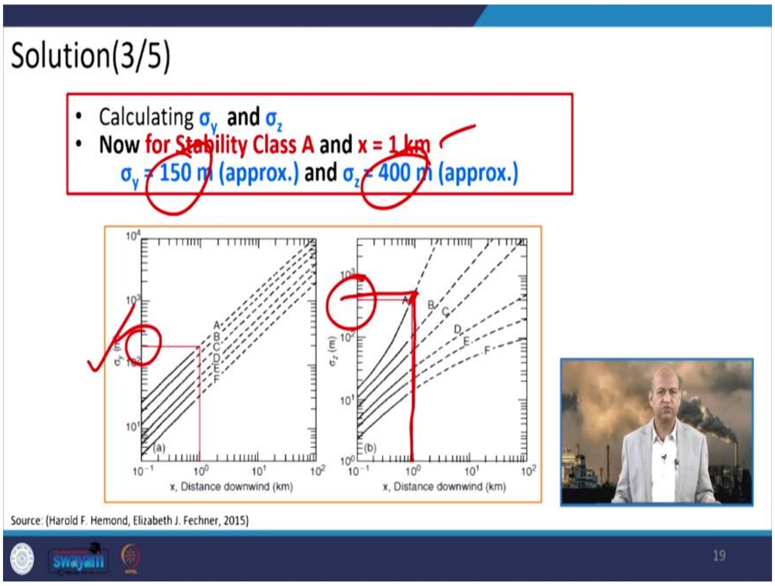

Now, we need to calculate σy and σz. Stability classification we already know it is given A, downwind distance is given 1 kilometer. So, 1 kilometer we go here for calculation of σy we go up to A, this curve for the classification stability classification A, then go left side wherever it intersect that is the σy value and that is around 150 meter here.

Similarly, for σz go for 1 kilometer on the X axis go up to this A, curve for A classification of the stability then go left and you calculate σz that is around 400 meter. So, σy σz value we have calculated from these curves.

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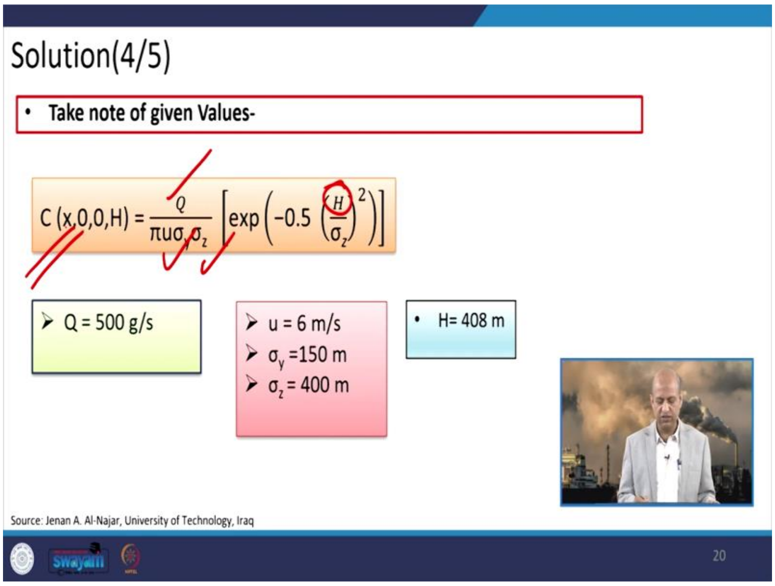

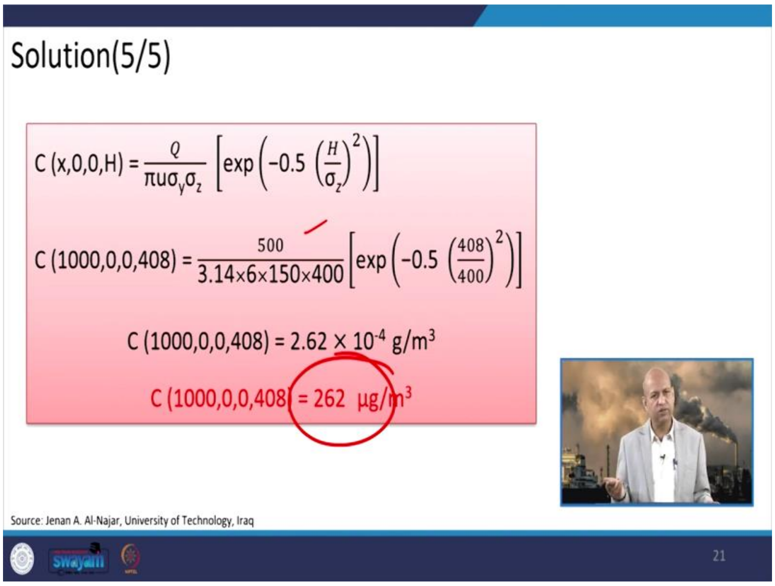

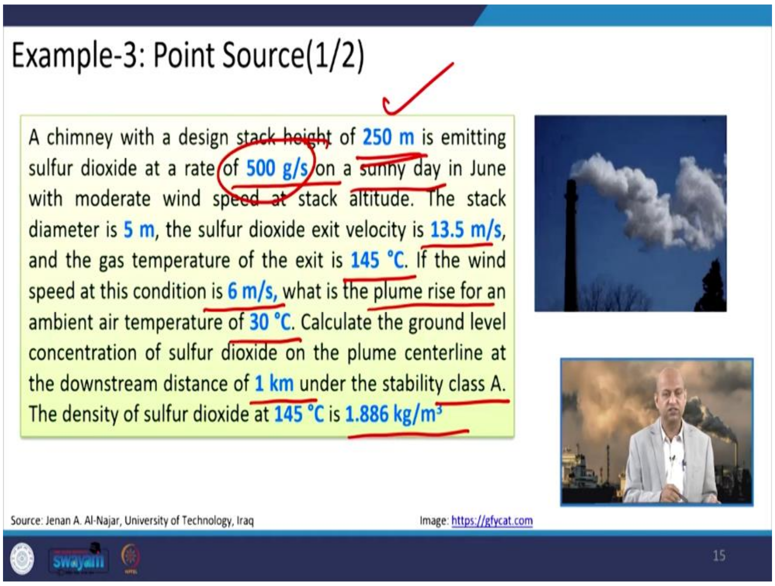

Now, what we need to do? We have to put these values σy σz, Q is given already, H we have calculated effectively stack height 408 just we calculated, σy σz we calculated, u is also given, and the Q is 500 gram per second, you can see here 500 gram per second this is the Q value.

$$C\ (1000,0,0,408) = \frac{500}{3.14\times6\times150\times400}\left[\exp\left(-0.5\ \left(\frac{408}{400}\right)^2\right)\right]$$

$$C\ (1000,0,0,408) = 2.62 \times 10^{-4}\ g/m^3$$

$$C\ (1000,0,0,408) = 262\ \ \mu g/m^3$$

So, put those values and we calculate the concentration at this 1 kilometre, we calculate how much it is, it is you put those values all and concentration is around 262 microgram per cubic meter. So, these are the you know different ways to apply this point source Gaussian dispersion model to calculate either concentration when effective height, stack height and downwind distance or literal distance that is Y is given. Or otherwise, if concentration is given, then you calculate the effective stack height.

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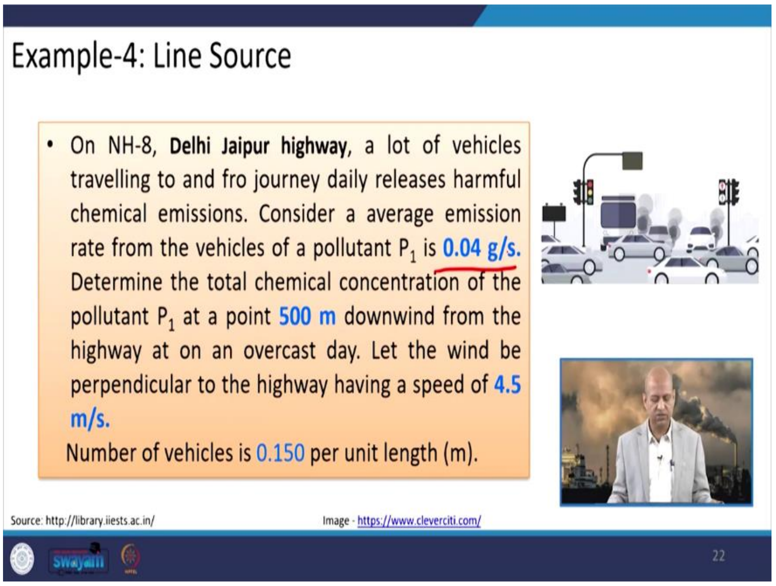

Now, we come to the line source. So, line source like on the road vehicles are moving and exhaust emissions are there from tailpipe and those this line of the emissions is there and the vertical distance we need to know the concentration to the normal or perpendicular direction of this line source. So, let us assume another example that on NH-8, Delhi Jaipur highway, a lot of vehicles traveling to and fro journey daily release harmful chemical emissions as different kinds of air pollutants.

Now, consider an average emission rate from the vehicles of a pollutant P_1 which is given 0.04 gram per second. What is to be determined? Determine the total chemical concentration of that pollutant P_1 at a point 500 meter downwind from the highway. So, downwind from the highway means, we assume that wind is blowing perpendicular to the highway, you can remember that line source dispersion model we discussed.

So, we assume that the wind is perpendicular to the highway. So, on that downwind distance around 500 meter what will be the concentration. The wind we assumed that the perpendicular to the highway is around 4.5 meter per second. And the number of vehicles is around 0.15 per unit of length, that is per unit of length means meter, per meter 0.15 vehicles are given. You can say like per 100 meter 15 vehicles are there, that is the number of vehicles going through these lines.

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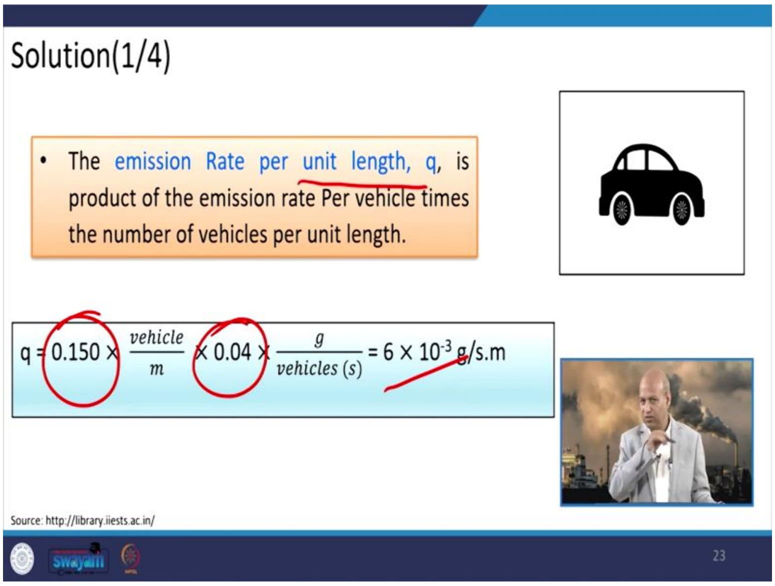

So, we now use this particular value which is given of the vehicle number. So, emission rate per unit length q, we need to calculate q gram per meter per second, it is given per second but we need to calculate per meter per second. And per meter vehicle are given 0.150. So, if one vehicle is emitting this much.

$$q = 0.150 \times \frac{vehicle}{m} \times 0.04 \times \frac{g}{vehicles\ (s)} = 6 \times 10^{-3}\ g/s.m$$

So, these vehicles in per meter they will be multiplied and we can get that 6 x 10^{-3} gram per second per meter, this is the emission rate on that particular line source, that we will use.

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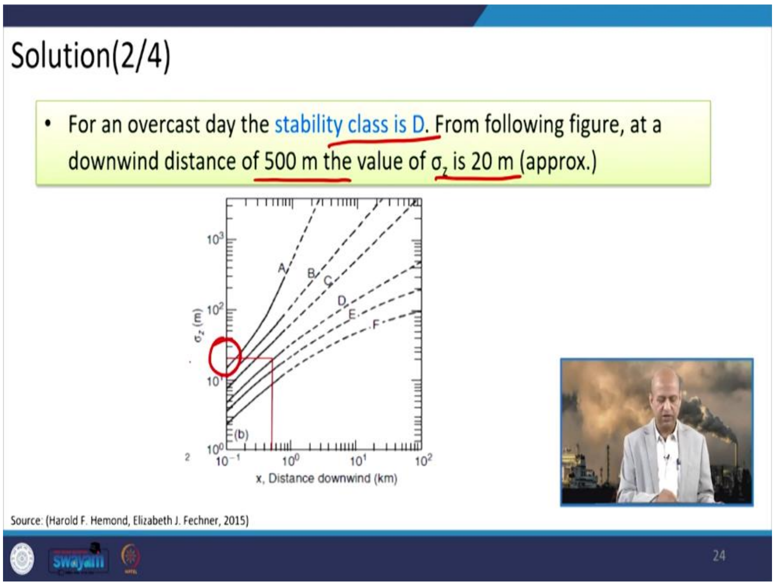

Now, for an overcast day stability classification is D. And from following figure we can calculate the σz value for 500 meter, σz value is around 20 meter for D.

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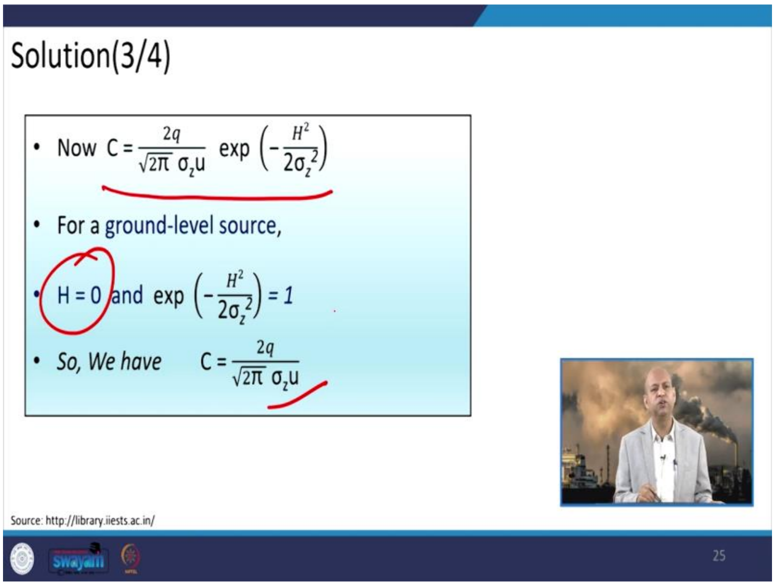

Now, we apply this particular equation where even effective stack height is given, but here effective stack height is zero because we assumed these ground level emissions from the tailpipe of the vehicles. So, this parameter will go away, only this 2q upon square root of 2 pi and σz u. This simple equation will be applied for line source dispersion.

$$C = \frac{2q}{\sqrt{2\pi}\ \sigma_z u}\ \exp\left(-\frac{H^2}{2\sigma_z^2}\right)$$

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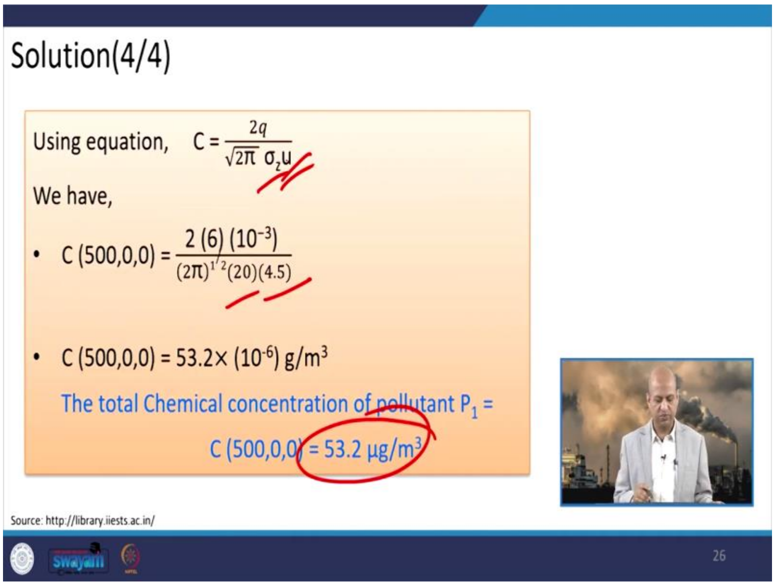

$$C\,(500,0,0) = \frac{2\,(6)\,(10^{-3})}{(2\pi)1/2(20)(4.5)}$$

$$C\,(500,0,0) = 53.2\times\;(10^{-6})\;g/m^3$$

So, we put those values, q we have we have calculated 6 x 10^{-3} and this value is 20 and 4.5 that is the value of the u and σz which we just calculated we put and we calculate concentration around 53.2 micrograms per cubic meter at the distance of how much 500 meter, 500 meter distance perpendicular to the highway line source. So, that is the application of line source dispersion model.

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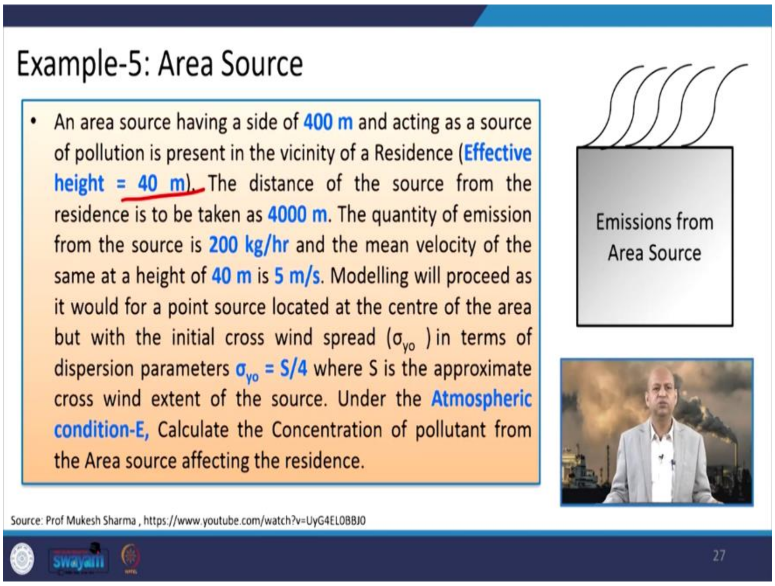

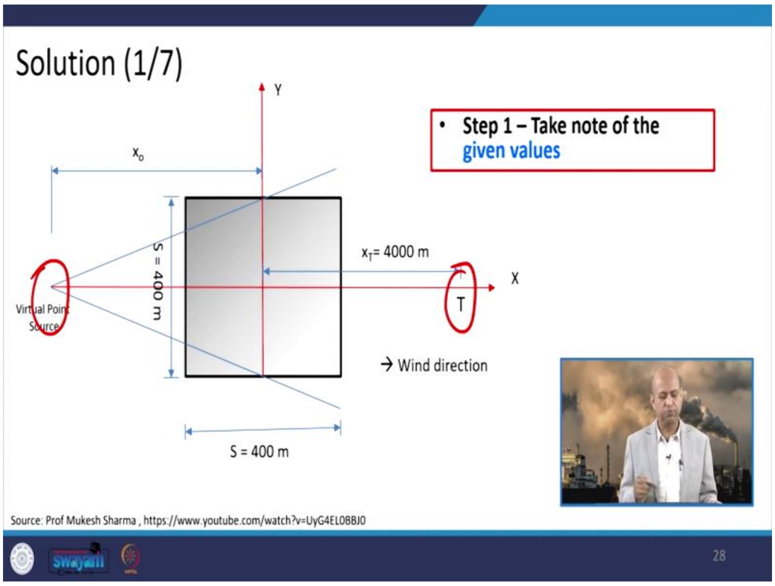

Now, we come to the area source. And area source we have seen that particular methodology, where we assume this virtual point source, we convert area source into a point source kind of analogy and we apply that relationship which we have discussed already. So, the same methodology we will use.

So, what is the values which are given for area source problem, this is the last example. So, an area source which is having a side of 400 meter, 400 by 400 meter we assume square area source. And acting as a source of pollutant is present in the vicinity of a residence effective stack height, so the effective height of 40 meter we assume this area source, you know a lot of plumes and emissions are there and effective stack height we are assuming as 40 meter.

The distance of the source from the residence is to be taken around for 4000 meter that is 4 kilometre. And the quantity of emission from the sources 200 kilogram per hour and the mean velocity at the height is 40 meter that is effective stack height is around 5 meter per second that is the wind velocity. And then the modeling will proceed as it would be a point source as we have assumed as a virtual point source.

So, that would be there. For a crosswind speed, that is σ_{y0} in terms of dispersion parameter that is σ_{y0} which is S/4, S is the approximate crosswind extent of the source under the atmospheric condition, E it has been assumed. So, we need to calculate concentration of the pollutant from the area source affecting that residential colony which is 4000 meter away from the source.

So, 4000 meter away from the source this is the residential colony where we need to calculate concentration that is the from the center of this area source the distance is given. X_0 is the distance of this virtual source which we assume that is the point source. S is 400 meter it is given. And we need to calculate X_0 and we will add into this X_T.

So, that we can get the total distance from the point source that is the virtual point source to the receptor and then we can apply the simple points or dispersion modeling equation.

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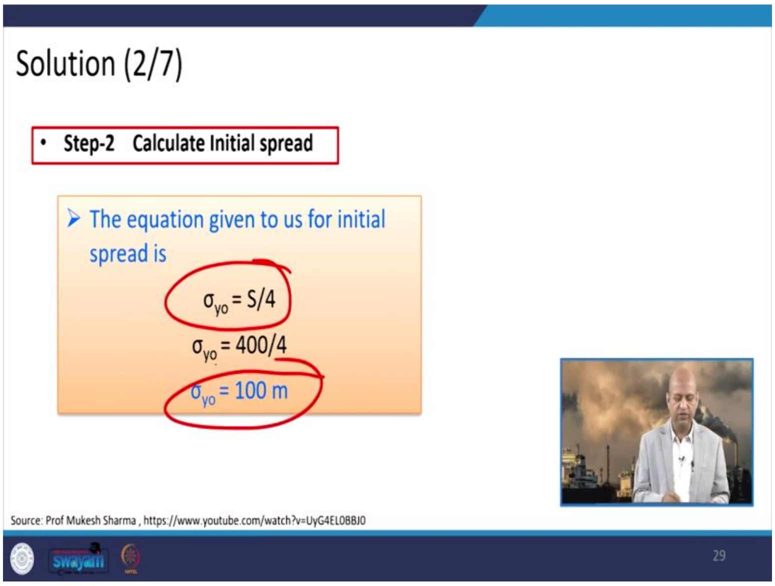

So, σ_{y0}, S/4, this relationship we already know, S = 400 meter is given. So, you know 100 meter is the σ_{y0}.

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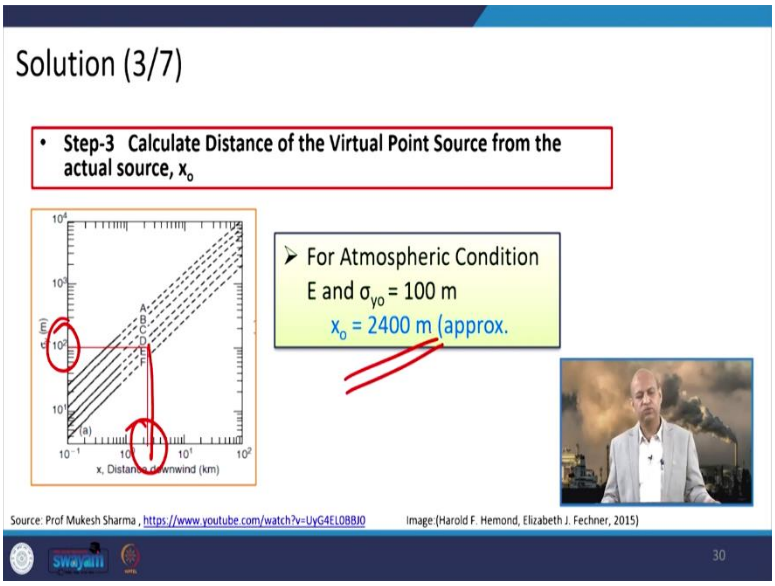

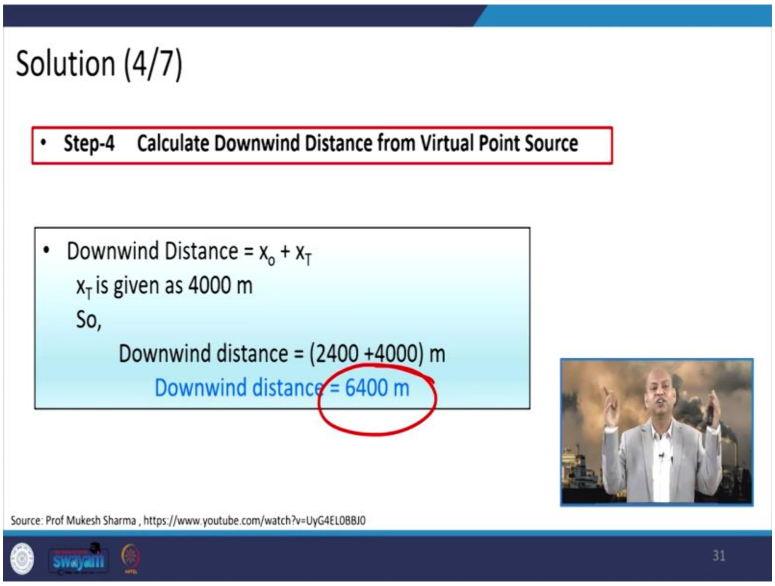

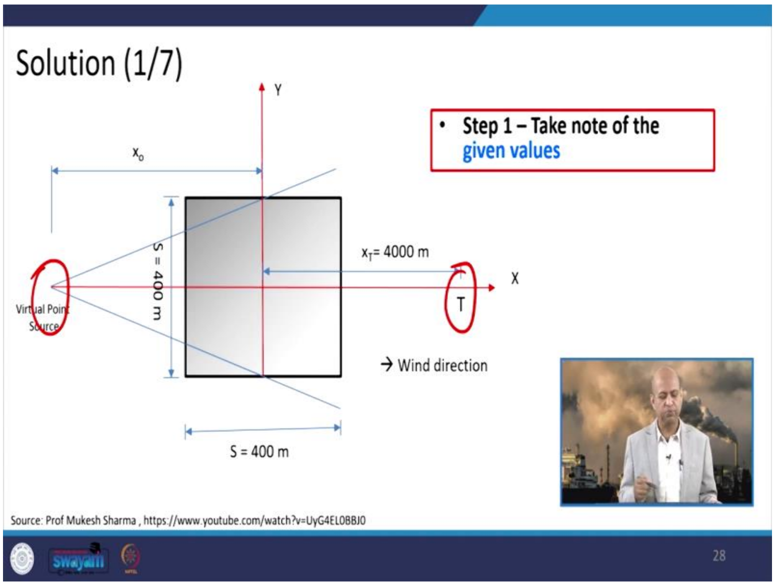

For σ_{y0}, now we need to calculate x value. So, σ_{y0}, here you go to the stability classification curves. So, E stability classification is given, come to the E, go down you get this X value this is around 2400 meter. So, now, this 2400 meter is this one, this is 2400 meter, you add into 4000 meter you get the total distance that is 6400 meter, 6400 meter is the distance of that receptor or residential colony from the virtual point source.

Virtual point source is nothing but the area source. We are assuming that this virtual point source is emitting as much admission as is coming from the area source. So, that is assumption-based calculations.

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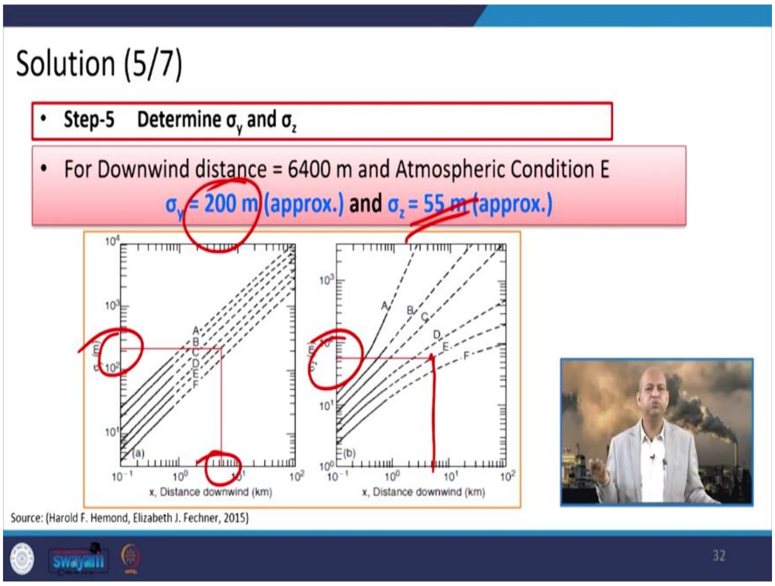

So, again we need to have σy and σz because we got this x value 6400 meter. So, for this 6400 meter you go to this E classification, go left side get the σy which is 200 meter. Similarly, for σz go up to the E classification curve, go left get σz value which is around 55 meter. So, now you have σy and σz.

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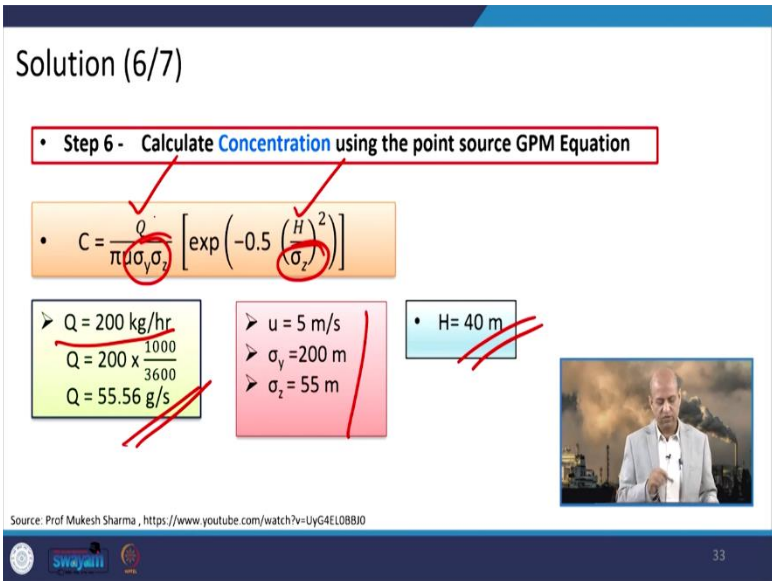

Again, the same equation of the point source dispersion model you can apply, Q value is there σy σz we have calculated, σz we know now H effective stack height already given 40 meter. So, that we will use this 40 meter. u = 5 meter is given again at that effective stack height in the problem it is given, otherwise you can calculate, you can, it is very easy.

σy and σz values are there. So, we put those like Q value 200 kilogram per hour that value is given, you can convert it into gram per second this equation is for gram per second. So, put those values into gram per second.

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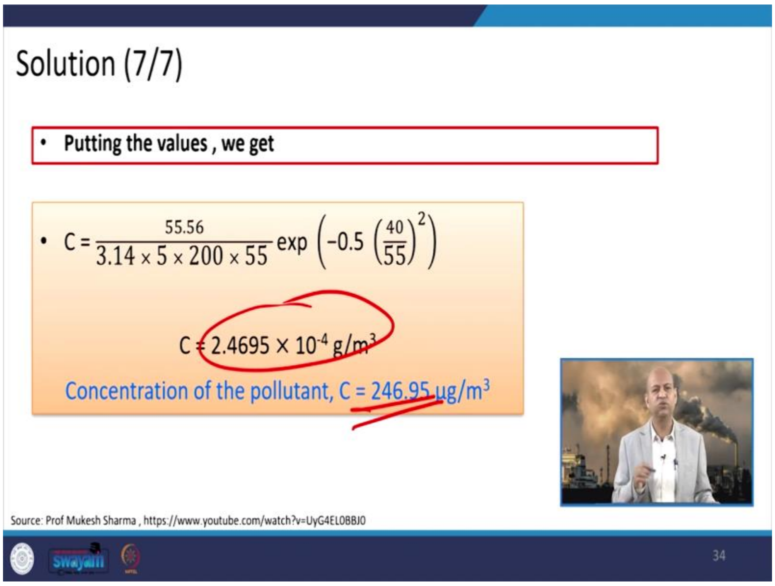

$$C = \frac{55.56}{3.14 \times 5 \times 200 \times 55} \exp\left(-0.5\left(\frac{40}{55}\right)^2\right)$$

$$C = 2.4695 \times 10^{-4} \text{ g/m}^3$$

And ultimately the concentration you calculate is around 246.95 or 247 microgram per cubic meter. So, this is the application of area source converting into virtual point source and calculating using the point source dispersion, Gaussian dispersion modeling approach.

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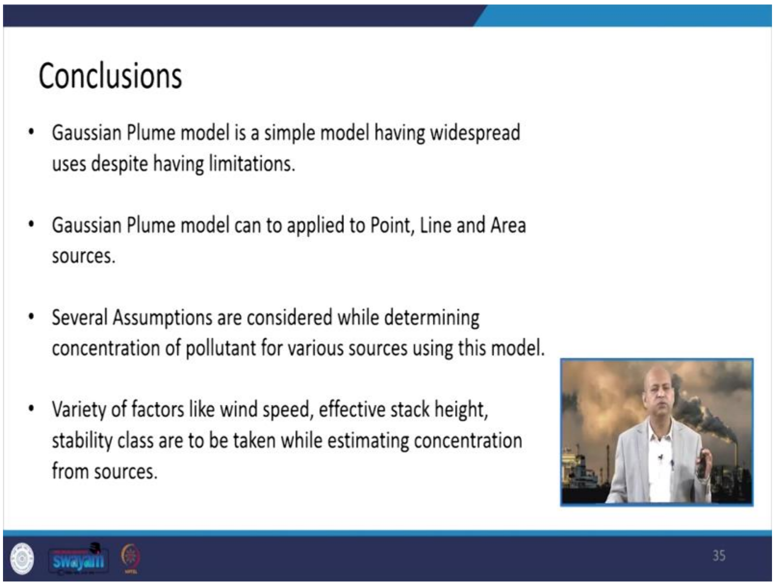

So, in conclusion, we can say that the Gaussian plume model is very simple model it has a lot of assumptions although, but for policy makers it is a quick calculation approach basically and it is used widely spread, it is very popular. Despite so many limitations and assumptions. Then Gaussian plume model can be applied to all point line and area sources as we have seen, line source no problem, area source you convert into virtual point source and then again apply that is again very simple.

Although several assumptions are there for estimating concentrations from various sources using this model, but rough values are okay for policymaking or these baseline scenario creations. Variety of factors are there like wind speed or effective stack height, stability classes, all these affect in fact these concentrations, so, we need to be careful about those things. Like for example, effective stack height is important.

So, you need to calculate plume rise if effective stack height is not given. If the wind velocity is given at the ground level, and you need to have the wind velocity at the effective stack height. So, you have to apply that, if you remember $(u_1/u_2) = (z_1/z_2)^p$. So, that equation you can use to calculate the wind speed at the effective stack height. So, those kinds of things are there you have to be alert, so that you do not make any mistakes, because these equations work on certain assumptions.

Like u is the velocity at the effective stack height. So, you have to be careful that the wind velocity should be at the effective stack height, if it is not given then you have to compute. So, all those things then σy σz values you need to calculate, all those. If it is away from the central line, then you have to be careful about the y value otherwise y you can put zero. So, these are the things for today it is all.

So, I hope, this particular tutorial kind of exercise will help you to visualize properly how to apply the Gaussian plume dispersion model in calculating these concentrations at the ground level or at any distance. These are the simple examples which we have discussed, but you can have little bit more complex examples.

I would advise that please solve on your own and you will be able to appreciate this particular approach of Gaussian dispersion model. So, this is all for today. These are the references which you can go at leisure to know more about this particular approach of Gaussian plume dispersion model. So, thank you for your kind attention. See you in the next lecture. Thanks again.