Lighter Than Air Systems
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Lecture - 38
Tutorial Problem 05 on Change in Atmospheric Pressure

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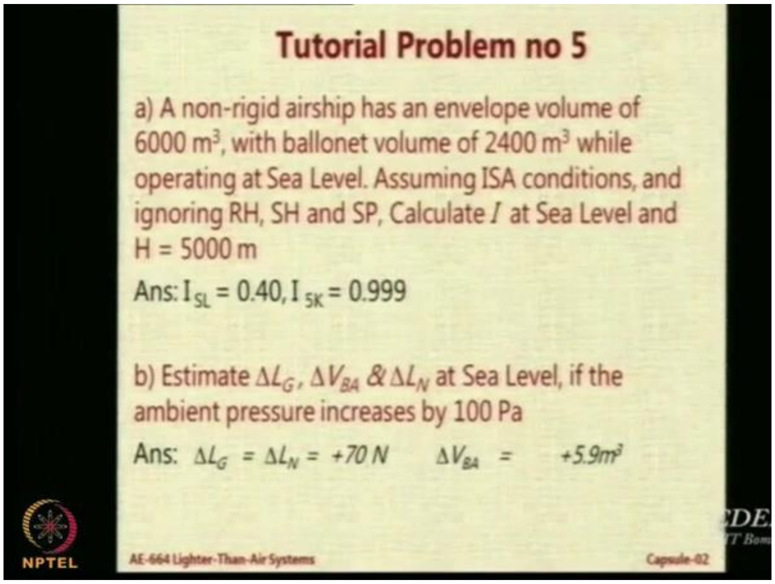

So let us see if you all understood this by doing a simple tutorial problem. So, this problem will run now in the whole class for all the example that we see. So, we assume that there is airship of 6000 meter cube and envelope volume and a ballonet of 2400 meter cube at sea level condition. So, we are looking sea level conditions and for the simplicity we ignoring the humidity and that e will be zero.

We are also ignoring super heat and also ignoring the super pressure. So, calculate I at sea level and I equal to H equal to 5000 meters. First part of this I at sea level you should do it orally. What will be ISA at sea level? 0.6 simple, 6000 total - 2400 air, difference will be 3600 divide by 6000 that will be amount of the fraction of the gas so it is 0.6. So, we are coming to the same question that I showed you earlier. Sea level the value of I is 0.6.

Now I am asking you what happens to I at H is equal to 5000 m? It will be 1 but just confirm it. It should be 1 because you just now seen that graph. For sea level condition I is equal to 0.6 and it goes to 1.0. So, reconfirm this, you may get 0.99 or 0.999 either etcetera, confirm it, please. How do you confirm this? Where is that formula I_2 by I_1. So, what you need to do is to calculate the pressure at 5000 meters. How do you do that? What is the pressure at sea level? 101325 Pascals.

How do you get the ambient air pressure under ISA conditions at 5000 meters? So that is the simple formula which I will like you to remember and that is that the parameter is called Delta δ and other parameter called theta θ. θ is temperature ratio so $\theta = \frac{T}{T_0}$, T_0 being the sea level condition and T being conditions at any altitude. So, $\frac{T}{T_0}$ is the temperature ratio. So, the value of T at any altitude of up to 11 kilometers 11000 meters will be 6.5 degree reduced per kilometer altitude from sea level value of 288.16 or take it as 288.

The first keep the value of temperature at this particular altitude that will be 288 - 5 into 6.5. So, now you have the temperature at 5 kilometer altitude in ISA conditions. Now the pressure ratio that is $\frac{P}{P_0}$ also called as delta δ.

$$\delta = \theta^{5.235} = \left(\frac{T}{T_0}\right)^{5.25}$$

I think. This is only under ISA conditions so the value of $\frac{P}{P_0}$ or $\frac{P_2}{P_1}$ where 2 is 5000 feet and 1 is Sea level that will be equal to $\left(\frac{T_2}{T_1}\right)^{5.256}$

So given the value of P 5000 by P sea level 0.5, 3 digit it is ok, if you have 4 digit sufficient. So, what will be I_2 by I_1? I_2 by I_1 will be equal to the pressure ratio only. So, to get I_2 you just multiply I_1 which is 0.6 with this ratio. Now, I think you are doing the opposite instead of dividing your multiplying so you are getting 2 in fact you should divide them. So,

$$I_2 = I_1 * \frac{P_1}{P_2}$$

P_1 is a sea level P_2 is the Ambient 5000? So, that is right I_{SL} is equal to 0.4 not 0.4 it is 0.6 and I at 5000 m is 0.999. Now let us calculate the change in the gross lift. I want to correct it; I_{SL} is 0.6 is not 0.4 and I at 5000 m is 0.999.

So, estimate ΔL_g, ΔV_{ba} and ΔL_N. So, ΔV_{ba} is what? It is volume of the ballonet not the weight so you have gotten it from the density. It is already in ISA conditions therefore density of ISA is 1.256 kg/m^3. So, first calculate ΔL_g then W_{ba} hence V_{ba} and then ΔL_N which is the net lift.

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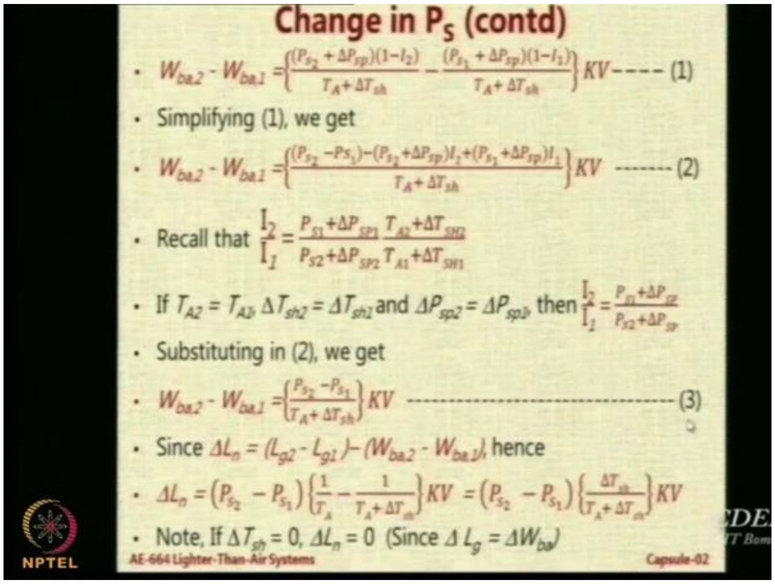

So, I will open the formulae for you. You have to use these two expressions. First expression that you need to use L_g. So, L_g will be 100 into K V by T_A all you need is the value of K, V is the volume which is already given 5000 meter cube. T_A is the ambient air temperature and you are talking about sea level.

So, what is ΔL_g, 33 Newtons, no ΔL_g 33 kN so much change it is only 100 Pascals, 101325 is the total pressure and ΔP is only 100. It should 70, I think around 70 is what I expect. Around 70, let us go up and look at how do you get the value of volume of ballonet air.

For that you have to use equation number 3, equation number 3 contains difference of the pressure. So, that ΔP is $P_{s2} - P_{s1}$ is 100 divided by T_A, which is ambient air temperature 288.16. ΔT_{SH} is 0, ΔT_{SH} is being ignored. No super heat may change in the current calculations, so we will get the rate of the ballonet air and with that density we can get the Volume. So, what is the volume.

Change in volume in ballonet air, all students must bring calculator in this class. I think it is quite straight forward why so much time. What is ΔW_{ba}? 71 what grams, kg, Newton? Newton, so now you get it from density from density get it in meter cube, 6 meter cube that is right that is the correct answer. It should be approximately 5.926 meter cube. Now what about the ΔL_N? ΔL_N will be equal to ΔL_g. Now it is the time for me to correct it and make it 0.6.