Lighter Than Air Systems
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Lecture - 49
Flight to Lower Ground Elevation

Look at this particular limitation of airships. We are operating from an origin location O, which is at a height H_O to another destination which is D at the height of H_D. Obviously either the destination would be at the same altitude or at a lower altitude or higher altitude.

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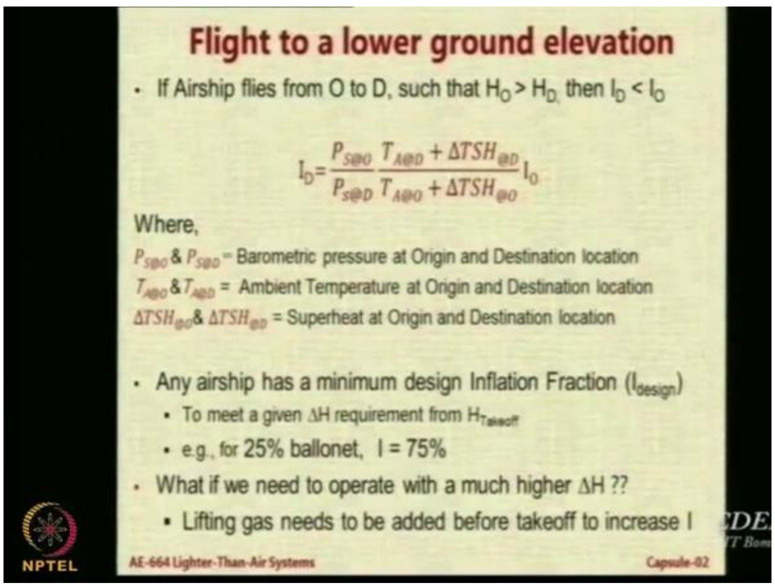

Now if we fly to elevation, takeoff from you take off from a place like Pune at what elevation is Pune from the sea level? Is not equal to sea level is much higher. Or just to make it more dramatic let us look at the Lonavala we know it had some height from sea level. So, you design the airship to fly from Lonavala. You have taken care of the ballonet a volume that when it goes from Lonavala to some maximum pressure altitude the ballonet will become flush.

So, what is the amount of air in the ballonet at ground level is maximum or minimum? They are full at ground level the ballonet is completely full. As the airship goes to higher altitude you take out the air. What will happen if you operate from an altitude go to higher altitude then you come to a much lower altitude. Do you see any problem? Why they distort? No on the other hand the ballonet will become full but save to go down there is no volume available in the ballonet to taking the gas needed to go down.

So, you remember a problem you are not able to go down. So, if an airship is designed to operate from Pune and to go only to some height. If you bring to Mumbai, you cannot land and when it wants to come below for that what will you do? You lose gas, one way you expel some gas. So, it is important. So, if an airship flies from a location O that is origin to a location D that is destination. Such that the height of the origin is more than the height of the destination then the inflation fraction at destination that is I_D is going to be lower than the fraction at origin.

The value of I_D can be obtained by simply looking at the ratio of pressures and temperatures plus the superheat. This is your familiar formula to use only thing is I added S@O for ambient pressure at origin etcetera. Now please note these are the barometric pressure heights at the origin and destination T as ambient temperature and the superheat. Now you have a minimum inflation fraction already designed in airship to take care of delta H for the altitude change.

So, for example I designed the airship to take off from Pune to a height of 2 kilometers from Pune I will work out how much is the ballonet volume needed as a percentage of the total volume (1 – I) so 25% so if one fourth of the volume occupied by ballonet 3/4th by the LTA gas. At the ground level I will design a ballonet for that size. So, if you have a given inflation fraction, but the inflation function needed at destination is more.

So, therefore what do you do if you want to operate the much higher ΔH? ΔH being the height change which means if I want to go from same thing from Pune to higher altitude and come down to Mumbai delta H required from Mumbai that height. What do I do? I already given the answer to you in my initial discussion. The only option you have is to change the lifting gas. You have to add lifting gas before the take off. So, take care of the height difference that you have to.

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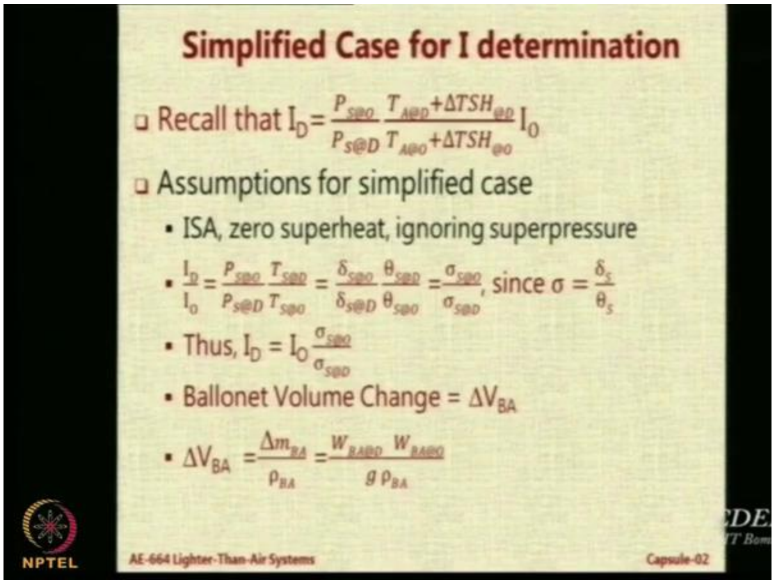

So let us look at this formula and go for some simplification. What simplification where superheat will be ignored. Then under ISA conditions you have a fixed pressure at sea level case at least. So, you can say that $\frac{I_D}{I_O}$ that is inflation fraction at the destination upon the inflation fraction at the beginning is equal to

$$\frac{I_D}{I_O} = \frac{P_{S@O}}{P_{S@D}} \frac{T_{S@D}}{T_{S@O}}$$

On simplification we get

$$I_D = I_O \frac{\sigma_{S@O}}{\sigma_{S@D}}$$

Therefore, you look at the atmospheric chart find out the density at any altitude. Find density at the altitude from which you are operating. Calculate the σ values and the ratio of that gives you the required inflation fraction. So, the change in the ballonet volume will be easily obtainable as the from the inflation fraction directly.