Lighter-Than-Air Systems
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Lecture - 54
Sea Level Inflation Fraction

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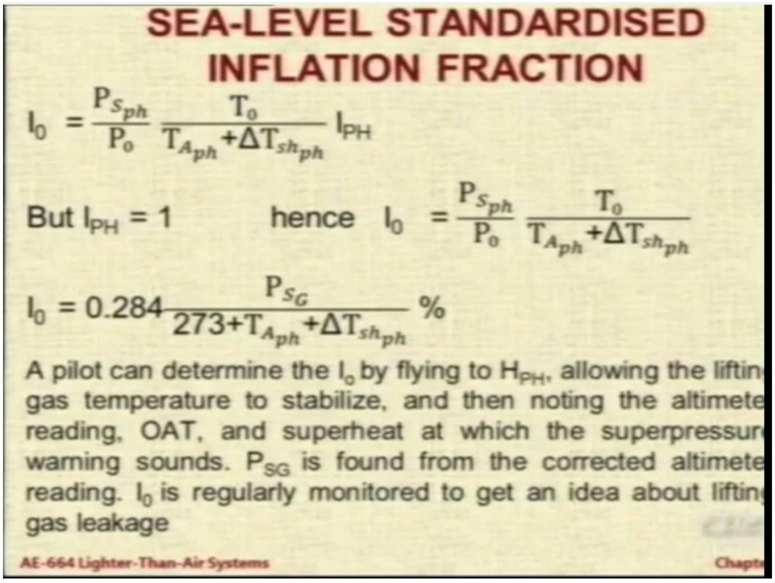

Now let us look into this little bit more deeper and see if we can get. So once again I am replacing the previous expression. I am just calling it as I_0 and I_{PH} where I_{PH} stands for the inflation fraction at pressure altitude, pressure height and I_0 as the inflation fraction at the sea level of the ground conditions. But $I_{PH} = 1$ because at pressure altitude the ballonet becomes flush.

So, the percentage I_0 needed for you to fly, so the same question could have been given in the reverse form saying that an airship has to fly up to 1500 meters find the sea level inflation fraction. So, we will use this expression to get the value I_0 needed the ground level to reach a particular operating altitude without exceeding the pressure height. So, interestingly the inflation fraction that you need to provide it also allows you to check the health of the airship.

For example, when a pilot is operating an airship over a period of say 2 months, 6 months, etc., you can determine what you can do is pressure height is known to you by calculations. So, let us say you inflate every time with a given inflation pressure, sorry inflation fraction let us say

90% and let me fly to the pressure altitude. And then you fly steadily so that you allow the temperature to stabilize and find out at what height you are reaching.

So, if the conditions are ideal and if there is no gas leakage, there is no problem in the system, then what will happen is that with a given inflation fraction allowing the gas to stabilize you will reach a pressure altitude, let us say the 1500 meters. But now over a period of time over 3-4 months some gas will leak, perhaps there is a small hole somewhere which was patched up but before it was patched up some gas has gone perhaps through the fabric there is going to be some leakage of lifting gas.

So, what will happen is that there is something called a superpressure warning. That means when the pilot flies at up at the pressure altitude, the superpressure is 0. But if you go slightly higher, then it starts getting pressurized inside because outside pressure is falling, inside pressure is same. So when you reach some ΔP there is a warning that do not go above this you are stretching the envelope that is the safest altitude permitted to fly slightly above the pressure altitude.

So, to monitor the health of the airship, you can continuously fly over a period of time till you hear the alarm that means now you have reached a condition read the altimeter and then you can get the idea that am I able to get altitude which I should get. For example after 3 months, you might find that this superpressure alarm is sounding when I reach only 1450 meters. That means I am not able to go 50 meters more.

This is because the lifting glass is not the same amount as previously. So, this gives you an idea about the deterioration of the airship. Now when the pressure height achievable falls below a number it is time to pumping more gas inside or to go for the purification of the gas inside. So this is the operational point. So, the inflation pressure report at ground level to reach a particular altitude is used by the airship pilots to monitor the health of the airship continuously.

You can have a same problem in aircraft. In aircraft for a given engine rating, the pilot will keep on flying to an altitude where the climb rate is a given value, let us say 10 meter per second and to check the health of the aircraft you can check this value. You might find that after some time because of the loss in the efficiency of the engine, you may not get the required thrust or the thrust which it should give.

Because of that the altitude up to which you can go will be lower than the maximum. So, you come to know that there is some fault or some problem. So, such methods are used by performance engineers for monitoring the health of the aircraft.

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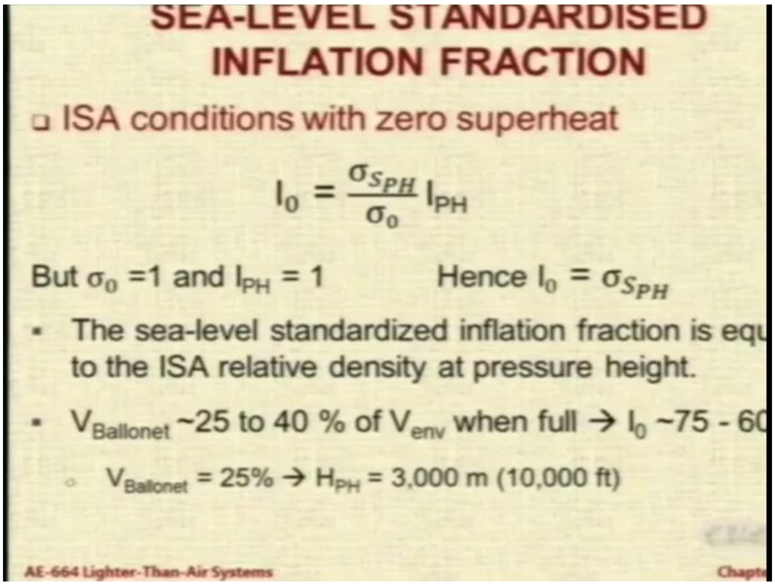

Now, simple formula for the inflation fraction at sea level for any pressure altitude ratio of the two densities. So, this gives you a very simple definition. It says that if you want to fly a particular altitude from sea level under ISA conditions, let us say you want to fly at a height of 1500 meters, then the inflation fraction will be equal to σ at 1500 meters from the atmospheric tables, simple.

Therefore if you want to fly, you know if you want to fly with the Ballonet volume of 25 to 40% of the V_{env}, then you would automatically get height as 3 kilometres because σ at 3 kilometers equal to 0.25, sorry 0.75. Similarly, if you want to go higher you have to put more air in the ballonet. So, this is going to continuously reduce the volume available for the LTA gas inside the envelope.

As the airship wants to go higher and higher, you have to put more and more air in the ballonet on the ground level. So, it can happen that to be able to get to a higher altitude half the envelope is full of air and the remaining half only is full of the lifting gas. Do you understand this? So, a very simple way of finding the required inflation fraction is to look at the desired pressure altitude and find the density ratio of that particular altitude and that much percentage should be the inflation fraction automatically.