Lighter-Than-Air Systems
Prof. Rajkumar S. Pant
Department of Aerospace Engineering
Indian Institute of Technology - Bombay

Lecture - 59
Pressure Height for Other LTA Vehicles

Finally, we will very briefly look at the concept of pressure altitude for other LTA vehicles. What we have seen so far is only for a classical non rigid airship which has a ballonet inside and an envelope. But there are other LTA vehicles. There is a hot air balloon, there is a superpressure balloon, there is also a rigid airship. So, let us very briefly see for them what happens.

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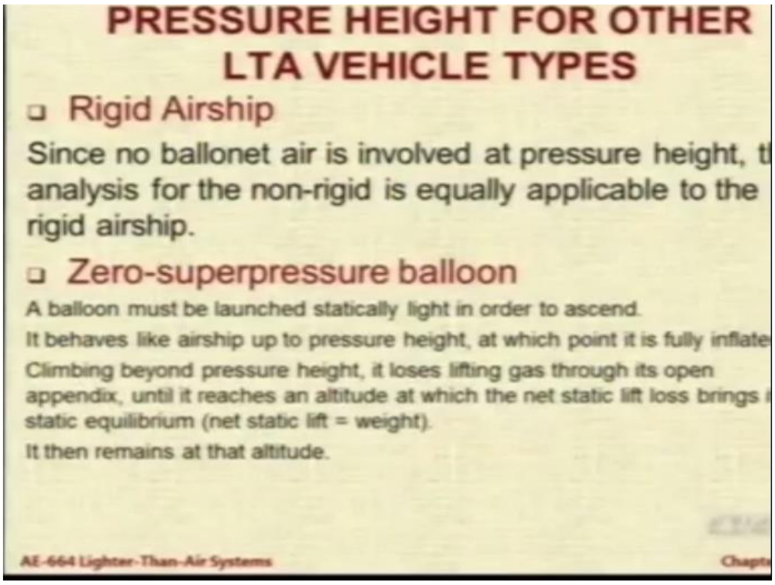

Let us look at a rigd airship. Now rigid airship does not have any ballonet. It just has gas bags inside a structure. So, the analysis that was done so far is applicable for them also. Now if you look at zero-superpressure balloon that means a balloon which is having the pressure inside just equal to atmosphere, this is called zero-superpressure balloon. Now, let us assume that this balloon, now this balloon it has to go up. It cannot have no buyoncy.

It has to be statically light, right. So, it has to contain a volume more than that which gives you lift equal to weight. So, the buoyant lift will be more than the weight that is how it will go up, right. Now up to a pressure height it be like an airship at which point it is fully inflated. So, what is happening is the balloon is not fully inflated at sea level, as it goes up it goes up, it goes up, the gas inside is expanding.

When it reaches the pressure altitude, it is fully expanded. Once it is fully expanded, there is no room for expansion unless you stretch the envelope. So, if you want to go above this altitude, again you have to lose the lifting gas. So, even there they have a small appendix. And then it will start going to a state it will reach an equilibrium. After that it cannot go up, it cannot come down unless you rupture it.

If you rupture it, the gas is lost. It loses the buoyant lift, it comes down. So, it will remain up to a desired altitude and this is what they do. They want the balloon to fly at some given altitude, so let us say 40 kilometer altitude. So, they will design in such a way that at 40 kilometer altitude it is now neutrally buoyant and then it will remain there.

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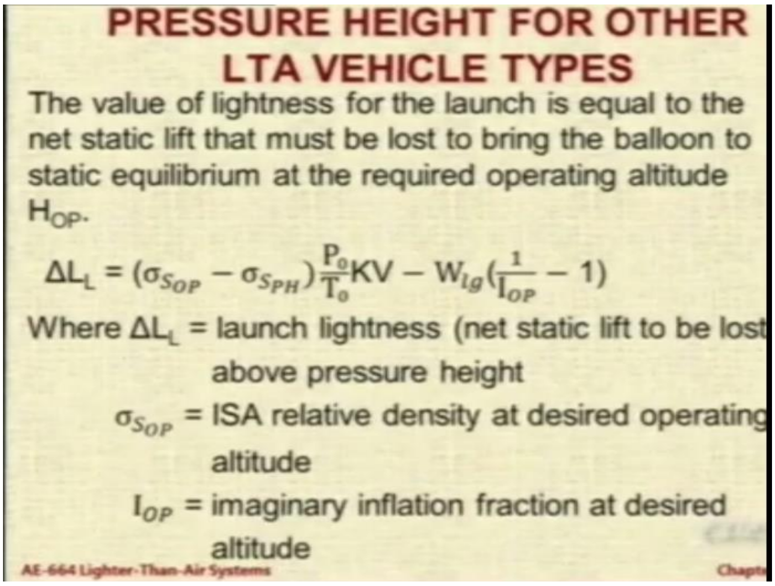

Now this is just a calculation that how much statically light it should be. So, you can work out that the lightness should be equal to the difference

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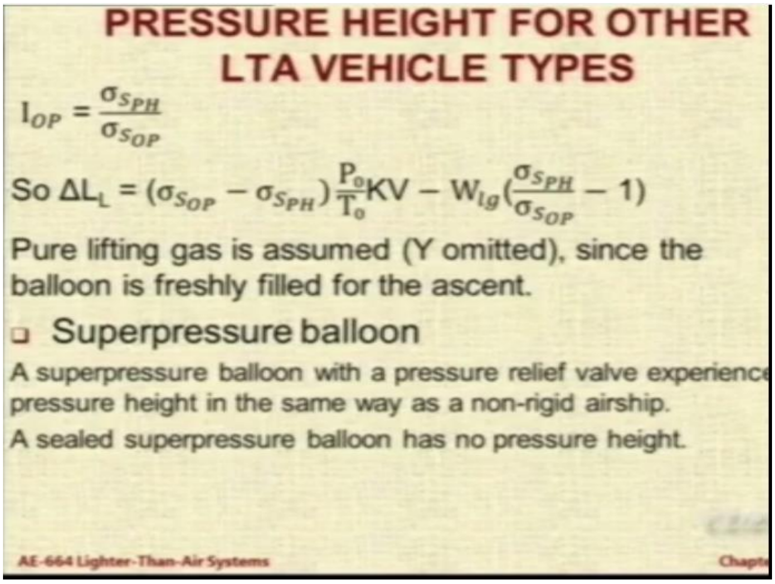

I am not going to go into the detail of this because this is a little bit beyond the scope of a basic LTA course. Now, let us look at suprepressure balloon. But I will leave in the notes so that you can do it yourself. Superpressure balloon is basically having a pressure relief valve. It has got pressure more than what is needed, so it is tight. But there is a pressure relief valve. So just like another airship as it goes up, when it exceeds the place where the superpressure is equal to the ΔP, the valve will open and it will just keep going up.

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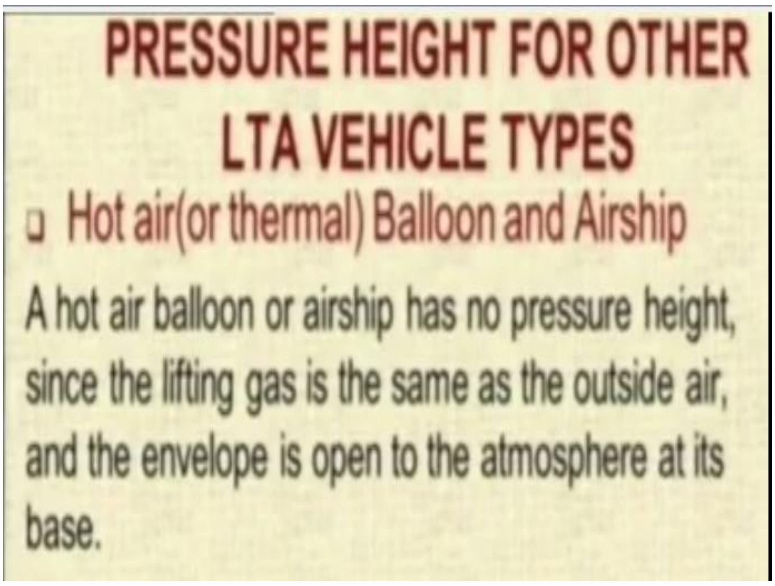

Now if you look at the hot air airship or a thermal balloon, what is there inside that? You have a chamber which has got hot air and you have a heating element below and the throat is open. There is no ballonet there. There is no pressure height because the lifting gas is the same as the outside air and it is open to the atmosphere at its base. So just by virtue of heating the air you create buoyancy.

So, there is nothing like a pressure altitude for it as long as you can keep on heating the air and the outside air is cooler that delta density into volume will keep giving you lift. So, it can technically go to any altitude it wants to go. But the energy requirement as it goes higher and higher temperature also falls that temperature will be conducted inside. So, the hot air inside actually will start getting cooled because of the heat transfer.

You pump in more heat from inside, a time will come when you cannot exceed it. So it will basically remain at that altitude. So with this, we have finished the theoretical calculation for the static lift. This portion as I mentioned in the beginning of the class was left out and now it is completed so that is why this is part of a capsule 2 only.