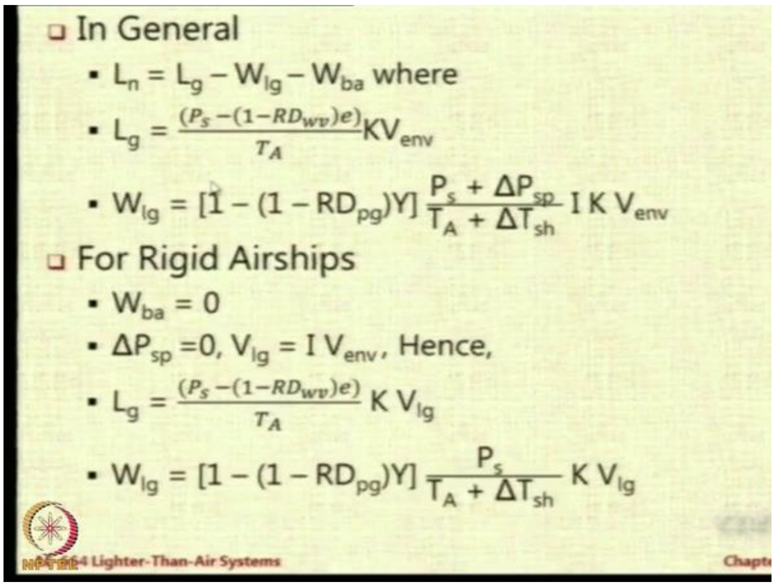
Lighter Than Air Systems
Prof. Rajkumar S. Pant
Department of Aerospace Engineering
Indian Institute of Technology - Bombay

Lecture - 34
Net Static Lift for Other LTA Systems

(Refer Slide Time: 00:24)



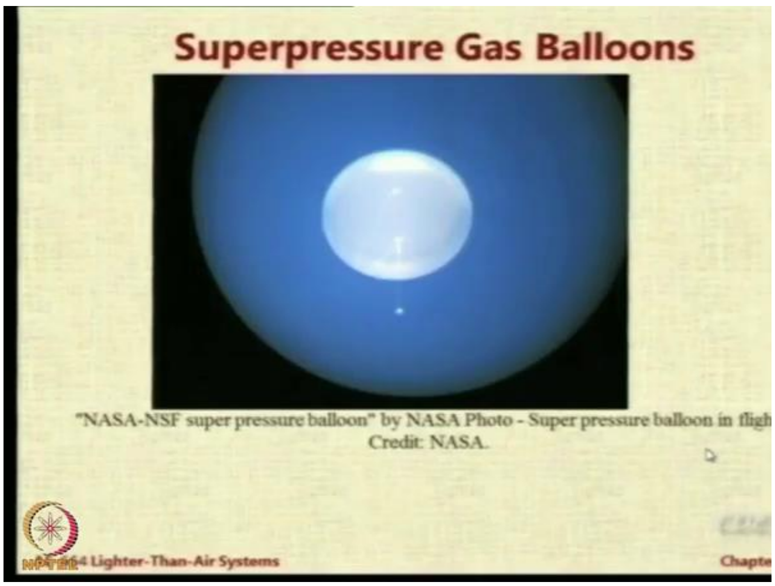
So, there are the familiar expressions that we know already for any LTA vehicle for the net lift, gross lift and their weight of the lifting gas. What about the weight of ballonet air? That is going to be zero here. So, W_{ba} will be equal to zero. What else will change if it is a rigid airship? What do you think will change? See we are looking at the structure weight for anything so far. So, what should it come for rigid airship?

In all our discussion we are only looking at now the static lift produced by the system. So, the static look of this system we are not concerned about the weight because we are looking that. So now what about the super pressure? Will we have any super pressure in rigid airships? No, because you are not going to inflate the rigid airship at the pressure at the air atmospheric. We do that in a normal non rigid airship because we need to maintain the shape.

Where shape is maintained by the structure so therefore there is no super pressure. P_{sp} will go zero. Similarly, volume of the lifting gas will be equal to the net infraction fraction I times V_{env} where this I is basically summation of I_n upon V_{env} that is value of the lifting gas. Agree. Put this is in the expression and you will get back the lifting gas instead of using V_{env} we will use directly Volume of lifting gas. Because envelope is not containing the entire gas.

The gas available is only V_{lg}. Similarly, W_{lg} will knock of the P_{sp} here and we will knock of this V_{env} as actually I into V_{env} is already there so catch of these I and V_{env} and replace it with V_{lg}. So, these are the changes that will happen if you have a rigid airship.

(Refer Slide Time: 02:45)

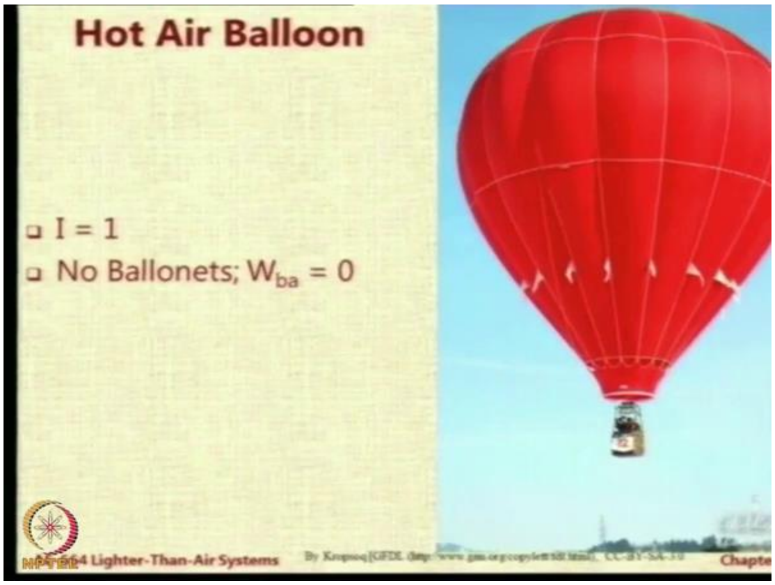


Let us look at another form of LTA vehicle which is a super pressure balloon. Now this is a very interesting system about which we should spend a couple of minutes understanding. So, a super pressure balloon is basically a balloon which is generally made up of very thin fabric very thin envelope material. And we inflate it on the sea level or low altitude with less amount LTA gas just enough to lift it up.

After that as it goes up and envelope starts expanding. Because of the loss in the ambient pressure due to which there was a pressure differential. Ultimately at the desired altitude or the altitude where you want it to be deployed it will occupy the maximum shape. If for some reason if the pressure has to; if the pressure fall; if the pressure becomes more that pressure than pressure release valve also if needed but it will occupy the maximum shape when it is at the desired attitude.

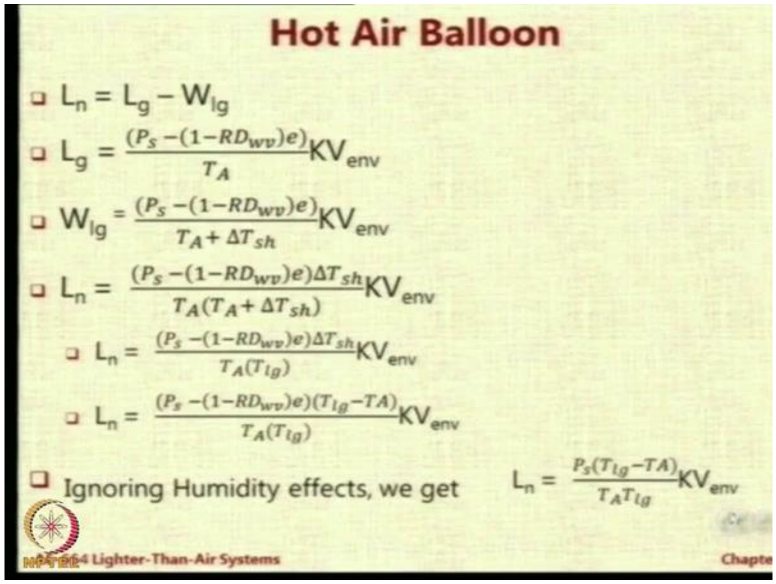
So, V_{env} going to increase as it ascends therefore the infraction fraction will become now more than one because the volume occupied by the lifting gas at the altitude will be less and that value will become larger and larger till it reaches equal to total volume of the envelope. Secondly, we again have no ballonets in this case so therefore W_{ba} is going to be zero. So, you can change the expressions and get it.

(Refer Slide Time: 04:27)



Now let us look at the hot air balloon which is what you do in the design. So, your task is hot air balloon you should pay more attention to this particular term, what happened hot air balloon? So please tell me what happen to hot balloons. Do you have ballonet? No, what about the infraction fraction 0 or 100, 0 means no gas no lifting gas that is possible if you put back, if you fly over vacuum. So, I will be equal to 1 that is the infraction fraction and W_{ba} will be equal to zero.

(Refer Slide Time: 05:05)



So, once you do that W_{ba} term will be cancelled and wherever we use I you have to put equal to one. So, these are expression you will get I am just putting it here. If you also ignore humidity effects here e will be equal to zero. And then we have this classical formula which is used by balloonist. So, what do balloonist do? They are interested in the net lift that is available because that is very useful weight.

If these net lifts now we come to the aircraft of the system weight if this net lift is less than the weight then it will not go up net lift first thing subtract the self weight remaining will be payload that is how much you can take it up. So, the net lift available will be the ambient pressure P_s times temperature of lifting gas which is inside the balloon minus temperature of the ambient air it should be T_A. I will correct that divide by T_A into T_{lg} times K into V_{env} where K is a constant.

So, when you design your balloon, you can use this particular formula. If you can convince yourself that in Mumbai, we can ignore super heat. I do not know whether you can do that. However, you cannot do that. You must consider super heat when you fly air balloon in Mumbai at least because you know, our atmosphere is actually having very high humidity. And humidity is going to subtract from the lift.

If you notice the terms which represent humidity basically this term $(1 - RD_{wv})e$, this term is a subtractive term which means the net lift is going to be; net lift if you see the net lift is going to be less because of humidity. So, if you ignore humidity, it is up to you make a mistake in your estimation.