**Lighter than Air Systems**
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**Module No # 01**
**Lecture No # 04**
**LTA gases, Types of Airships and their components**

Can we create or discover? I do not know a gas which has got density lower than hydrogen. If we can we will bring a revolution to LTA system. So this is the earlier research which I would urge people to look into. Can we think of creating either naturally discovering probably it is not there that is why we are not discovered it so far. But we do not know but can we not think of doing something so that the density of the gas reduces.

So practical limitation today is hydrogen But hydrogen somebody has said it is highly combustible. So let say we do not want to put a combustible gas. So now what do we do? The next best gas is helium. What is wrong with helium? It is very scare where in how helium is produced or how it is created? Fractional distillation of air ok yes I have with me in the lab a small helium leak detector which essentially does an analysis of ambient air and tell you how much helium is available.

If I bring that instrument here and move around it will show the amount of helium but 10 to the power minus 5 very small amount. So if I take the entire air in this room and passed it through a special filter I may get a small amount of helium. The whole process is very expensive. It is not commercially viable to recover helium from atmosphere. The presence is in traces. So how is helium produced? So what happens?

Ok so this is the first question on model for everybody. I want you to tell me where is helium available? What is the cost of helium? Which country had maximum amount of helium reserves and the toughest question is in India where is helium being produced? Not purchase and sold that way I can give you so many phone numbers. Naturally occurring helium where is it being mined in India. Let say if you want to get me a commercial price for helium.

And tell me for example how many resources are available? What is the expected quantity of helium. So let us do some study about availability of helium because helium is our principle LTA

gas. We are forgetting now what about hydrogen? Is there is any shortage of hydrogen. Can it be easily produced? Is it easily available? It is easily available right. Everybody who does welding normally has hydrogen cylinder. Party balloons ok you can create hydrogen from water also.

So if you can do something to hydrogen to make it non-combustible and also not loose its density that is another great discovery ok. But it is not easy. So maybe somebody can search and tell me if there is are efforts going in this direction to create less combustible or un-combustible hydrogen. ADRDE ok so find out and tell me. What ADRDE is doing what is that?

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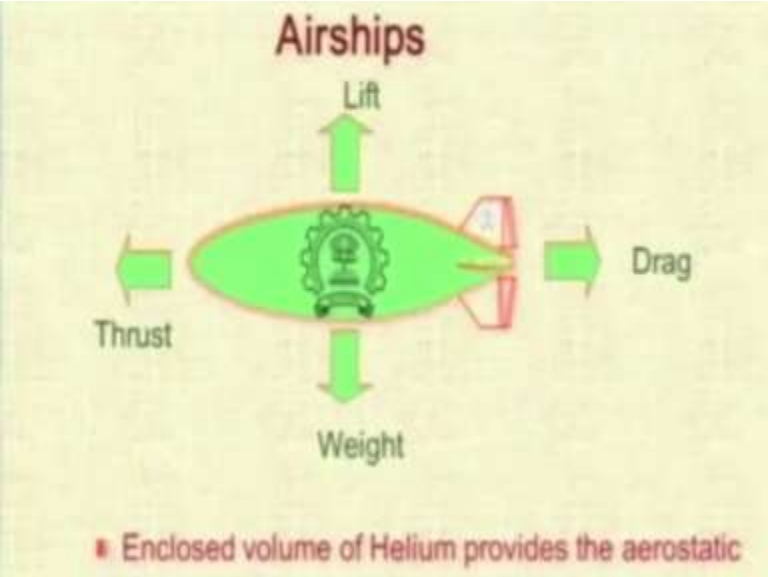


Alright so this is the first thing I want to do.

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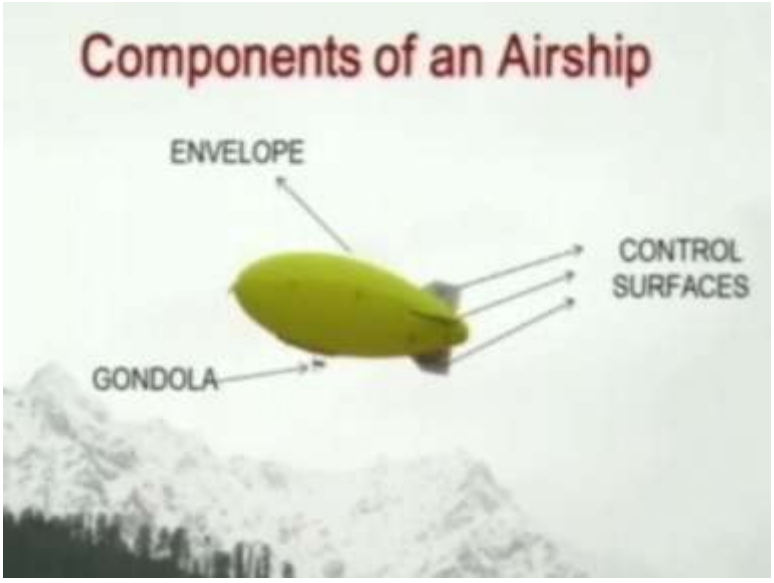


Now here I have here is your slide which tells you about the components of an airship. So like an aircraft we have control surfaces. But in the aircraft, we normally see only 1 vertically tail normal we see 1 vertical tail on the top and we see a conventional horizontal tail. Here also we see horizontal tail but here we also see a tail on the bottom. So this is another interesting question that I want you to think about.

Why is it so that in aircraft you can manage with 1 vertical tail and 2 horizontal tail and nothing below or why you do not put anything below. In airships on the other hand almost always you will see 4 tails. And interestingly in case if you want only one vertical tail in airships we put it below not above. So that too I want you to figure out on a single fin airship single vertical fin airship why do we see vertical tail below not above and first of all why do we see if possible people put two of them.

So that is a second question of Moodle. Now the envelope of the airship is equivalent to the wing of the aircraft the main lift producing system. And the gondola of the body which is below the envelope is equivalent to the fuselage of the aircraft where you put the passenger, payload etc., But interestingly the gondola is much smaller size compare to the wing and we see the opposite in aircraft. Generally the fuselage is bigger than the wing is relatively smaller or of the same size. Here the gondola is much smaller than the actually envelope.

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Alright there are four types of airship from the structural configuration and I will not spend more time here because we will have a special section on special configuration of airships. But just to tell you very briefly that this rigid airship where the things that we saw mostly in the past they had a rigid frame work totally rigid framework. On the other extreme is the hot air airship this is the hybrid balloon.

So this is the hot air balloon but its envelope will be shaped like a airship envelope. So below the balloon you will have the same heating elements. And this balloon will get inflated with hot air and you will also have integral on that the vertical and horizontal surfaces which are also filled with hot air and you can fly and you can sell kit-Kat make money by. I know a Russian pilot who says i like to fly hot air airships and kit-Kat will pays for it ok or beer company pays for it.

Because they just put the Ads in the balloon and the revenue they get is used for their own flying. So this are like a very intelligent modification to a hot air balloon. Then on the bottom left we have non rigid airship. This is airship which has got no moving parts sorry I am sorry it has got no structure member inside. This is an airship which has got no structure member inside. So the entire thing can collapse and be filled into a bag.

So last summer I went to brazil to spend 2 months in a company and I took an airship envelope with me in the suitcase which was non rigid type just fold it, pack it in the back and take it. It was 12 and half kilograms the ship is 8 meters in length when it is inflated and it can give around 15

kg payload capacity but It can pack into my suitcase because it is non rigid. And then we have a semi rigid which is a combination of both on a cross between rigid and non-rigid some part of it.

So there is internal frame work structure but the envelope is flexible. In the rigid you have an external frame work and you have inside gas bags here there are no gas bags. This envelope is the gas bag but there is structure inside. So as I said we will discuss about this more when we come to the next configuration. Ok I think this is historical facts and we will come to that later.

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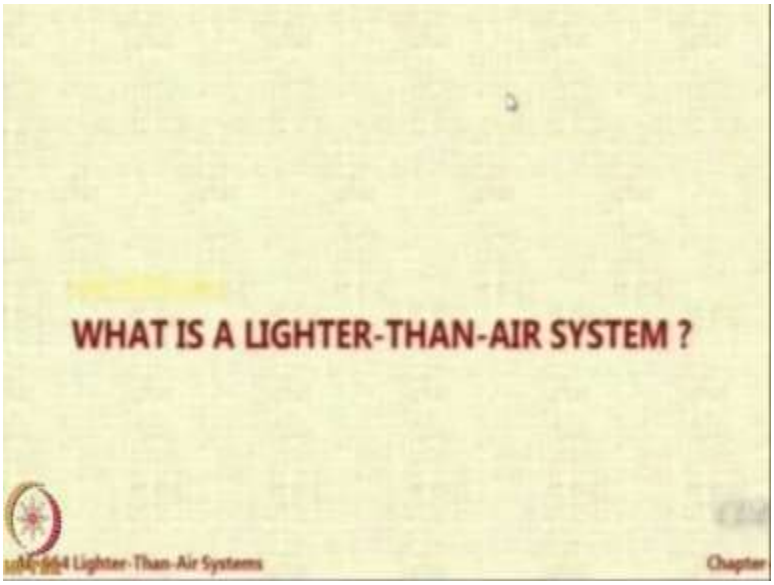


So we have come to the end of today's class it is already twelve thirty. May be I can take few questions that you have based on the discussion we had so far or based on what you have heard so for? So either any point that you would like to get clarify. We have few minutes before we wind up. Yes there is a question here yes the question that we have asked is what is the maximum of altitude? Which these airships can go?

The maximum altitude to which the airships generally fly is around maybe 11 to 12000 feet that is typical maximum altitude at which they can fly. Please understand that in an airship there is no benefit is flying higher. In an aircraft the efficiency of the propel systems becomes more efficient when we go to higher altitudes. In case of airships there is no advantage because most airships are using either an IC engine or some of them use gas turbine but there is no advantage in really going much higher.

And generally airships are made to be seen because their body is used to advertise something. So normally airships fly at around a 1500 to 2000 feet above the ground level. They have no benefit in making them like an helicopter they lose payload capacity as they go higher and higher that is the another reason. So the loss in payload capacity with altitude is very dramatic in airships; that is why they do not fly very high.

Yes but the ability to carry payload will sharply fall at high altitude. So you may be flying very smoothly but not payload. And nobody can see you. And something goes wrong and then you will have great time coming down. So that is why the whole purpose is not to fly very high. So above the ground level they are generally 2000 to 3000 feet not more. Unless there are regulatory requirement unless they are made to fly little bit higher by the air traffic control they rather fly as low as possible.

But clear from the ground turbulence, the turbulence from the ground is up to around 500 meters. That is around 1700 feet. So that is why they fly just above the ground level of the earth just above that where the weather is clearly steady anything else? It is good question if there is a break away aerostat that is what it is called. An aerostat which has got a tethered break so what will happen is that it will start rising up.

Why it rise up because in general the total lift produce by the envelope of an aerostat is kept slightly more 15% so more than weight to ensure that the rope remains tight. So that it remains more or less vertical. So when that tether is cut it will become a free flying balloon it will rise up. As it rises up the ambient air density will fall whereas the density inside will remain almost the same or the same. So the delta row will increase.

So envelope will getting stretch ok and a time will come when the envelope cannot take it. So it will tear ok. So we have done some studies on mathematical modeling of breakaway aerostats. We will cover that part of the course towards to the in the modern trends. We will show you some results of our studies on breakaway aerostats ok. So where do thing we have? Ok so let me first explain to you that an airship or aerostat envelope is not a high pressure balloon.

The pressure inside is only slightly more than outside. Typical values are around 500 Newton's per square meter higher. So sea level pressure 101325 and the delta P is only 500 just to maintain

the shape. And of course we have some calculations where to determine this number. There are kind of loads coming on aerostat envelope we calculate these particular number. But it is not very high so therefore the tendency of the gas inside to gush out is not so high. But if there is a hole on the top then being lighter than air gas it will tend to go out and it will go out.

However studies have shown that because the pressure is not so much more than atmospheric the rate at which gas is pushes out are not very large. Interestingly if the hole is on the bottom side then what will happen simply is the outside air will come inside. Because the gas wants to push the envelope up inside if the hole is created some gas will come out very soon you will find that ambient air will start going inside and it will be making airship is slightly heavy.

But to answer your questions specifically there have been instances of envelope tear during flight the time taken for the balloon to come down has been 3 hour 2 and half hours. Enough for you to do recently there was a German airship accident in which the pilot was able to steer the airship with a puncture envelope away from the human territory and unfortunately he died because in the crash landing there was some fire not because of hydrogen.

The fire was because of the engine and the gasoline in the engine spilled out and got fire not the envelope, the envelope was helium. Because legally speaking or regulatory bodies; do not permit use of hydrogen for any human carrying airship. So today you cannot make an airship and fly with human being on both either pilot or passenger where both with hydrogen. It is legally not permitted today.

So in this case helium there was an envelope tear but people where saved the airship got fire and the pilot lost his live but it took quite amount of time. There is a you tube video where it show it is slowly coming down and getting little bit neutrally buoyant and drifting by wind and again coming down. So it is not catastrophic not catastrophic. We had one experience interestingly in IIT Bombay where we were flying a small RC airship and you know a remote controller has got an aerial a telescopic aerial which comes out.

So while starting the engine the pilot who is holding this by mistake his aerial hit the propeller tip and the tip of the aerial broke and it went through the envelope inside. But we did not notice it, airship was flown it began flying then my son was on field with me. He was in class 7 that time he

observed that it is bit flabby. Why it is so buggy? He said. So we got it down and then we discovered that there is whole on the bottom and then we found that tip and then we did a rewind of the video and we could see the antenna hitting and there was a sound and the tip broke of it.

So whole from the bottom no problem or not much problem from the top yes and one more thing I want to tell you the recent study from the module of dynamics of aerostat. There was a question asked that as the gas comes out there going to be a thrust created so will that affect the dynamics of airship. So there was confusion was the thrust which is creating only 2% of magnitude of the total lift.

And the plots of the trajectory with and without this considered are all identical. So to answer your question, operationally there are measures available to recover a airship even when the envelope is. And finally I will show you a video of our own testing in Gymkhana ground in which we put fire a hydrogen filled balloon to see how it explodes. And that video has become viral all over the world now. Because I will show you, you can draw a conclusion when you see the video ok. I think in that note we can close.