**Lighter-than-Air Systems**
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**Lecture -09**
**Some Queries on Aerostats**

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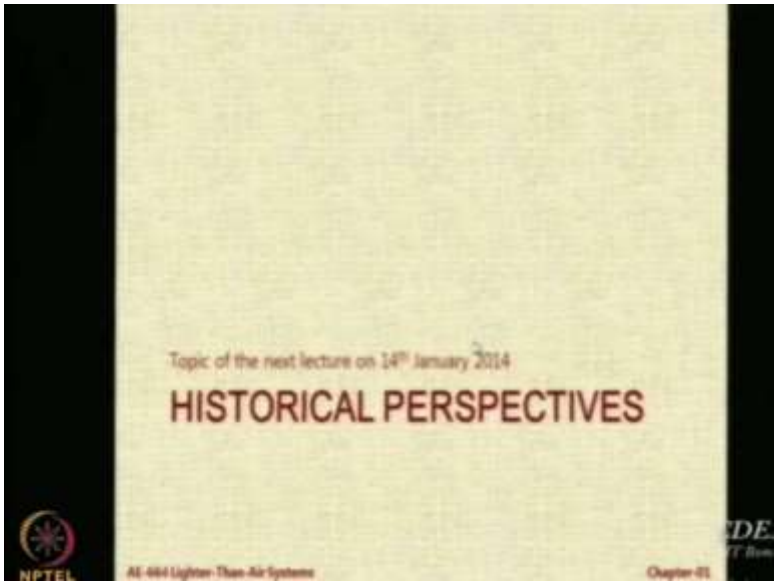


So now the next time when we meet which will be on I think 14th of January we will go back in history and we will try to look at how this technology first came into being and then subsequently, how it went ahead further. I also want to inform you about the first assignment that we will be looking at in this course. Allows it next time because it is to do what we cover in the next lecture.

At this point, I think we can take some questions or doubts that you may have regarding the modern aerostat or airships based on what you saw or if anything else we have in mind. We can take these questions. Yes, please mention your name as you before you speak. There is no difference, except a manned airship. Normally it is designed with a higher factor of safety for every structural component and in manned airships use of hydrogen as a lifting gas is not permitted by law.

So the best of my information that is the only difference between a manned airship and an unmanned system. Yes, there are these examples of hydrogen systems in which people have used

a manned airships with the tether. So now whether you will call it as a tethered airship or a man carrying an aerostat that is up to you. But yes, but what kind of application did you have in mind for a manned aerostat?

We say the endurance is 48 hours, let me correct you. The 48 Hours endurance is for a manned airship. For a aerostat the endurance could be even 6 months. Just a function of how much gas type the envelope can be made. And over how much period of time the gas will leak out sufficiently to run the buoyancy is completely lost and she starts coming down. And if you use so much height it becomes ineffective.

So, you are talking of an application where you have a tether and then you have an airship. So it will move around or whether it is stationary. So if it is stationary why do you want to put a man on board? What will be the benefit? No, the differences are only this, that the usage of LTA gas there are some constraints as well as because of human being on board in the safety issues, there are higher factors safety's in the design. Anybody else has any questions?

Yes, name. Let everybody know you also, I know her but others should also know, yes Ramya. Oh yes, we will have a special lecture on materials used for LTA systems. Anyway we will discuss what is done to ensure that the gas leakage is minimized. So I will just tell you basically what we do is there are two approaches. One approach is to use a double chamber envelope.

So you can have like a football, internal bladder will be only for controlling the gas leakage or to hold a gas and the external envelope will be to take care of all the loads, scrubbings and other issues. Or with modern technology, you can have a single fabric with either laminates or coatings. So you can think about multiple laminates. There are two envelopes. One example is Tedlar and mylar. These are two kinds of preventing materials.

So many people use Tedlar, mylar laminate. Similarly what most people do is they go for coatings. So if they take a base fabric for strength, they coat inside for gas retention, they coat outside for atmospheric UV protection or ability to withstand the scrubbing of other loads. So, this is what is normally done. Any other questions anybody has? Yes, But you have not mentioned your name.

How do airships come down? This is a very good question because I have learned that whatever goes up must come down. But in this case of airships, how do they come down? So first question is how do they go up? The mechanism which is used to make them go up, I would say a kind of reverse of that is used to bring them down. For example, you saw in the airship video that the power plant was tilted to give vector thrust.

So vector thrust was overcoming gravity to go up. Of course, gravity is overcome by buoyancy but you want to physically go up to create an unbalanced force, you can do it by tilting the engine. So you can do the reverse to bring it down. That is one way of doing it. That is a very technologically expensive way of doing the thing. Of course airships do have thrust vectoring mechanisms.

So can someone help in this? It is a very interesting question and it needs a little bit of thought on how do we bring it down? So like what would you do to bring an airship down? Name? Vineeth, from which department are you? Bring it down or pull you down. When a boat reaches near the shore, they throw a rope. There is a big poll and tie around it and then some people pull it. Similarly, we can bring some airships down by physically pulling it down.

This is one way of doing it. But then you have to either you have to fly very near the ground, so there is a rope always hanging below. Suppose you are above that. Let us say you are at thousand feet. Now you can throw a thousand feet rope and ask people to pull you down. It is difficult. Yes, tell me. This is one way of doing it. You have a small air bag inside the gas bag. So when you have the right amount of air along with the lifting gas inside such that lift is more than or equal to the weight, it will go up.

But when you want to make it heavy, you can collect air from atmosphere in that air bag. So you can have a system which just takes in ambient air. Now this air is heavier than the gas inside. So the net weight increases, so she will slowly start sinking down. This is one way of doing it. Yes, please say. Controlled venting of helium is a way to bring it down, to bring the airship down but very expensive way of doing it.

Because then you are losing it is like consuming fuel or consuming their gas. So it is done but only in an emergency is when other things fail and you desperately want to come down. Then, venting of helium gas is perhaps the last resource available to you to reduce the lift any other way of bringing an airship down? Yeah, reverse thrust vectoring. Yes, so you create a downward force and you bring it down. Anything else you can do?

Reduce the volume of the balloon, how do you do that? So what are you saying is that you will do something, so that the envelope volume is reduced. Yes, it can be done, it can be done. This is a really nice innovative way of doing it. This is this is something which we have to think about. When we do any aerostatics at that point we will realize it, whether we can have a multi compartment gas bag and then you can push gas from say three bags into one bag and then collapse 3 bags.

So that the volume of the envelope reduces but the mass of the gas remains the same. We have to revisit this when we come to aerostatics. There was something that you were saying. Liquefy the gas inside. A very complicated mechanism because the system that you have to carry on board to liquefy the gas will be difficult. I will tell you simpler methods of doing it. Yes, this is what I was going to say.

Collect water vapour from the atmosphere, condense it, you get water, which is very heavy and that can. But you have to wait for a situation when there is water vapor. Above Sahara desert there is no water in the atmosphere and you cannot come down. You have to wait for rain. You cannot do that. So it is done. Collection of water is done. In fact, what also we do is the exhaust of the engine. Even there, there is some water vapor sometimes.

So we will see that all this will be a part of the course any other way of bringing it down. So why not do the following. Why not make it heavier than air in the first place? So that when you want to bring it down, do nothing. It will come down. So what you do is, remember that when you are flying at some speed because of the shape it will generate some dynamic lift. If you are a clever aerospace designer, you will be able to give a shape that gives you a very good lift.

Or more lift than drag, you know, that is what we do. We want to have higher L by D, lift over drag. So if I can carefully shape the envelope in such a way that when it starts moving it starts lifting. Let us say 10%, 15% of the total lift comes from dynamic lift. So you are heavy on the ground, the total buoyancy is, let us say 1000 and the vehicle weight is 1,200. So 200 kg force you create by maybe tilting the engine.

Or 200, 220, 230kg force. So you start moving up, you acquire some speed. Now the dynamic lift starts coming. Then you can release the engine and when you fly at some particular speed you might be able to manage comfortably with the dynamic lift plus the started lift equal to weight. Supplementing with the thrust vectoring and when we want to come down it will stop flying.

Now this is what we do when we fly our airships. Our airships are normally heavier than air. But the only reason we want to come down if things go wrong what do I want? I want the airship to come down. So already I called them LTA vehicles. In reality, I cheat and fly HTA vehicles. So you can tell it has a buoyant, heavier than air vehicle to be very precise. So this is one solution. True, very true.

But you see one has to do a trade-off between what is the total consumption of fuel? Either you have to always fly lighter than air. You fly lighter than air and then have some system which will bring it down forcefully. So which of them will consume more power or more fuel? We do not know, right now. So from a safety point of view, normally airships are flown statically heavy.

The static heaviness of a typical airship with 50 passengers is around 500 kg which means there is a 500 kg force acting down always. So if you are offsetting gravity with a 500 kg lag, so that if something goes wrong, you can slowly come down. Anything else? Yes, so this is called a static heaviness, so you can make it around 6 to 10% statically heavy. So the extent of buoyant force is only 90 or 95 percent. 5 percent, you would like to create by aerdynamic forces.

You can what we do is, in our flight, we mount the engine on a slight angle. So, as she takes off it is not following flight, it is always giving, so one component of the engine always giving me that

minus that gravitational or download force. So when the engine stops, comes down. Anything else? Prathik, you have something. So it means you are going to introduce helium from balloon into the air stream of the engine.

No, instead of that, I would say why do you need to get small systems, which only do this? Because if you mix air and helium how will you recover only helium from that? No, what someone said is simply to release the helium. Liquefaction this; what has been attempted is a small liquefaction system inside the envelope, which when commanded, liquefies the gas and pushing the cylinder.

But you see that the same engine is having an airstream. In that you will introduce helium stream. And that then the fan will compress it and then you have to push it back inside the envelope, then where will it go? See whether you have an integrated system or a dedicated system, we decide based on our assessment of the cost complexity and weight. It can be done. I mean things can be done to attempt it, right?

So now last time I mentioned something on the moodle page for the moodle page and one person has responded to that. Also we have got some information about helium now on the moodle page towards to also now proceed further. So the question for you to attempt at the end of this lecture is find out photographs, videos, description of very innovative uses of airships and aerostats which will add value to our understanding.

So if you look at something about an application which are not shown or which you think will really add value or even excitement to our study, please give links of that on the moodle page and the second question is think of other innovative ways people have used for bringing an airship down or buoyancy control. Ok, on that note, we will stop for the day.