Lighter-Than-Air Systems
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Lecture – 24
In-Flight Ballast Collection Methods

So let us look at some schemes which people have suggested. These schemes have their own positives and negatives. And I want you to suggest some more schemes and also I want you to collect more and more data about whatever we have studied.

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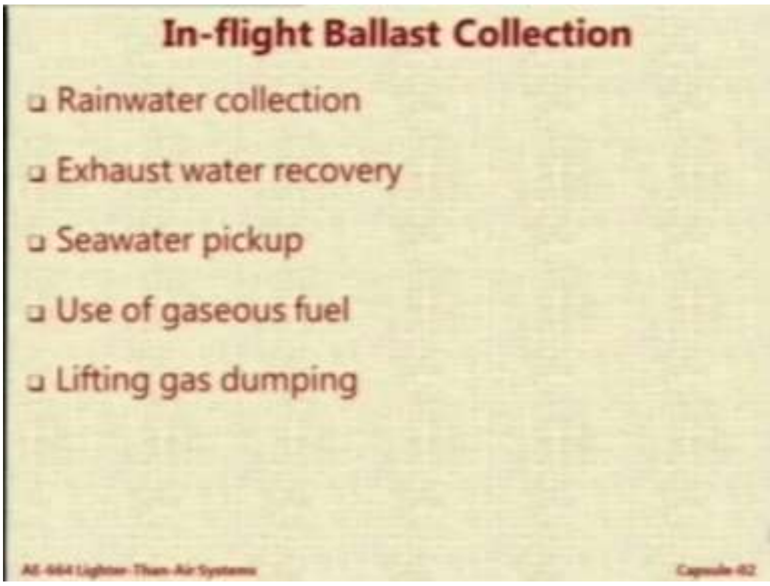

So, one very common method is called as rainwater harvesting or collecting rainwater. The other one is called as exhaust water recovery okay. You condense the water vapor present in the exhaust and recover it. One is sea water pickup. That means you find a river or a lake which has got usable water, you go down, scoop, pick it up and then take off. Then we will have very innovative systems use of gaseous fuel, I talk about it more.

And when lifting gas dumpings, this is the ultimate. If you want to make yourself heavy just get rid of the lifting gas okay you will become heavy. Worst case is tear the envelope you will crash down, what can you do? Okay. So, let us see number of collection.

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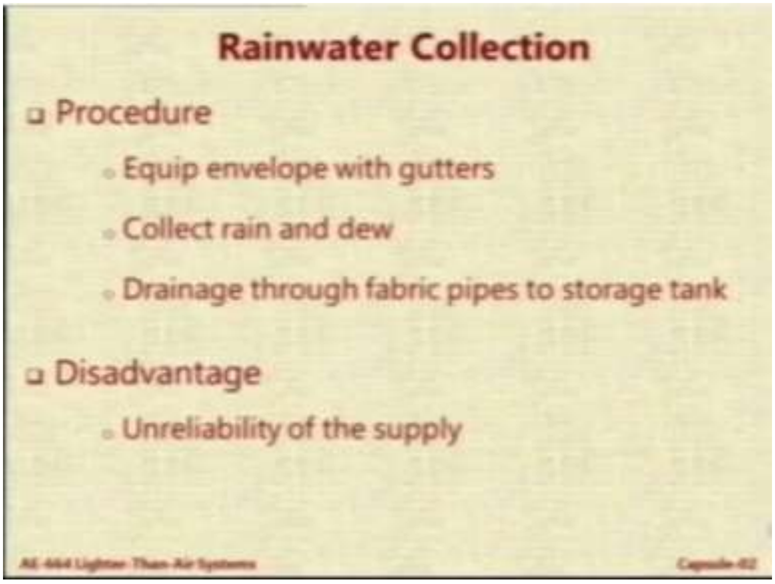

Now the procedure is very simple. The envelope has got some gutters. Gutters are basically you must have seen some of these car doors they have these channels on the top of the doors so that the rainwater can go along those and this is called as a gutter. In buses also we have gutters on the road to channlize the water. Similar thing you can do on the envelope, you can make these small C shaped collecting tubes.

So it is a large envelope okay. The envelope could be 70 meters, 60 meters in length. On this large envelope rain is falling. The water is collecting. You channelize the water collect it into the collector tanks. You can even collect dew because overnight during flying dew will collect on the envelope because of the temperature drop. That becomes water vapor condensation, collect that water.

You will be amazed at how much water you can get by collecting dew. Airships are able to use it for their static heaviness issue. And all of that is collected and taken to a storage tank. Now, what are the disadvantages of this?

“Professor – student conversation starts.”

Water will have more. Yeah water become more rare thing. Weight of the control system itself may make you statically heavy. Correct.

So by bad design the amount of water collected may be far less than the weight of the collection system.

“Professor – student conversation ends.”

So then it is not really a good solution okay, but still you can say okay it is a bad design. It weighs a lot, we will reduce the payload, but this is the only way we have. So this is one way of doing it, right. So I want you to upload on a Moodle page some more information on this.

Maybe some pictures of these gutters and some information on which airship how much water it has collected. Let us know, let us learn something from what is available.

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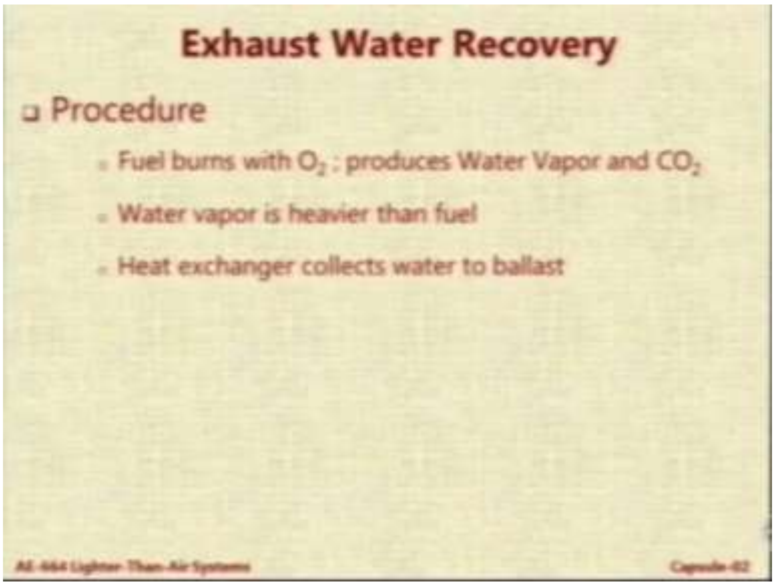

This is a very interesting system, exhaust water recovery system. So obviously when you burn fuel normally most of the cases airship uses these IC engines in most cases and then you have a passenger carrying airships, they use IC engines which has an exhaust. The exhaust contains CO_2 and water vapor. So what you can do is condense the water vapor, make it go through a condenser okay.

And then the heat exchanger will condense the water that will be piped the water it is the ballast. What is the problem with this?

"Professor – student conversation starts."

Yes, raise your hands please. Extra weight of these systems. Correct, there will be extra weight of all these systems. What else?

"Professor – student conversation ends."

Suppose I use electrical engines or I use engines which do not have an exhaust containing water vapor okay.

So a turbine engine for example. It does not have water vapor exhaust. So finished. So the moment you use turbine engine and why will you use turbine engine? For efficiency, for the power and there are airships like spaceship 600-B which I showed you. It uses a turbine engine, but then you cannot use this kind of system. Then exhaust will have other things also, undesirable things.

When you recover water you have to also deal with those nasty things, coke and then you have to clean it every time. So, it can be a nuisance but it is one way of doing it okay. This is self explanatory okay.

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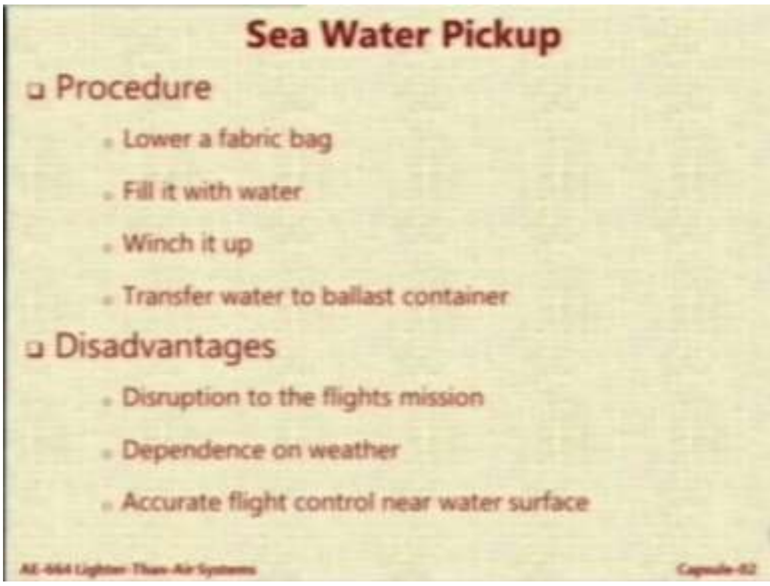

So, you can lower a fabric bag and winch it up and collected it. What is problem? No sea. No sea is there. So you go where there is sea. So you are going somewhere, is anomalous, go and collect water first, then we will go there. So that means your mission will change okay. Then you have to depend on weather and more over the problem is it is easy to say like this collect water from sea. Sea is not stationary. Sea is also having disturbances.

Water contains so many things. It contains salt, that is very corrosive, your envelope material may start getting corroded. Operating in a marine environment is very difficult. Your system will get getting corroded. So it is easy to say that collect water from sea or from lake, but it is not always possible. But people have done it because they say in long distance flight or airships, let us try these techniques to collect water because that will help us fly more efficiently.

It will give us larger endurance, otherwise we have to come on land and refuel. This was one very brilliant system which was given by the Germans okay. This is called a use of gaseous fuel. Now to understand this okay.

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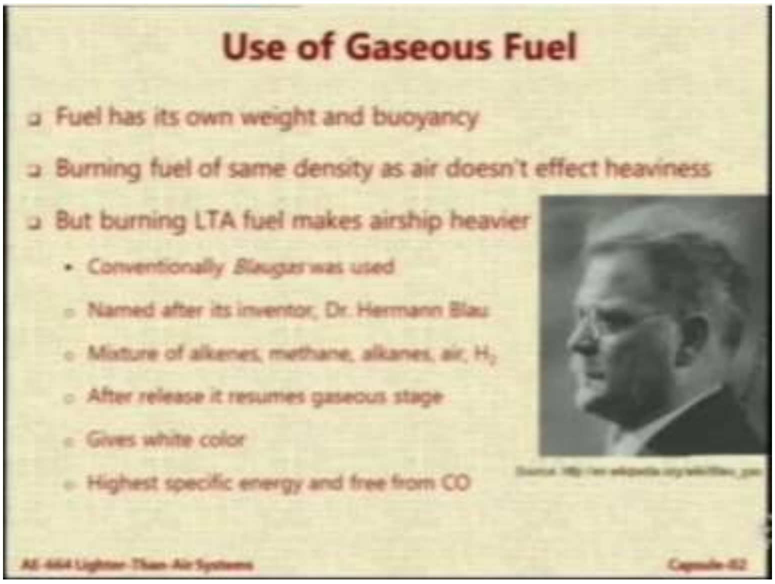

Now the fuel that you use it also has its own weight and buoyancy, it is a fluid. Now if you use fuel and if you have its density controlled, so let us say I burn fuel and I will collect the product of combustion. So if I do that, then I am not actually going for actual loss of their density. So there was a gas called Blaugas, which was suggested by this gentleman Dr. Hermann Blau from Germany.

Some people say the color was blue that is why blaugas, actually it is because of this gentleman. He came up with this particular. This is a combination of, nice look at the amount of research people have done to try and overcome this problem. It is not a trivial problem, you may laugh at it. But I challenge you to think of better methods of doing this. It will be a big contribution to LTA systems. So that itself is a mixture.

It is a mixture of alkenes, methane, allcanes, air and hydrogen. And this particular after release it resumes gaseous stage. So this is the fuel. You consume the fuel, put it back in the envelope or put it back somewhere. And free from carbon monoxide, so no danger of poisoning or you know killing anybody and it gives high. So this is something I really want you to read about. And this was the secret weapon which the Germans claimed they had to use airships in second world war.

They said that with this secret project, we will be able to rule the airspaces. Unfortunately, the two accidents Hindenburg followed by the R101 happened. And because of that airship got a very bad name. So this whole technology, Hitler took a decision, we will stop using airships because they are giving bad name to our Third Reich. That is it, it got canceled, but this was a brilliant way of handling.

There are other ways also, which we will see later.

“Professor – student conversation starts.”

Sir, yeah. Sir is not volume a big issue in this case. It is. It is a big issue, yes. But when you are looking at large airships, we have gas bags inside.

“Professor – student conversation ends.”

You do have a lot of spare place available to store these things. So volume is a big issue.

It can only be practically used for very larger ships. So more about it after you read things. Let us get some more information about this from the contributions on the Moodle page okay, right.

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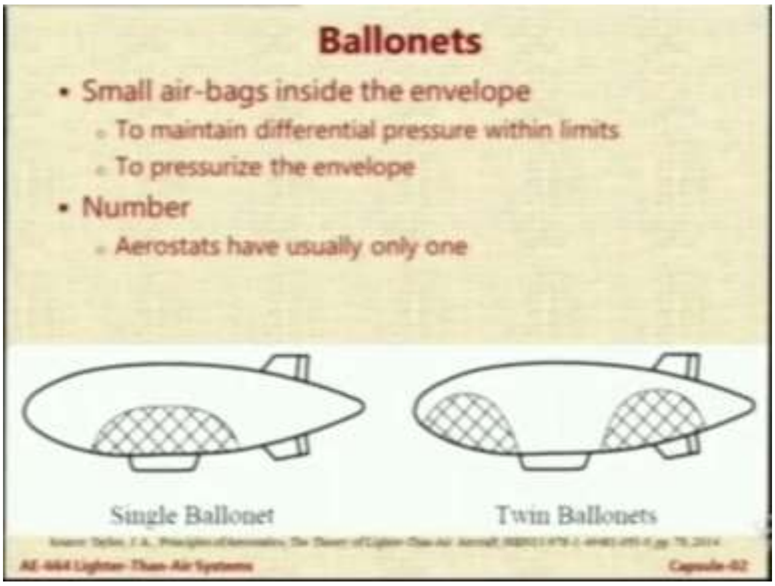

Now the other option is lifting gas dumping. So that means wherever you want to become heavy, heavier than air, just dump hydrogen, obviously you cannot dump helium. Hydrogen I can still afford to dump because it was not very expensive. I can refill it again without too much loss okay, But helium is very expensive, you cannot afford to dump helium like this and then say we will recover.

Only in emergency it is permitted. In emergency, everything is permitted, no, which saves the lives or which saves the system. So, we have got a system in our airship for gas release in emergency to bring the airship down. But it is used only in emergency okay. Now, the last thing we shall do today is this particular concept of ballonets. Ballonet is a French word which means a small balloon.

And ballonets are used in airships for controlling the pressure of the LTA gas and the envelope so that it does not go beyond the limits of the envelope. And also in case there is a situation when the envelope loses pressure for some reason, it pressurizes it to maintain the shape of the envelope. So these are airbags, which are mounted inside the gas bag. So, obviously suction of air inside the ballonet will make it heavy and removal of air from the ballonate will make it light.

So, this becomes another quick way of controlling the static heaviness, which is what Chinmay was referring to. We can use ballonet so we can suck in air, throw out air, make the airship heavy or light as the need may be okay. So there could be single ballonet, there could be multiple ballonate, Generally we see either a single ballonet or a two ballonet system. So one is used in aerostats because aerostats generally are going to only maintain its current position.

They are stationary, they do not fly. So once is enough in the center and airships use two ballonets. I will show you why, there is a reason for that. And we have them fore and aft. Normally there are two, one in the front one in the back and in behind the center of gravity normally as far away as practically possible. So that gives you a hint that they will be used for moment imbalance.

And then you also have some very special airships called as a high altitude airships or HAA. Again on this there will be a special lecture towards the end. These are seen to have not just two, but also two additional ballonet for roll okay. They are called as pioneer ballonet, but right now they are only conceptual in nature. So we will limit our discussion to only airships and aerostats. Hence, we will assume that there is either a single ballonet or there are two ballonets.

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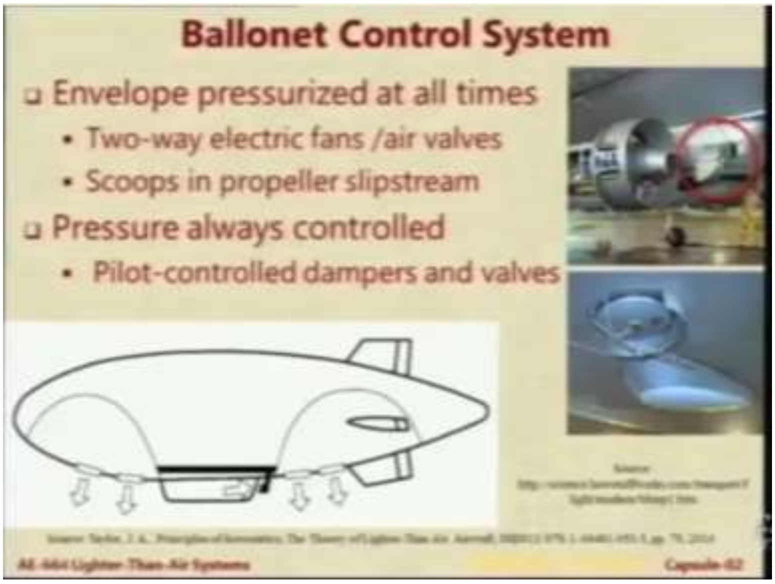

Now, let us see the control system of the ballonet. Envelope has to be kept pressurized at all times because it is flying or remaining stationary in the presence of ambient winds. So if the envelope pressure falls below a particular limit, the system will not maintain its shape okay. So one way is that you have these two way electric fans or air valves. There is a picture which you can see where this is an air valve.

So as required, it can take out the air. And to fill in the ballonet you can use the propeller wash. So there is a scoop to collect the air which is just like an open faced collector behind the propeller. So when the propeller throws air behind, under high pressure this air can be pushed inside the ballonet. There can be a valve which will open and close. So if you want to fill air in the ballonet, open the valve, it is coming in from the propellor anyway or if it is not needed you just close it.

So you could take in air by a two way fan or by a scoop. You can throw air by valve. Now, the pressure inside the envelope is always controlled within certain limits which ensures the health of the envelope so that it is not overstressed. It is never overstressed. So, this is done by dampers and valves which are controlled by the pilot. So what is meant by a damper? A damper basically is the same thing.

You can see there is some kind of a collector here and then there is a duct or a piping which goes to both the ballonets front and back. So this is a scoop which collects air and sends air to the ballonet. There may be a stopper, there may be a valve here which will not allow it to come in. So it is constantly pressing, but the valve is closed. When it wants to go or when it allows to opens up and this thing goes inside.

These are controlled by the pilots okay. So, in this case we have not shown the two way fan. We have shown only a one way valve and a scoop, but in some airships you do not use these scoops, etc., or or ducting, you just make these valves two way. So, there is an electrical motor which will operate in blower mode and in the exhaust mode and then you can. So let me show you the testing, testing of one of these systems.

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So, we have attached a smoke generator onto one of these valves in an actual airship. This is a big airship. There is a company called Airship Ventures, which as I remember flies airships over San Francisco or many other places in the US for aerial sightseeing. So, they have uploaded this video okay. Just to save time, I will just take it ahead. So, you can see right now the smoke is coming out of the envelope.

Now it will be sucked inside. Now it is being thrown out. So, this way you can. Now there is a huge ballonet inside this valve. So, by this you can control the amount of air that you have inside.
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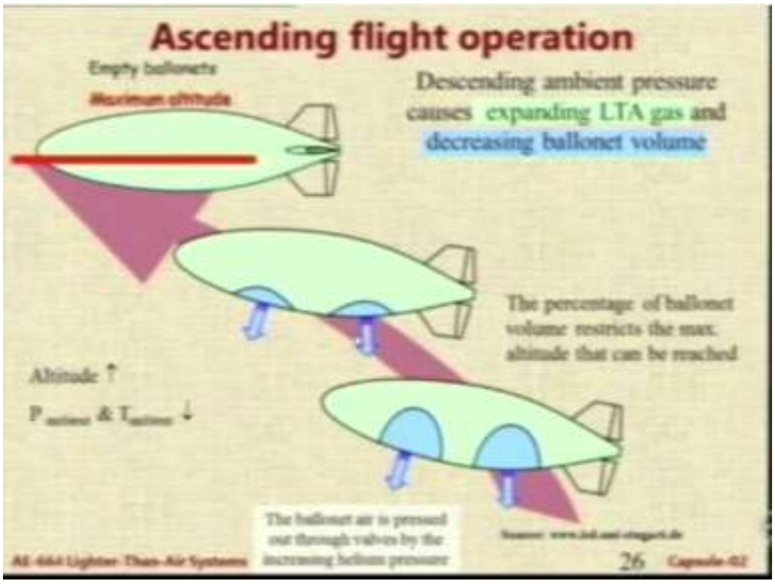

This is how ballonet work. Let us say there is an ascending flight. The altitude is increasing. So, the pressure and temperature are reducing and the envelope which has got this green LTA gas this now would like to expand okay. The expansion will push the air out from the blue ballonets. So, this is how the ballonet will become less air. Now they will reach a height at which there is no ballonet available now because the entire air has been pushed out.

That particular height will become the maximum permissible altitude at which you can travel with this system. Because to fly above this altitude or to operate above this altitude, the only way in which you can do that is to lose gas. But if you lose gas, then again when you start coming down you will come and stop at some height and you cannot go down. So it is unsafe to operate above this altitude. So, this particular altitude is like the ceiling of an aircraft.

This is a ceiling of operation for an airship. The altitude at which the ballonet are completely flushed and there is no further air in it to be thrown out. So, as you go up the pressure outside is falling. The pressure inside is maintained within some small range which ensures the fabric is healthy. So the delta P is going to change. If I do not allow more envelope, more space for the gas it will cause a tear and the pressure will increase.

So that is why we use these airbags inside the gas bags for controlling the amount of volume available for the lifting gas.

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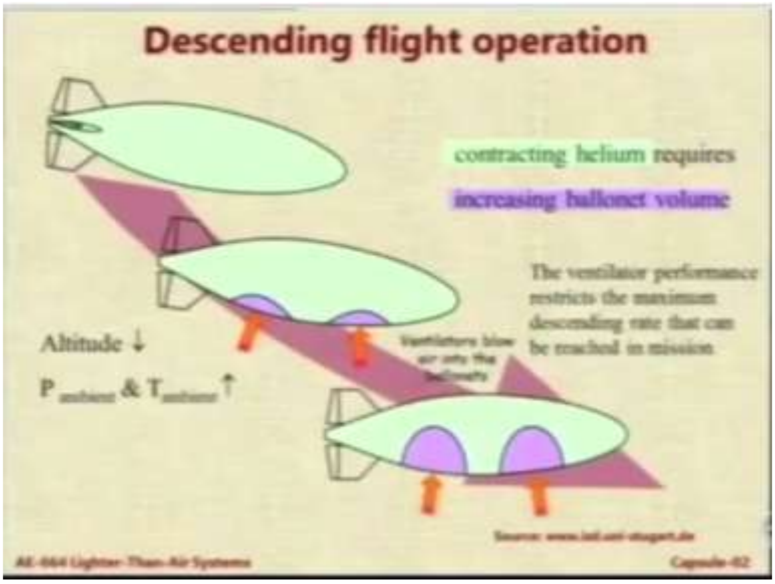

The reverse happens when you come down. When you are at the ceiling or at some altitude ballonet flush. Now, the air is going to contract as you come down because the ambient temperature and pressure are now readily increasing with time. So there are ventilators which will blow in the air and when you come down to the ground the ballonet becomes full okay.

So, now with this please understand that that delta H which an airship can attain is limited by the volume of the ballonet.

This is very important point. It is good better off you are noting it down. This is a very serious limitation of an airship. For an aircraft, the delta H depends on the loss in the performance of the engines of the power plant. Because beyond a particular altitude, the power available will not be able to meet the power required. So when power available equal the power required, you reach the ceiling.

Above that you just cannot go, you can go momentarily, but you will fall back. You cannot have a sustained flight at an altitude above the absolute ceiling. In the case of airships, you can take off from sea level and go to a height of say 3 kilometers. When you take off from a height of 4 kilometers, you can still go up, but the delta H will be less. So, you cannot operate airships from sea level to very high altitudes.

But you can operate them from high altitude to higher altitude. Of course, delta H unless you change the ballonet and you make it larger. So, then it means redesign of the whole thing.

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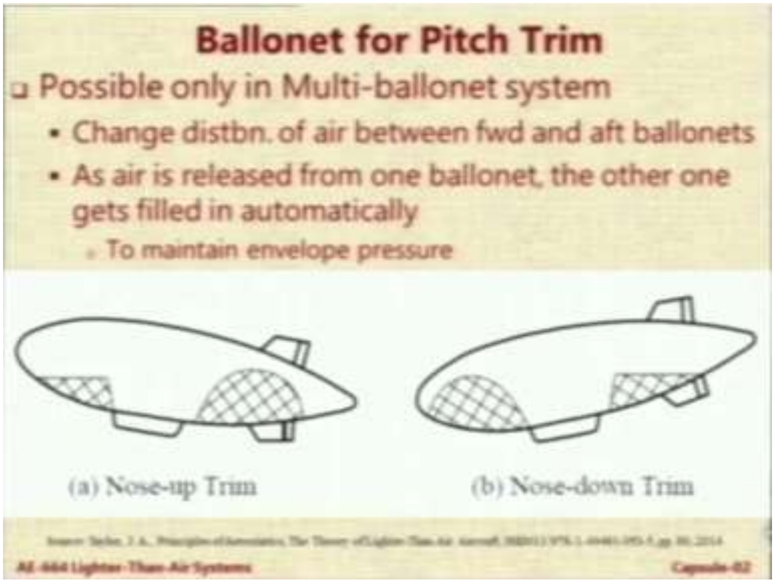

We can also use ballonet for pitch trim. Now pitch, for those of you who do nto understand much of flight dynamics, basically pitch is this nose down nose up motion of an aircraft. And trim means when I want it to point at a particular angle, let us say I want it to have an equilibrium angle of 3 degrees, nose up or nose down. So, for that I should be able to do something so that it rests at that angle or it achieves that angle and stabilizes, this is called as trimming.

So, this you can do by adjusting the air in the ballonet. So, the picture which shows figure A, we have removed air from the nose from the fore ballonet. But if I do only that, then I will disturb the pressure balance. So I have to automatically increase the pressure on the rear ballonet or increase the gas in rear ballonet. But with this, now the note is going to be up. So, this will allow you to fly with a nose up attitude. This is required for takeoff, you want to be nose up.

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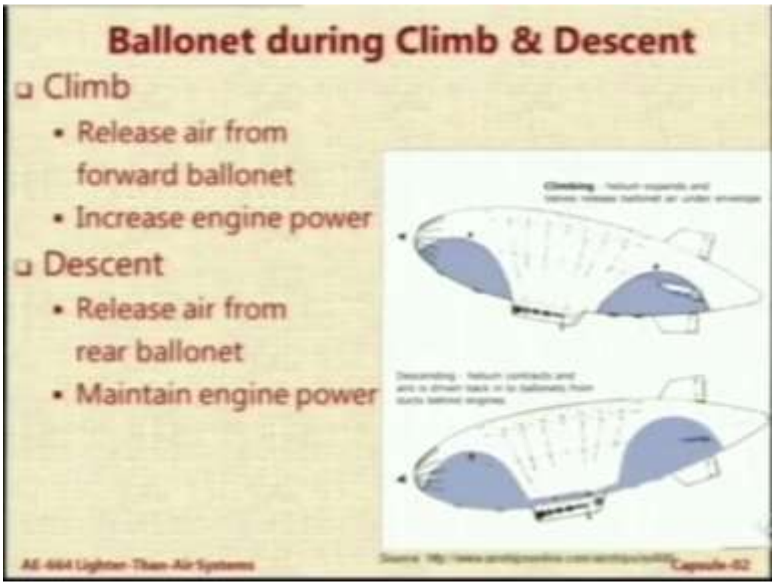

Now during climb and descent. So, during climb when I want to climb, I will want the nose to go up so that the propulsion system takes me like this. For the nose to go up, I will remove the air from the forward ballonet. So the airship will pitch up and then I put more throttle. So I will increase the thrust. For descent, I do the opposite. I can release air from the rear ballonet.

And now I maintain the same power because if I go for more power I will go very fast. So, I maintain the power and go down, I will descend. So, this is what is the situation in the case of climb and descent of an airship.

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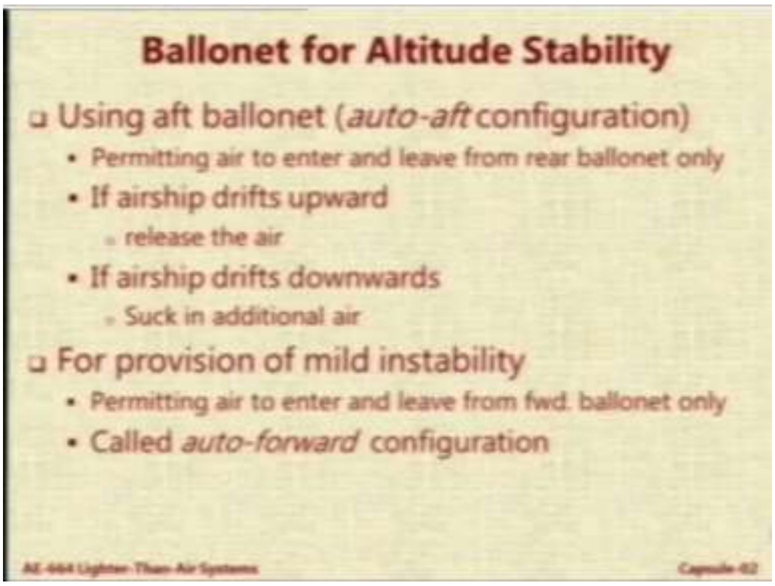

And finally, suppose I want to fly level as I may have said that it is important to fly level when you are in long distance flight. I do not want the pilot to continually do these things. I would like it to be done automatically. The airship should maintain the height automatically. For that we have something called as an auto-aft configuration. That means you permit the air to enter and leave only from the rear ballonet.

So, if the airship drifts upward because of some reason, then you release the air, it will come down. If it drifts downwards, you suck in more air, it will come up okay. And if you want to create the opposite, you want to have some instability because that gives you more control. When you are maneuvering something, you need more control. At that time you need less stability. You can do the opposite, you can switch on to the auto-forward configuration.

So in this case, it will become unstable. It will allow you to do things which are not being able to done. So next time when we meet, we will discuss about the estimation of static lift.