Lighter-Than-Air Systems
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Lecture - 84
Steam and IC Engines for Airships

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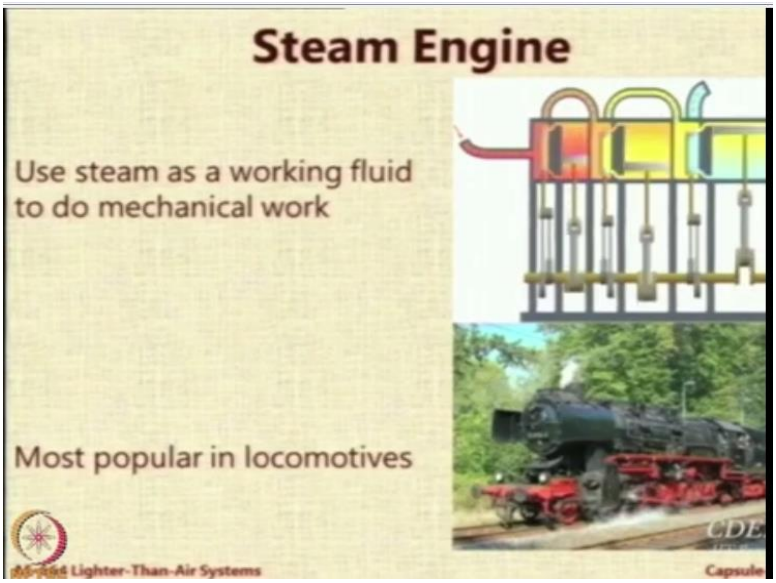

Let us look at first steam engine. The first one we saw already with Henry Giffard. But steam engine basically, can someone tell me what is meant by steam engine? What is a steam engine? It uses steam as the fluid for doing mechanical work. So, what is so special in steam so that it can be used to do mechanical work? Why is steam? A preferred fluid for doing mechanical work in an automotive engine, locomotive engine sorry.

"Professor – student conversation starts." Steam holds high heat volume capacity, that is right. The capacity to hold heat in a given amount of volume is very high for steam that is the main reason. **"Profressor – student conversation ends."** You must have heard or read about latent heat of steam, correct. The amount of energy it can absorb before undergoing the phase change or to undergo a phase change. So, steam is a fluid that can retain a large amount of heat.

Secondly, steam can be easily created by heating water which is easily available. These are the two motivating factors which led to the steam engine and a steam engine is available they also use it for the airship. So, this is a small video of the working of a steam engine. So, what you do is you basically pass steam from the inlet and that steam goes into a chamber. So, now you

can see there is a crankshaft and that crankshaft is being moved up and down by sequence of inlets and outlets containing steam.

So, there are 3 chambers here. In all 3 chambers, what is happening is basically a reciprocating piston is being moved by steam, but the temperature of the steam is slowly reducing as it does work. So, you may not be able to recover in a small space the entire energy that a steam engine can produce, so therefore it work in stages. And then finally there is an outlet which throw out the steam.

Such engines as you all know are very popular in locomotives and a very compact version of steam engines were used in the past to propel airships also.

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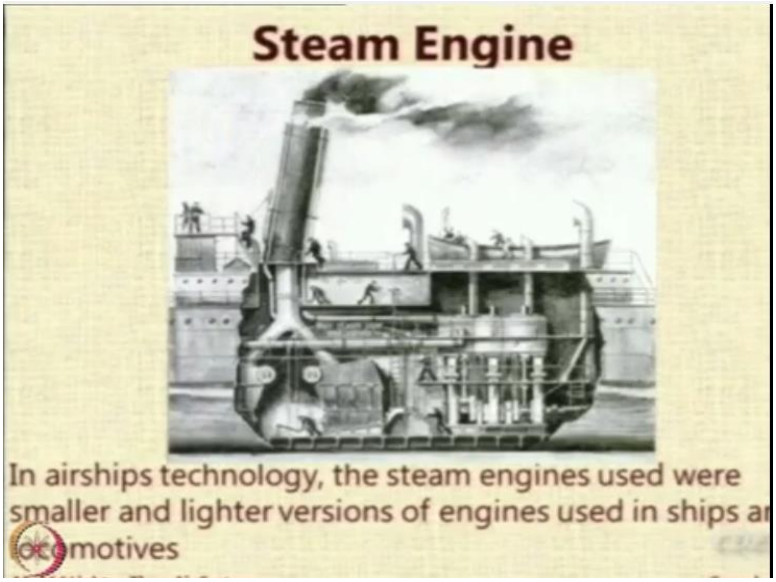

So, the same steam steam engine that goes into ships. They made compacted, maybe less power but compacted is used in steam engines for airships.

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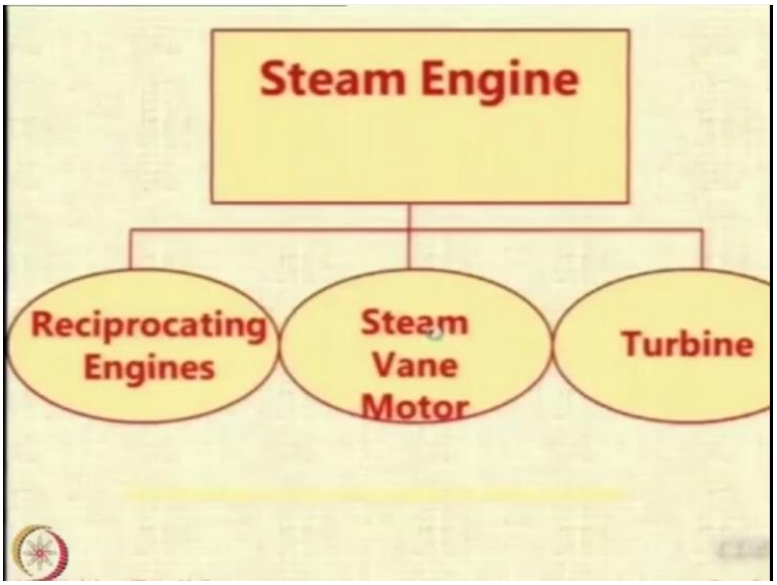

And inside engines also there are various subsystems. What we saw just now is the reciprocating engine. So, steam is used for a reciprocating piston. You can also have vane motors where there are some cup like things which move, rotate because of the flow of high speed steam. You can also put a turbine and make a turbine move by impinging steam into it. All of them have their pluses and minuses.

But what I would like to share with you is a very interesting experiment done around 12 years ago 2003 if I remember rightly. There was some people experimenting with bringing back steam for powering LTA systems. Now why on earth do you think people would like to look at steam as a LTA system in this today's generation? What do you think is the motivation. Now this particular experiment that I will show you it is not that much to provide propulsive power for the engine.

This is an attempt to use steam as a lifting gas. And what would be the motivation? The high cost of helium and more than high costs the continuous less availability. So, recently we put a proposal to an agency for funding application of LTA systems for the farmers agricultural applications. So one question that were raised is how do you think farmers will be able to afford? Helium is out of question, availability is also a problem.

Hydrogen, yes it is relatively cheaper, but still operating costs can be very high. So someone said can we use steam as a lifting gas? So that so I want here showcase this thing to you. Looks like I will have to, but I have this information offline. So I will probably be able to but you know it was nice to see it there.

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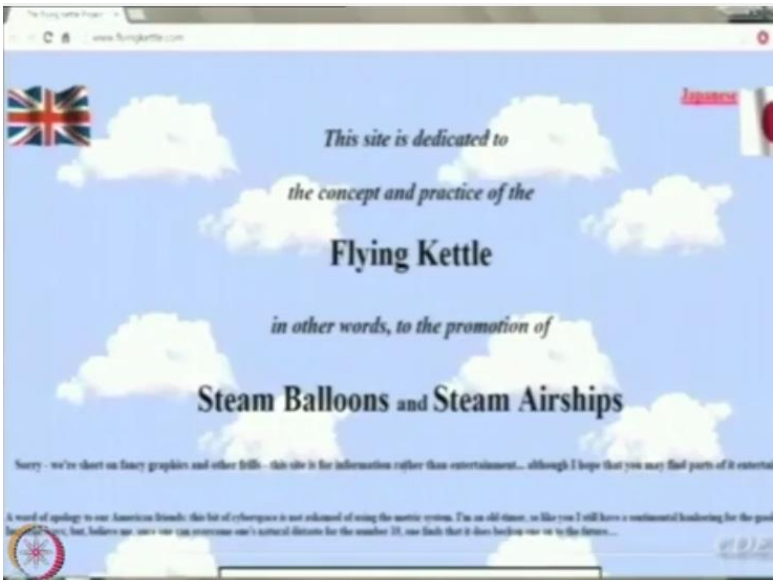

So this website I would like you to study in detail when you go back home. It is called as the Flying Kettle and basically steam balloons and steam airships. It is is called as flyingkettle.com

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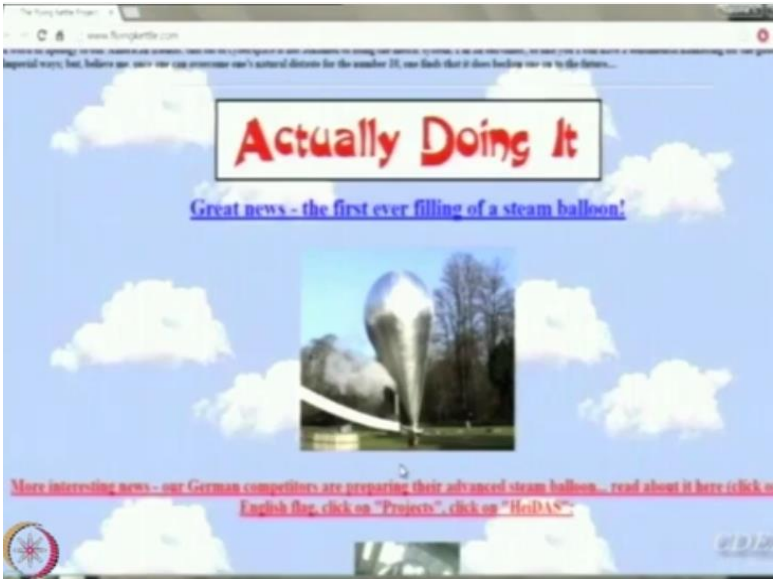

So the idea is to use steam for balloons and airships. **(Video Starts: 06:30)** So let us see a testing. What I will try to do is I will try to put the audio also. I do not know which of these cables will work? **(Video Ends: 07:35)** So, this is a very special purpose material called as hideous which is able to withstand steam at 100 degrees centigrade. It is able to hold it without structural problems without leakage.

So, simply these people are also if you notice there is a steam engine here. This is a small steam engine which generates steam, steam generators I should say.

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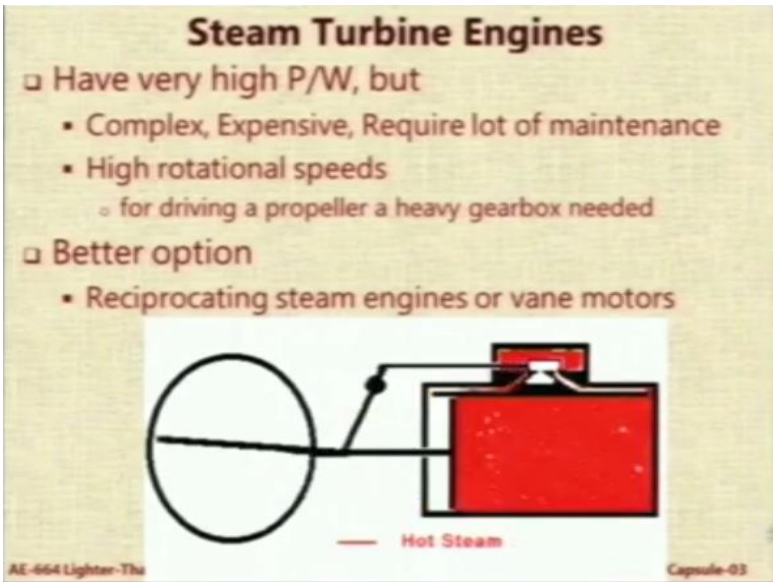

So steam turbine engines very high power to weight ratio and that is the principal attraction. The power available versus the weight of the system is very high, but they are not very straightforward to operate. They are complex, expensive and require a lot of maintenance. Secondly you need very high rpm's. Therefore, you need a very heavy gearbox because the engine will produce high rpm and to reduce it down to the propeller rpm you need to protect the gearbox.

So, another option would be to either use a reciprocating steam engine or vane motor. Now, this argument is just for steam turbines. So steam turbines are very commonly used and they are easily available. But the argument being made here is that steam turbines are not going to be useful because they are going to be very heavy and they are not going to be as effective. So, this is the best solution, reciprocating steam engines or vane motors these should be used.

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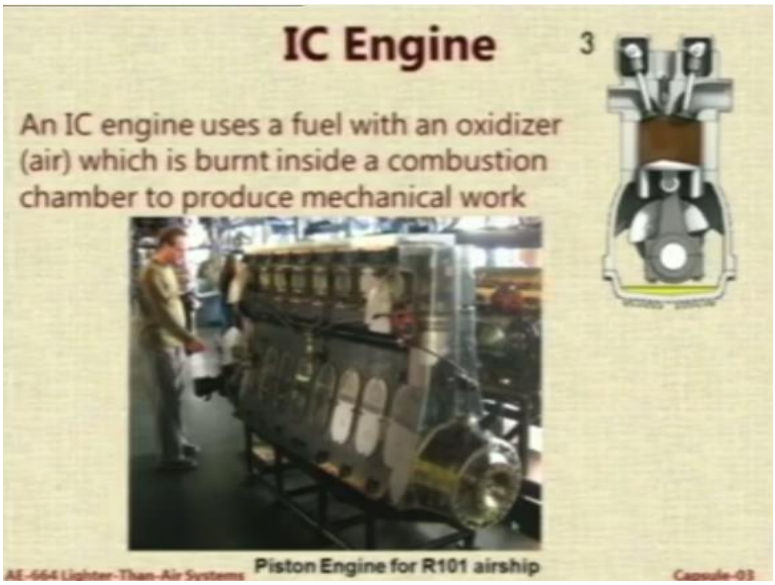
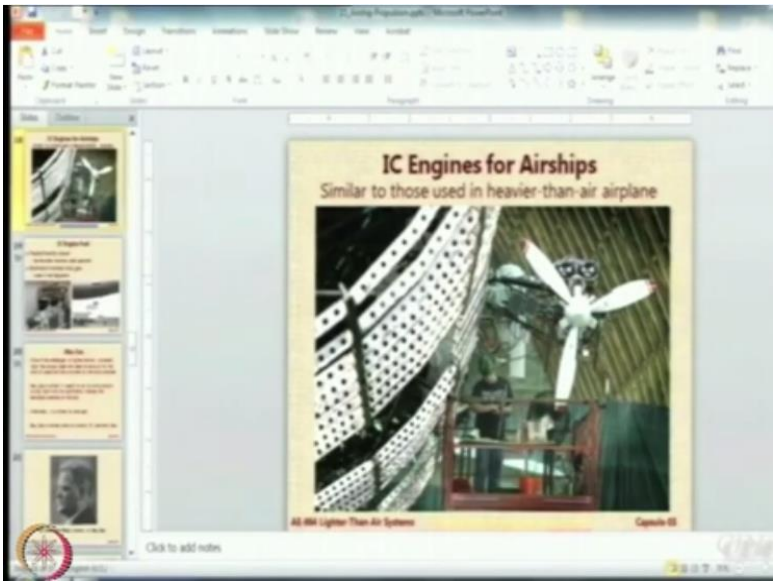


Let us go to IC engines which are very common. So, essentially an IC engine is one that uses an oxidizer which is mostly air and that is combusted inside a commercial chamber and that produces the required energy for the mechanical work. **(Video Starts: 09:40)** So, you can see the functioning of the IC engine as shown here in this small video. So you can see that the piston gets compressed and then there is an explosion.

In that explosion, there is an expansion of the gas which pushes the piston down. As the piston is pushed down, air is sucked in. And then this cycle continues. **(Video Ends: 09:58)** The valves were closed, air is compressed. Compressed air is combusted, it causes an expansion. The gas is expelled here. The air is inhaled here. **"Professor – student conversation starts."** So is this a two stroke engine or four stroke engine?

Four stroke engine. It is a two stroke engine. So how many of you say it is a two stroke engine? Why do you say it is a two stroke engine? Within in one complete cycle they move**.** Yes, but do not you have 4 separate steps? The triangular cam. **"Professor – student conversation ends."** Now, here is a picture of a piston engine which has been used for the R 101 airship.

Remember the airship which basically did not succeed. It was supposed to come to India from London from UK. So, they have designed a very special very narrowish piston prop engine for powering this particular airship. What you see here is the hub where the props will be mounted. **(Refer Slide Time: 11:34)**



And this is the IC engine of a modern airship. What you see is the framework of the airship. So, this is a semi-rigid airship with some framework inside engines were mounted So, let us have a look at this particular concept. This particular ship is called as Aeroscraft. So, aeroscraft is one of the modern designs. In fact, I would like to cover this in more detail when I look at modern airships. So let us move ahead.

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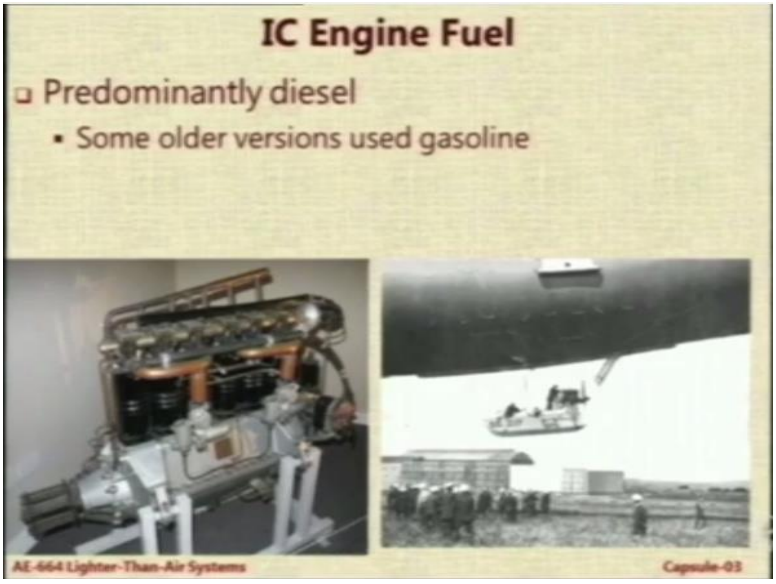

Now, about IC engine we have to be very careful about the kind of fuel we use. So, it is very important. In airships predominantly we use diesel engines and some older versions use gasoline. So now, what is the basic limitation or a problem with a diesel engine as compared to a gasoline fired engine? **"Professor – student conversation starts."** Rate of maintenance. What is it? Rate of maintenance. Maintenance is more or less in diesel? It is more. Why is it more? Works on a higher pressure. Correct. **"Professor – student conversation ends."**

The operative pressure is higher and therefore the vibration level is also higher. So, therefore even cars also the diesel cars once they go beyond around 35,000 kilometers and when they go for maintenance, there is a sudden increase in the maintenance costs. Till that particular distance or till the engine is touched, they might be efficient, they might be low in operation cost. So some older versions are using gasoline.

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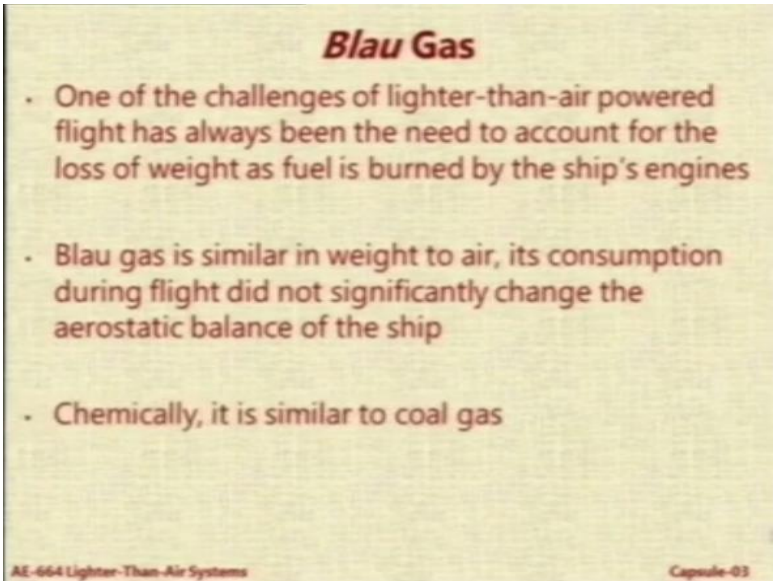

Germans as you all know how also use this blau gas. Do you remember this blau gas? It was asked in the exam also. And this particular gas was used in the Zeppelin. So just to remind you or refresh your memory we know that one of our challenges is to maintain the buoyancy. And this gets disturbed because of the loss of mass as the fuel is consumed. So the Germans came up with this secret weapon called blau gas which is similar to work in the air as air.

So its consumption during flight did not significantly change the balance of the airship. It is a low density fuel, density matching with that of air. Chemically, it is same as a coal gas.

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And it is not blue in color. It is called blau gas because of this gentleman who discovered this particular gas, right.

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And the first airship to use blau gas was the Graf Zeppelin LZ-127. The volumes required were very large and therefore it is very handy. It is really handy to have a gas like this which does not upset the buoyancy of the airship.