Lighter-Than-Air Systems
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Lecture - 86
Turboprops for Airships

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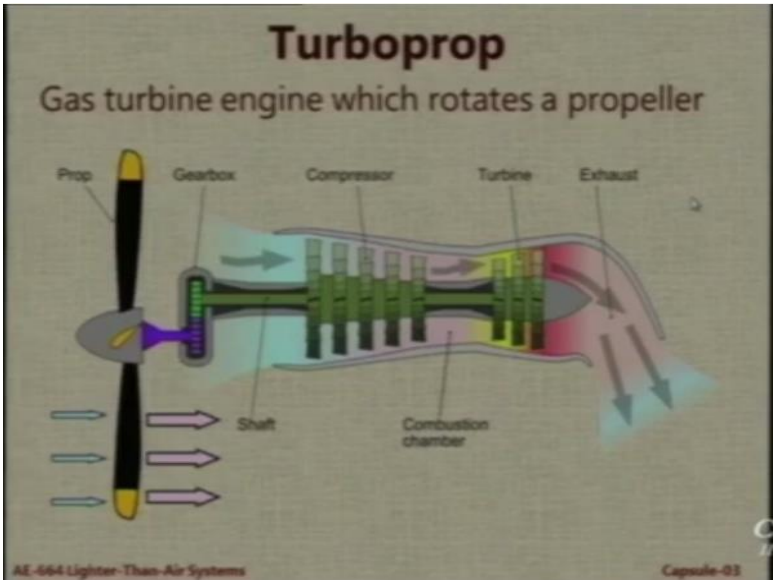

Now, there are also some other types of engines which are popular for airships. One of them is the turboprop type. The turboprop type is basically it comes in two versions actually, one is this particular figure where we see that a turbine, in this case an axial flow turbine having a compressor, combustion chamber and turbine. Onto the compressor shaft you attach a gearbox and that drives the propeller.

So, why do we need a gearbox? **"Professor – student conversation starts."** To reduce the rpm. To reduce the rpm of the propeller. At what rpm does the turbine normally move? In a gas turbine engine what is the rpm of the turbine? Typical value. Take a guess. No it is more, so around 30000 rpm for a typical turbine. In fact for very high powered turbines in commercial aircraft you can also expect 60,000 rpm, you can.

And at what rpm do you rotate the propeller of an aircraft engine? So why do not you guys have any feel for numbers? These are very simple engineering numbers you can calculate so many things, you can do so many coding, but you do not have any feel for basic numbers? No

that is less, it goes 1000, even 2000 sometimes. And small motor with which you play they go at much higher rpm. What do you think Amit? What rpm are your small EDF's.

It is 54,000. 54,000 rpm correct. So, small motors. But you cannot put a prop at the rpm. It will break away under the excessively high centrifugal forces plus it will be inefficient, it cannot extract the energy power at that particular rpm. So, from 30,000 to 2000 or 1000 you need to bring it down using a gearbox and that makes it very heavy that brings in maintenance costs. So, what is the other variety of engine that can be used?

If I want to couple a turbine to a propeller, one is a turboprop as shown here. Is there any other type of engine that you have heard of? So, now what is happening to the exhaust here. The exhaust here is giving you some thrust. That is small percentage I think. How much percentage? 10%, correct 15 to 20% sometimes, 10 to 15% is a good ballpark, very good. **"Professor – student conversation ends."**

So, the exhaust of this engine is also giving you thrust. But suppose you do not need thrust, you need power, yeah thrust is welcome because if you are giving forward force rather than getting from the propeller you will get it from the engine itself. It will give reaction, but sometimes you may not need it. So, have you heard of something called turboshaft engine? In that we close the exhaust or we do not use the exhaust for giving thrust.

The entire power of the turbine is absorbed by the propeller. Such engines are used in helicopters for example, turboshaft engines. In airships also we can use turboshaft engines, but they are not normally used, normally we use turboprop engines.

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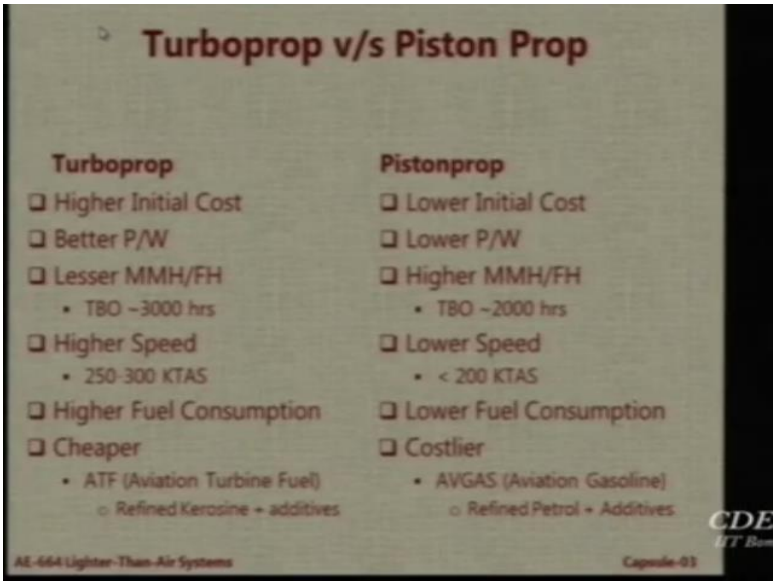

Now, this is a constant question that gets asked or it comes to the minds of the people who design airships. Now when I say airships I am talking about now passenger carrying airships, I am not looking over RC airships. So let us have a look at a few comparative matters between turboprop and piston prop for a passenger carrying airship. First we will go for turboprop. So it has a higher initial cost. It is more expensive to buy turboprop.

Why is that? Compared to IC engine, it is much more costlier. **"Professor – student conversation starts."** Because the turbines and the compressor are designed very carefully so the manufacturing has to be very costlier. Correct. The fact that you have a gas turbine cost will go up because that will have compressor, combustion chamber, turbine, high rpm's, very carefully alignment design. So therefore, they are costlier, but they give you a better power to weight ratio.

They give you a lesser maintenance man hours per flight hour. This is a term which is used to comment about the maintainability of an aircraft MMH by FH. So, what it means is how many hours has to be spent man hours in maintenance per unit hour of flight. So, what is your feel? Let us say take an aircraft like MiG-27 which is a high speed turbojet with reheat, what would be the maintenance man hours per flight hour? 20 to 30.

Yes good approximation, around 20 to 30. **"Professor – student conversation ends."** That means you fly it for 1 hour and then 30 hours of maintenance is needed by 1 person or 1 hour by 30 people whatever combination you like in between or 2 hours 15 people. So, around 20

to 30 man hours are needed per hour of flight. What kind of number do you expect for our commercial transport aircraft which flies for let us say 16, 17, 18 hours a day?

I mean it is around 8 to 10. So, this particular number is lower for turboprop compared to piston prop. Around 3000 hours is the time between overhaul. Now, when I say MMH by FH for an aircraft engine is not the only thing, engine is one part of it. There are other parts which consume time. So, do not get confused between aircraft MMH by FH and the engine MMH by FH.

As far as the engine is concerned the time between overhaul and the time required for over maintenance is more important. So, that number is lower for this one and it gives you higher speed capability. You can fly with 250 to 300 knots, but it has got a higher fuel consumption. However, the fuel is ATF, aviation turbine fuel which is nothing but a refined type of kerosene with some additives. This is much cheaper than the gasoline.

Those of you listened carefully to my case study on airship for Uttaranchal they realize that the consumption of fuel was more in case of the piston props but in case of airships compared to helicopters, but the cost was I mean they were different because the cost. Turboprops have a lower initial cost but they have no power to weight ratio. Higher MMH by FH, this is a mistake it should be 2000 hours, I will correct this. So, this is 2000 hours.

Speeds never more than 200 knots true airspeed. Fuel is costlier. The fuel used is AVGAS or aviation gasoline, which is petrol plus additives. So, since kerosene is cheaper than petrol, therefore the cost of ATF is generally lower than cost of AVGAS, also availability. So, that is why turboprop may actually have higher fuel consumption, but they may turn out to be cheaper to use because of the lower cost of the fuel.

So, what is the cost of petrol today in the market? Around 64-65 rupees. What will be the cost of ATF? It will approximately 100. Then AVGAS that is basically AVGAS refined pertrol. Kerosene, what is the cost of kerosene in the market? Much lower, it is 25-30 rupees. And therefore if you use ATF it will be also relatively cheaper. But these costs are artificial, I must always say because of the consumption.

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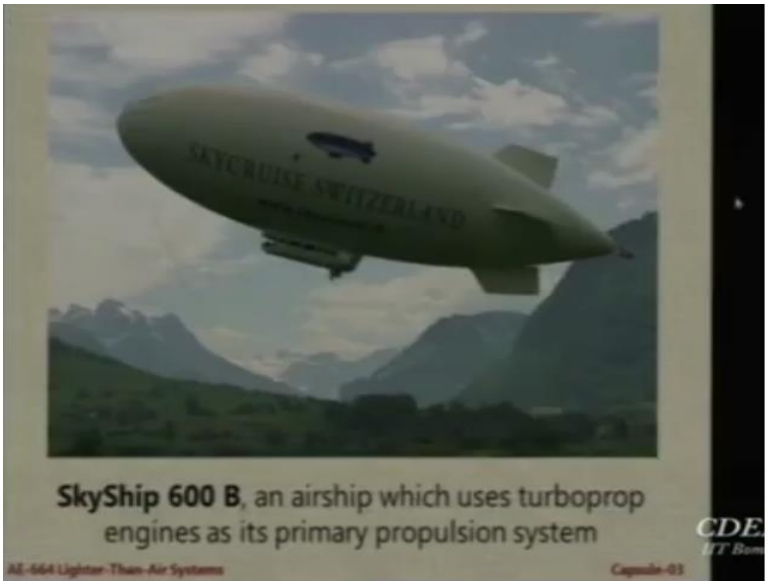

So the first airship to use turboprop as its principal powering system was the SkyShip 600. So, I want to show you a small film about this airship. Maybe I have shown you this film before. I do not know, but let us just see. **(Video Starts: 10:30)** This is the launch video of the SkyShip 600 B maiden flight. Have you seen this film. **(Video Ends: 16:20).**