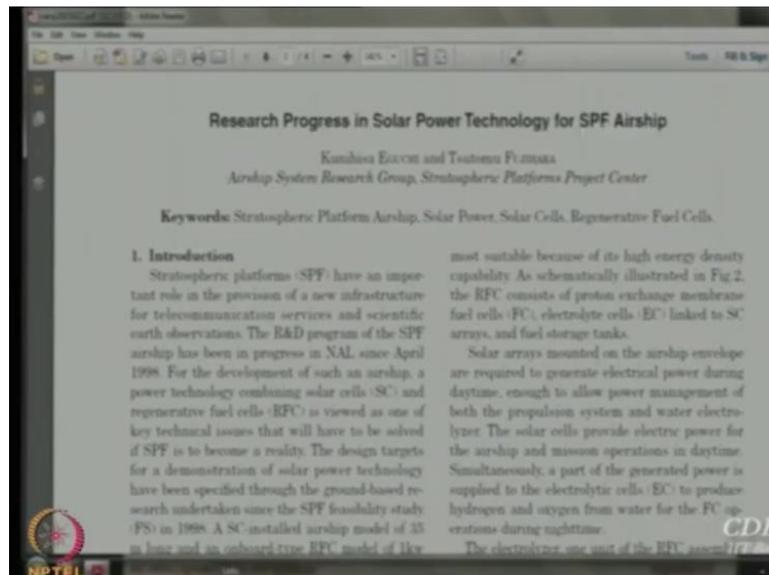


Lighter-Than-Air Systems
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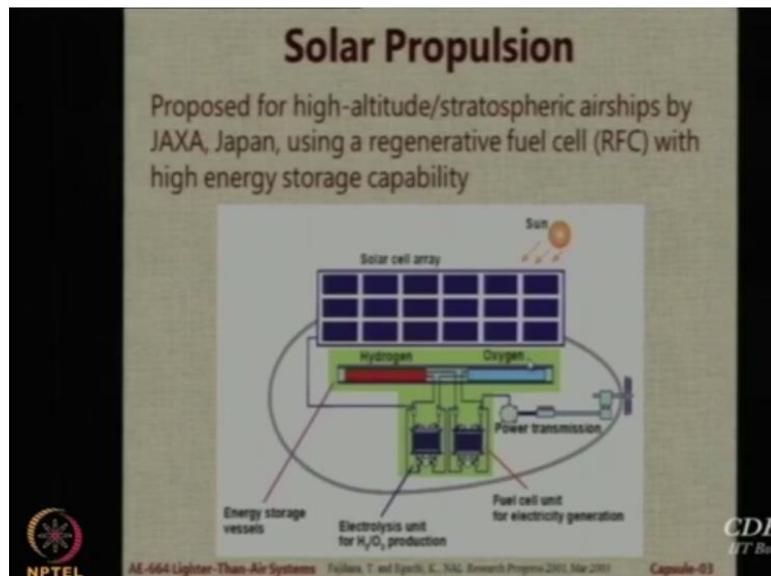
Lecture - 87
Solar Propulsion and Thrust Vectoring on Airships

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Now coming to the future about what is being planned. So the future is going to be driven by solar power. So, even in airships there have been attempts to go for use of solar regenerative fuel cells. This is a paper which I am going to upload. This is an interesting paper 2003 by JAXA in Japan. So I am going to upload this on the Moodle page. And there will be a special presentation on the stratospheric airships or high altitude airships. So, at that time we will discuss this in more detail.

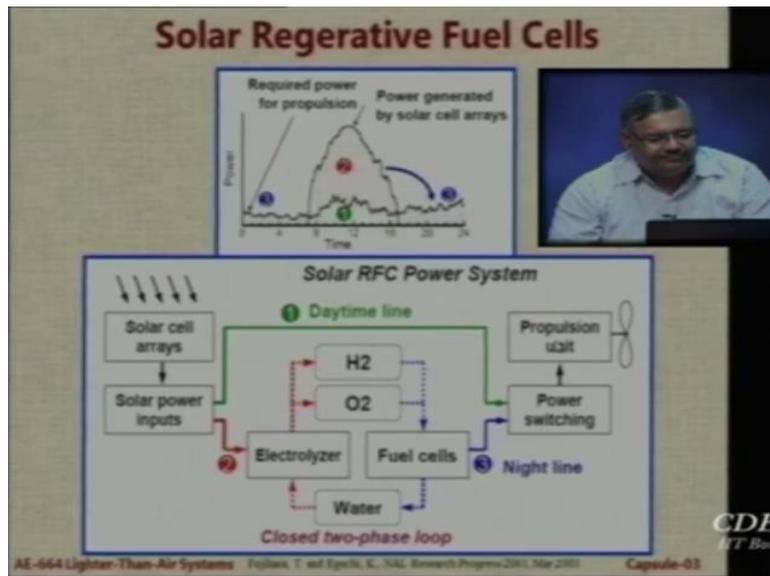
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Today we will just look at solar propulsion. So, especially for airships which are designed to be operating for a very long time, 3 months, 6 months without any interference by the humans, not for carrying passengers but for carrying communications payload. The suggestion is to use solar regenerative fuel cells as SRFC. So, how they work is that onboard the airship, there is an electrolysis unit which converts water into hydrogen and oxygen.

Then this hydrogen is pumped into onboard cylinders Do you have any idea about the dimension of this airship? It is 316 meters in length, 1000 feet in length. So, there is enough space on the bottom to store that much of water. Moreover, the requirement of water is not very high because you are regenerating it. You are creating hydrogen, oxygen pumping it into bottles, using hydrogen in the fuel cells, generating power and recovering it and again reusing it. And there is a huge envelope available for solar array. So, this is how they work.

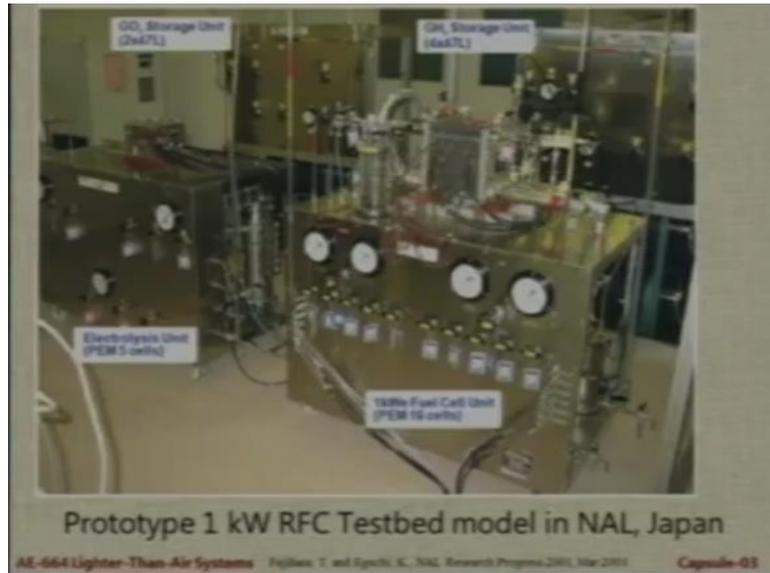
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During the daytime from something like 7 a.m. when the sun starts generating some power that is here point number 2, 7 a.m. to around 5 p.m. the solar power available is increasing. The peak is coming around noon and the power required by the airship is only this much these lines. So, the difference in the power of that is this, this minus this is used to store in the onboard batteries. And then the storage batteries provides power from this time when it is less than required till next day morning.

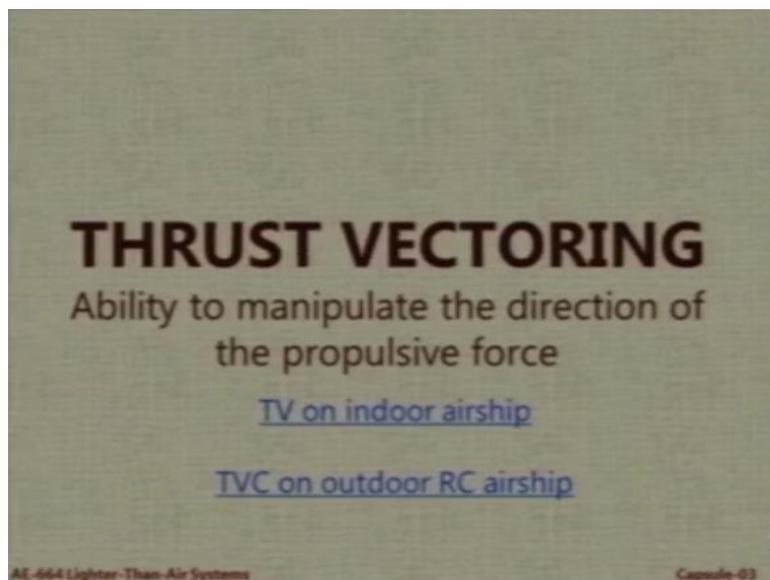
So in the nighttime, the battery are going to give the power, in the daytime the battery are going to be charged. So this is a schematic diagram. And you can see that water is electrolyzed into its H_2 and O_2 which goes into fuel cells. So in the nighttime there is power switching and the electrical engine is powered by hydrogen fuel cells. During the daytime, there as solar arrays will give solar power and then this is the daytime line, it bypasses the system and provides power.

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So this is not a theoretical concept. They have already made and tested the concept. So this is for sample of 1 kilowatt testbed which was made and tested by Japanese more than 12 years ago. So it is done already. But even now there is no stratospheric airship actually flying. Many countries are working on it including India and there are plans to bring it up.

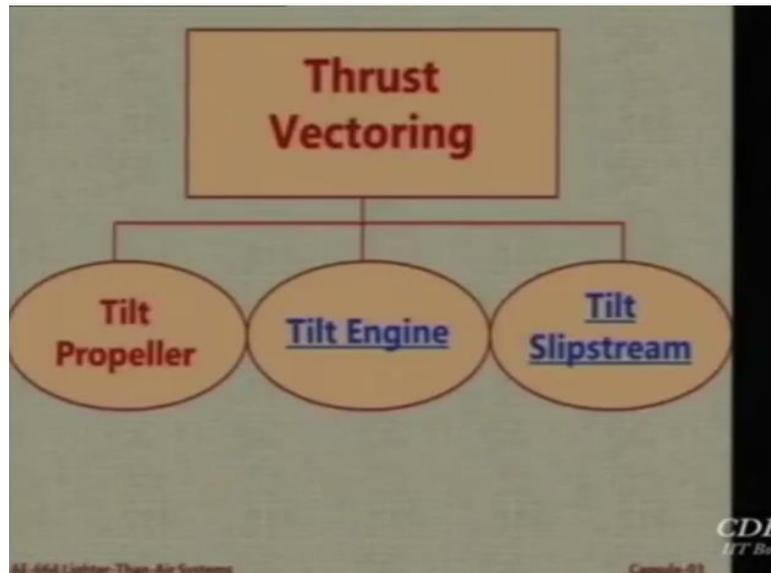
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We look at now thrust vectoring which is ability to manipulate the direction of the propulsive force in the direction that you would like to do. And here I would like to showcase to you 2 small videos (**Video Starts: 04:38**) One video is thrust vectoring on an indoor airship which was done by an intern recently as part of his internship. So this is a very simple gondola for an indoor airship. It will be mounted below the airship and on that there is a central rod with a servomotor.

So, we will see that they are controlling the direction with a remote. The motor can be swirled. **(Video Ends: 05:10)**. Then we also tested this system, a similar system, not the same system, but a much better system than this. This is a very simplistic system. **(Video Starts: 05:27)** So, you can see that a slightly bigger motor is being installed on a central shaft which is the gondola. What you see here on the back is the airship envelope. The white one is the airship envelope **(Video Ends: 06:06)**.

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So, this thrust vectoring is basically by tilting the whole engine because the entire motor was tilted up. One more example a tilt engine is what you already know.

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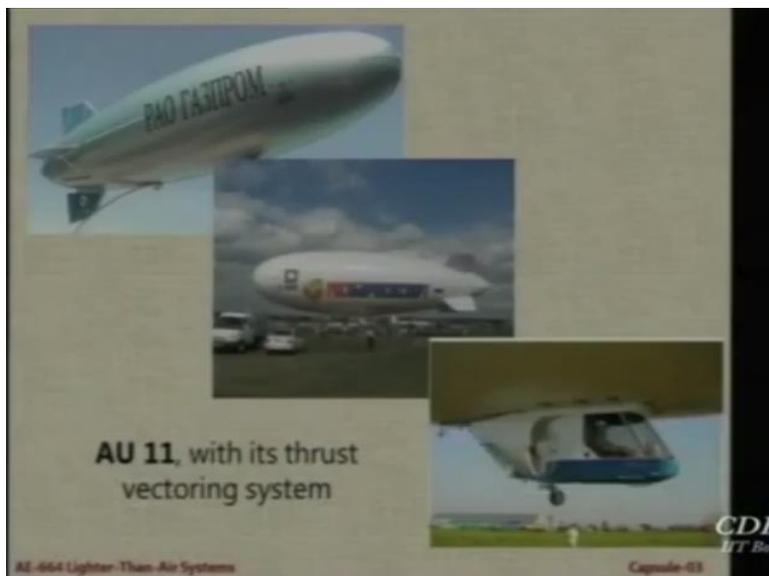
This is an example of tilting the engine. We have seen so many examples of this.

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The other example is tilting the slipstream. In this case, the engine is untouched, it is fixed, but the slipstream of the engine is deflected by a very intelligent use of connected vanes. Just like when you have these looms on the curtains, you can use it to control the vanes. So, the pilot basically operates a lever and with that lever these flat or slightly curved plates will deflect and they will deflect the slipstream which will give you the thrust vectoring. So, what you are seeing here is the thrust vectoring onto Russian airship called us AU 11.

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So, this is the picture of the Russian airship. It is a single pilot airship and the pilot has this thrust vectoring lever through which the engine mounted behind the pilot gives you the thrust vectoring. So, that is all I have today for the propulsion system.