Lighter-Than-Air Systems
Prof. Rajkumar S. Pant
Department of Aerospace Engineering
Indian Institute of Technology - Bombay

Lecture – 101
Technological Challenges in HALE Platforms Development – Part I

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Now come to the design development of these HALEP systems. So, these are actually key factors which drives the design atmospheric conditions because at that height we will encounter different wind speed at different locations and the power available due to solar energy and envelope shape optimization because it will encounter a drag, envelope technologies. You have to optimize the systems.

You have to minimize the structural systems to maximize the payload. Station keeping and thermal compensation because of temperature variations. Diurnal temperature variations is there, which will affect the performance, buoyancy and output of the solar systems. And lightning and electrostatic charge protection because it might affect or distract the envelope. And launch, recovery and ground handling. These are the challenges while design.

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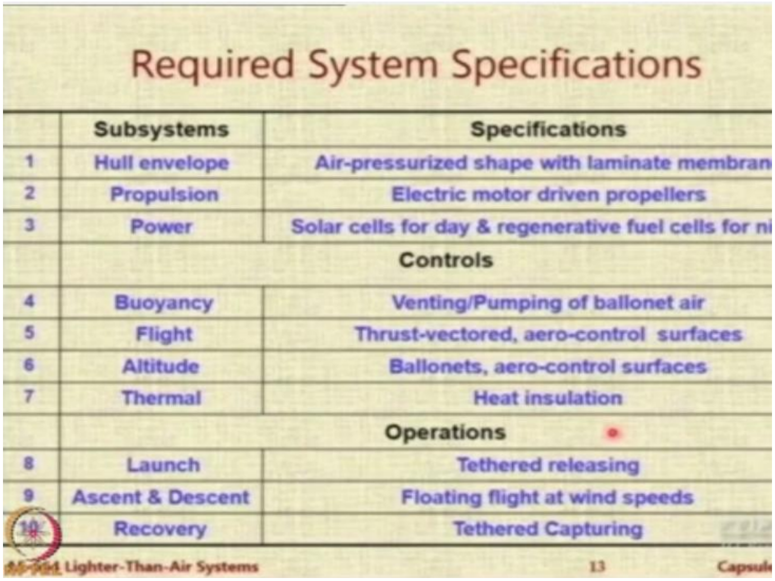

Required System Specifications

	Subsystems	Specifications
1	Hull envelope	Air-pressurized shape with laminate membran
2	Propulsion	Electric motor driven propellers
3	Power	Solar cells for day & regenerative fuel cells for ni
	Controls	
4	Buoyancy	Venting/Pumping of ballonet air
5	Flight	Thrust-vectored, aero-control surfaces
6	Altitude	Ballonets, aero-control surfaces
7	Thermal	Heat insulation
	Operations	
8	Launch	Tethered releasing
9	Ascent & Descent	Floating flight at wind speeds
10	Recovery	Tethered Capturing

So, these are the requirements because HALE you can see to control the buoyancy that is used to be another systems because due to the temperature variation and the height, the height of the systems will vary. So, you have to take care of that. And to fight with the drag because the wind direction will change, so there should be a proper thrust vectoring. Altitude control, thermal protection these are the systems requirement.

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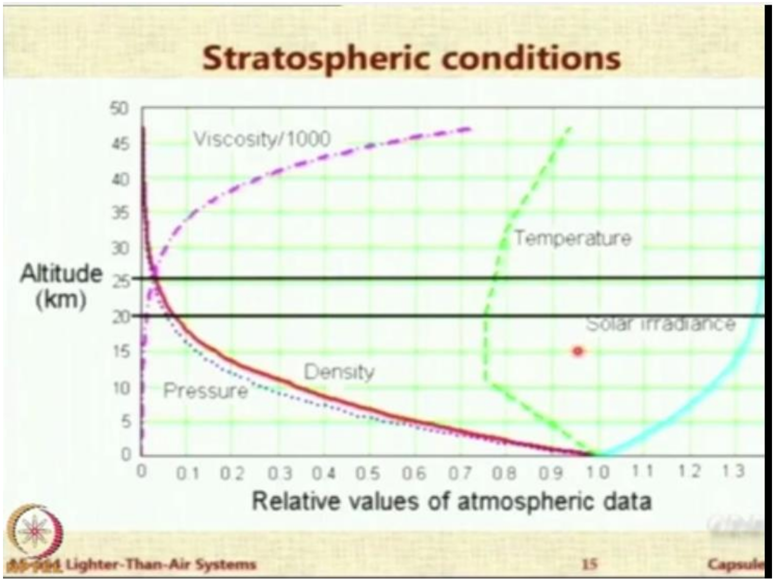

So, let us see what are the actual scenario at that height. So, at the altitude of around 20-25 kilometers, you will see the temperature and density and viscosity at that range it is actually optimum. You do not want to have very low low density because it will affect our buoyancy as well as if you will place below that height, higher density will lead drag and the temperature and solar irradiance. So, at that particular height it is optimum.

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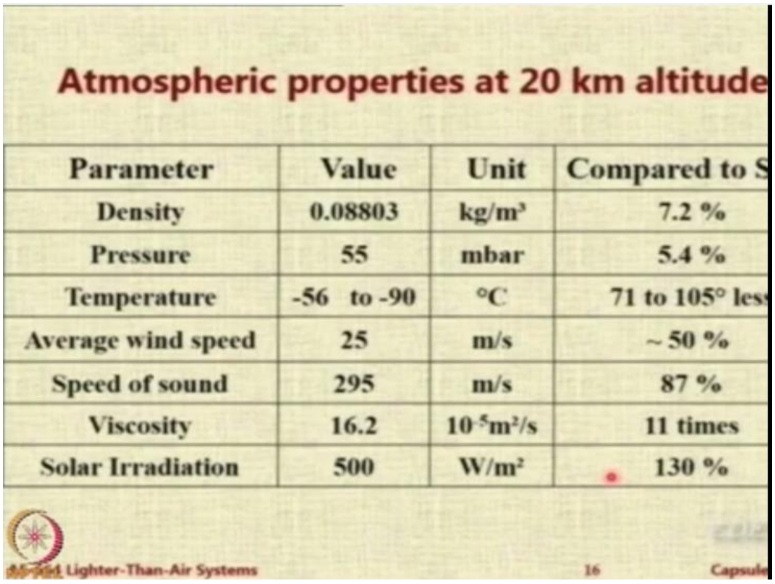

Atmospheric properties at 20 km altitude

Parameter	Value	Unit	Compared to S
Density	0.08803	kg/m^3	7.2 %
Pressure	55	mbar	5.4 %
Temperature	-56 to -90	°C	71 to 105° less
Average wind speed	25	m/s	~ 50 %
Speed of sound	295	m/s	87 %
Viscosity	16.2	$10^{-5}m^2/s$	11 times
Solar Irradiation	500	W/m^2	130 %

So, these are the typical parameters. You can see its ground density is about. How much density is at ground? 1.22 around that is 7.2% of that only. So, these are the typical values. Average wind speed is 25 meter per second. And solar irradiance is 500 and actual solar irradiance without elimination and without any loss it is around 1300-1365 watt per meter square and after that loss it used to be around a typical value of 500-400, it will depend upon location.

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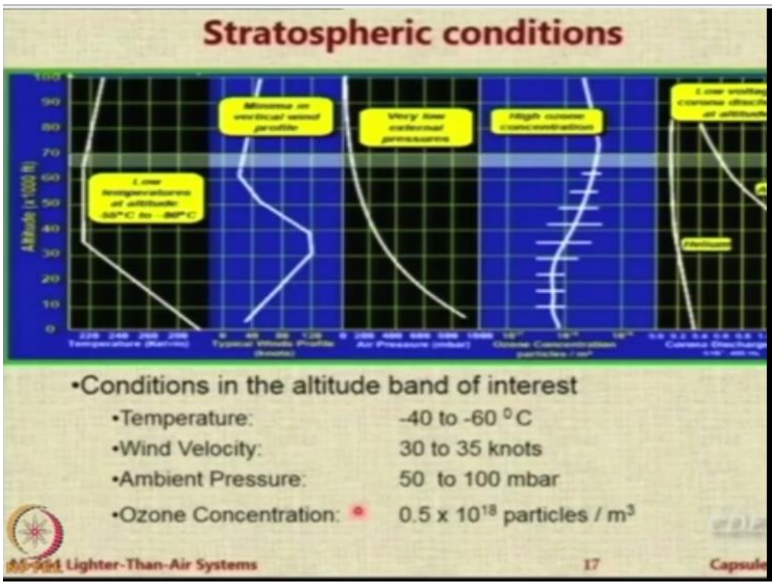

So, these are the variations with height. You can see in the unit. Is the video visible? Temperature variation. Wind you can see the minimum wind at that height and direction is changing. The temperature is minus.

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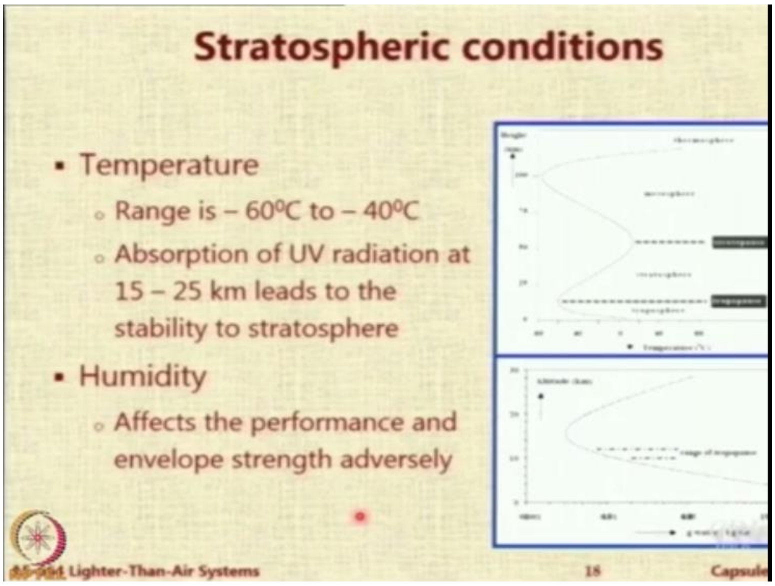

So, move on. So, the temperature range is –60 to –40 degree and that will affect envelope as well as it will affect the buoyancy, it will affect the power output from solar cells. Humidity is there. At that height humidity is less because humidity creates always a problem. It decrease the strength.

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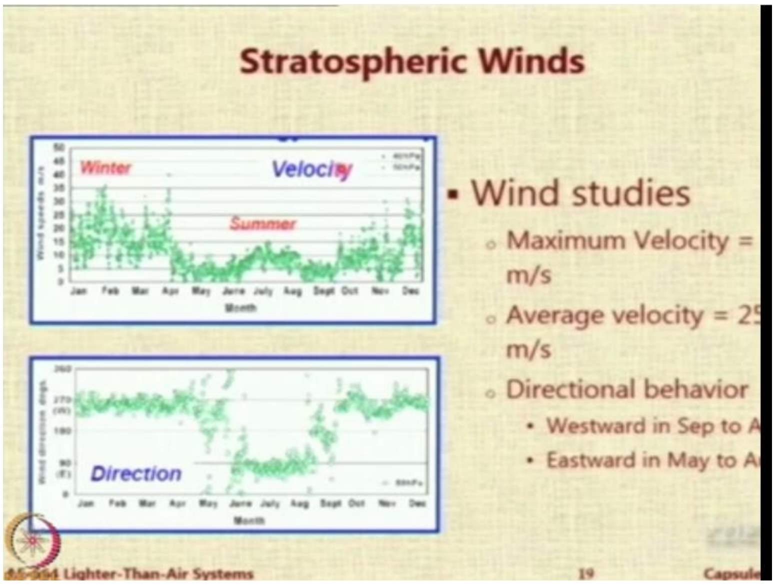

So the wind profile. It is actual wind studies shows the variation of wind over the year and goes a maximum up to around 45 to 50 meter per second and average velocity of 25. And actually the wind velocity and its direction is a major problem because when direction changes, you have to optimize the orientation of airship to minimize the drag because same wind velocity and airship is in longitudinal direction and lateral direction the drag will be different.

But whenever we will change the orientation of airship, the power output will change because it will depend on the relative position of earth's way that is the problem you have to take care. And direction will change. For some month in the year it will be in different direction, for some month it will be in different direction. So these are the challenges.

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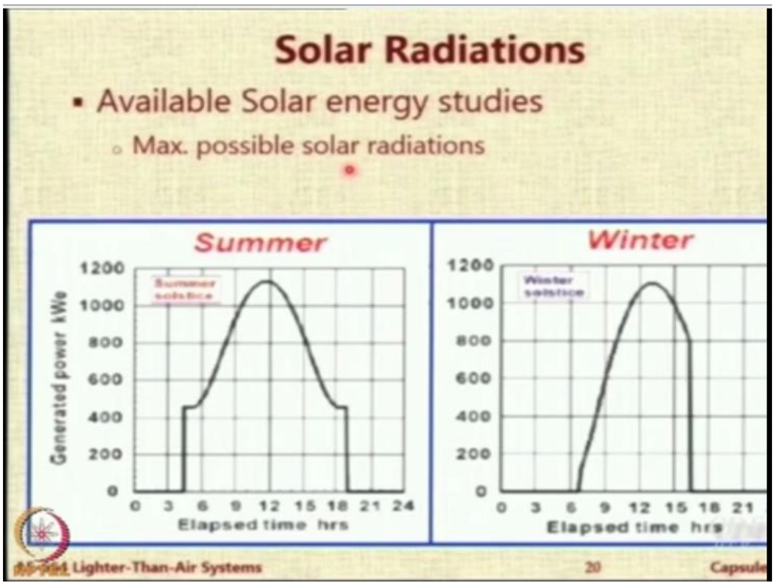

So, you have to keep it for a longer period of time. Suppose you have to keep it for a year, so you have to take care of the power availability in as winter as well. And the power availability will be lower in the winter and for the shorter duration of time and you have to store the power for a longer duration because night will be longer that is another challenge. Power available is more in summer you know.

So, storing power in the systems for restore that power it will be low, I mean it is small, but in winter you have to take care of that also. Otherwise, at night it will fail to provide a power to the propulsion system as well as payload because power requirement will be basically for two systems. For the payload we have what you have mounted like cameras or sensors or systems which will serve the purpose of the airship. And other power requirement will be for the propulsion systems to overcome the drag which it is causing at the height.