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SOLAR POWER IN COMMERCIAL AIRCRAFTS

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Abstract: *Renewable Energy aims at producing power using natural resources without damaging the Environment. A tremendous amount of energy is emitted by the Sun every day, and using this energy as a source of power for commercial aircrafts is our area of research. Our basic principle is to use solar power by means of solar panels to power the aircraft.*

We studied the power requirements of a commercial aircraft during different instances of its flight time and found that the power required during the lift was 2 to 3 times more than the power required during cruise. We suggest storing the energy from the Sun in batteries and using this power only during the lift time of the aircraft.

I. Introduction

Today, the world strives for clean, sustainable and economic source of energy. People ask, "Why is solar energy good?" but they fail to realize its importance. Solar energy is one of the best solutions to the environmental concerns such as global warming, depletion of ozone layer, air pollution, etc.

Solar energy is free and abundant. The energy produced by sun is 35000 times more than we consume, which can easily be used for practical purposes. A solar panel collects energy from the sun through photo-voltaic solar cells. This energy may be used to drive the electric motor to power the aircraft. During the night, the only energy available comes from the battery.

II. History

November 4, 1974 marked a revolution in the history of solar powered aircrafts when the first solar powered aircraft, Sunrise I flew for 20 minutes. The aircraft was designed by R.J. Boucher, which took its first flight on a dry lake at Camp Irwin. Sunrise I had a weight of 12.25 kg and a wingspan area of 9.76m. It consisted of 4096 solar cells in total which resulted in a power output of 450W. Sunrise I was caught in a sandstorm and got damaged seriously, following which a new and better version, Sunrise II was built which was tested on September 12, 1975. It had the same size of wingspan area, weighted considerably less and had a power output of 600W. The next big challenge after the solar models of airplanes were flown was to fly manned aircrafts powered by the Sun. The solar powered aircraft's first flight was a short jump which occurred on December 19, 1978 at Lasham Airfield, Hampshire, United Kingdom. It was just a short jump because of the incorrectly set pitch of the propeller. The solar version of his hang glider, Easy Riser was flown by Larry Mauro, named Solar Riser on April 29, 1979 which weighed 254 kg and had a wingspan of 30m which later on became part of NASA's ERAST program that started in 1994.

The next subsequent flights took place in 1979 on June 13, which covered a distance of a little less than 1.2 km (0.75 mi). The power needed for these flights was obtained using batteries that were recharged before the takeoff using solar cells. 3 successive aircraft, Pathfinder Plus, Centurion and Helios were constructed later on. On June 26, 2003 Helios, which had the objective to be feasible for eternal flight went through some structural failures and fell into the Pacific Ocean. Its objective was achieved on April 22, 2005 when the aircraft Solong, built by Alan Cocconi flew for 24 hours and 11 minutes using only renewable energy.

The next dream was to build an aircraft which could circle around the world non-stop using just solar energy. This was achieved using Solar Impulse. The world's first manned 26-hour solar powered flight was achieved on July 8, 2010 by Solar Impulse 1. After this, Solar Impulse 2 was designed which began its journey on March 9, 2015 which circumnavigated the Earth in a total of 17 stages and a time span of 16.5 months.

The next big dream is to create a solar powered aircraft which can fly continuously at high altitudes so that it can perform some of the functions that are currently being performed by the satellites.

III. Aerodynamic Properties of Aircrafts

A. Aerodynamics of wings

Aerodynamics explains the ability of an airplane to fly.
Anything that moves through air, whether small or big is affected by aerodynamics. Once a plane takes off, it is acted upon by four aerodynamic forces:

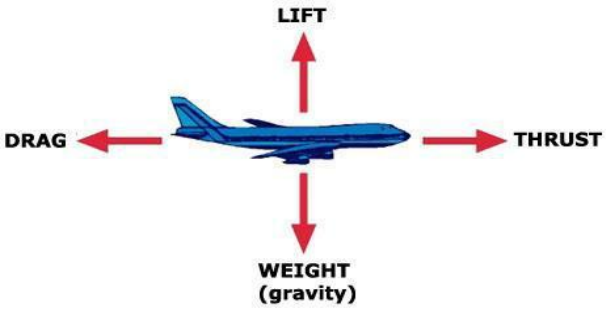
1) Weight- Everything is pulled down due to gravity. Weight is the product of gravitational force and the

mass of the object.it is the downward force that an aircraft must compensate to fly.

2) Lift- The force required to overcome the weight of the aircraft in order to fly is called lift.it should always be greater than the weight of the aircraft for it to move upward.

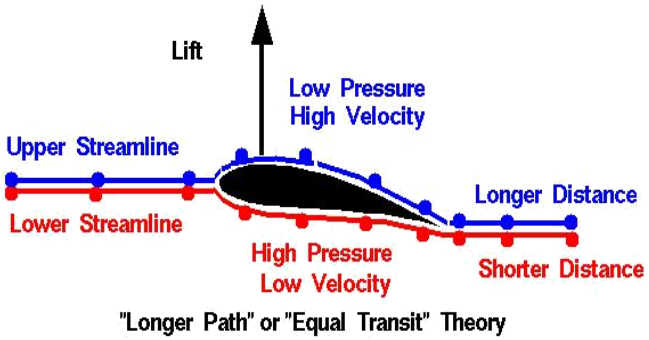
3) Drag- It is the force that opposes the forward motion of the aircraft, making it hard to move. The amount of drag depends on the shape of the object. Round and narrow surfaces usually have less drag as compared to the flat and the wide ones.

4) Thrust- It is the force required to overcome the drag of the aircraft and push it forward. Airplanes get their thrust either from the propeller, or the jet engines, depending upon the size of the airplane.



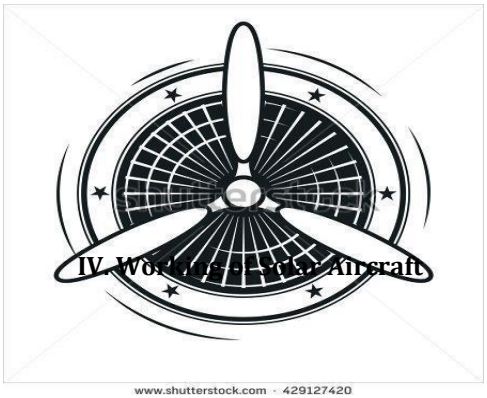
B. Concept of Lift

This answers the question," How do airplanes fly?" The airplane is held in the air by the opposing force known as lift. When the airplane moves, the air is separated at the leading edge of the airplane. The air which moves at the top of the airplane is faster than the air that moves below the airplane, which creates a region of low pressure over the airplane. As the air has the tendency to move from higher pressure to lower pressure region, the air below the airplane starts to move upward, thus producing a force known as lift. The lift is produced by every part of the plane, but the major part of this force is constituted by the wings.



C. Propulsion

The movement of airplane in the forward direction is possible due to propulsion. The propulsion is provided by the propeller present in the airplane. A propeller is a fan-like object which converts the rotational motion into thrust and moves the plane in the forward direction.



IV. Working Principle of Aircraft

A. Solar Panel

The Solar Panels use sunlight as the source of power, and convert this power into electrical energy which can be used for various applications.

Solar panel consists of photovoltaic cells, also known as solar cells.

The characteristics of the solar cells such as voltage, power etc. may vary according to the intensity of sunlight.

The average efficiency of solar panel is up to 20%.

The energy produced by the solar panels during the day is stored in the rechargeable batteries, which can be used at night.

B. Working:

The solar panels are attached over the wingspan of the aircraft.

There are two questions that must be answered for efficient working of solar powered aircrafts. They are:

1) How much power we can get from the sun?

2) How much power do we need to fly a plane?

These questions are answered by following calculations:

- Average wing area of a commercial airplane is 500 meter square
- Average area of solar panel is 1.93 meter square
- Average panels that can be accommodated= 500/1.93= 260 panels
- Average power produced by 1 solar panel is 275watts/hour
- Average number of solar cells in 1 solar panel is 72 cells
- Assuming 6 hours of direct sunlight on solar panels 275*6=1650watts/day
- Power produced by each aircraft 1650*260 = 429Kwatts/day
- Average efficiency of solar panel is 20%.

Therefore, the total usable power is approximately 86 kW/day.

Average installation cost of solar panels is Rs.30, 00,000.

V. Conclusion

Normal aircraft consumes 5 gallons of fuel per mile. Assuming the distance of flight to be 600 miles, 3000 gallons of fuel is used by the aircraft. On a one way trip as much as 25% of the fuel is used for takeoff. This implies about 750 gallons of fuels is used during takeoff, which costs about Rs.132000.This cost will be compensated in 23 one way trips of aircrafts. After these 23 trips airlines save on fuel, which will lead to reduced prices for the services they provide.

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