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Design and Analysis of Dodecahedral Tethered Aerostat

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Abstract : *To develop a design and fabricate of dodecahedral tethered aerostat system for the surveillance purpose. The aerostat that care of the design methodology and the fabricated process. The aerostat envelope was fabricated by special nylon material and PU coated material which provides the high strength to weight ratio on a sealing machine. The volume estimation, design principles and material selection are also discussed. The aerostat system will provide the better performance for lifting the payload and gas capacity. A light- weight camera was also mounted on a aerostat envelop, and it provides steady and distortion-free image of the covered place, thus establishing the efficacy of this aerostat for aerial surveillance. The camera of aerostat envelop should cover the radius of captured area of about 120m.*

Keywords: PU coated, Surveillance, Tethered

I. INDROTUCTION OF AEROSTAT

An aerostat is a lighter than air object that can stay stationary in the air and is tethered to the ground. Aerostat envelope derives the lifting force mainly by the buoyant effect that results from displacement of the higher density air surrounding it. The cover gas is generally helium because it is inert and provides adequate lifting capability. Mounting these sensors on elevated platforms like towers, aircrafts & balloons can increase lifting capacity of aerostat. The limitation of the height up to which a tower can be built, is obvious. Aircrafts have limited endurance of few hours whereas aerostats can remain operational constantly for days. Aerostats have been proven platforms for especially in surveillance and communication role for a variety of civil and military applications. Aerostat systems provide help in raising the electronic payloads for increasing their sight of range so it can be to overcome the ground obstructions like trees, buildings, mountains and similar obstructions.

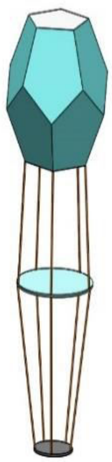
The aerostat consists of four major assemblies such as the hull and fin, shelter and radar platform, airborne power generator, and rigging and tether. The hull of the aerostat contains two parts separated by a gas-tight fabric partition. The upper chamber is filled with helium and provides the aerostat's lifting capability. The lower chamber of the hull is a pressurized air compartment.

II. DESIGN OF AEROSTAT

A. Design Principles

There are various aerostat of different shape are used in day today life. The literature survey for spherical shaped aerostat, ellipsoid shaped aerostat, spheroid shaped aerostat. There are some aerodynamic limitation found in these different aerostat. To overcome this a new dodecahedron aerostat will be designed.

Early aerostat were simple round spheres, with a payload hung beneath. The aerostat shape uses the minimum material to accommodate a given volume of lifting gas, making it the highest construction. However in any significant wind the aerostat shape is aerodynamically unstable and risking damage or the balloon breaking free and also the flow of wind is difficult.



To avoid this problem the dodecahedral aerostat was developed. This form has an elongated shape to reduce wind resistance and some form of surface to stabilize it so that it always points into the wind. The dodecahedral aerostat is an unpowered aerostat, as well as to reduce drag.

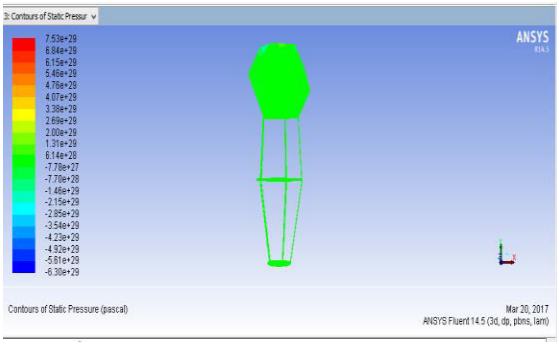


Fig 1: Design of aerostat model

TABLE 1
Design Specification of Aerostat Model

S.No.	Specification	Values
1	Maximum thickness	0.005 m
2	Side of the polygon	0.80 m
3	Height of the rope	100 m
4	Diameter of rope	0.005 cm
5	Diameter of balloon	0.54 m

B. **Volume and Shape Estimation**

1 liter of helium can lift 1 gram
Payload weight – 3kg
Helium gases density – 0.164 kg/m^3
Temperature – 300k
Gas constant for helium -0.164KJ/Kg K
Volume of dodecahedron $V=\frac{15+7\sqrt{5}}{4}a^3$
a = .80m
$=\frac{15+7\sqrt{5}}{4} * 0.80^3$
$=3.92m^3$
$M=V*\rho$ ------------3.1
=3.92*0.164
=0.64288kg
$M_{he}=\frac{PV}{RT}$ ------------3.2
=101.325*3.92/2.08*288
=0.6631kg
$M_{air}=\frac{PV}{RT}$ ------------3.3
=101.325*3.92/0.287*288
=4.805kg
$Payload=M_{air}–M_{he}$ ------------3.4
=4.805-0.6631
=4.1419kg.

III. ANALYSIS OF AEROSTAT MODEL

Analysis of aerostat model is taken for different velocity values.

Case (1): At velocity 27 m/ s

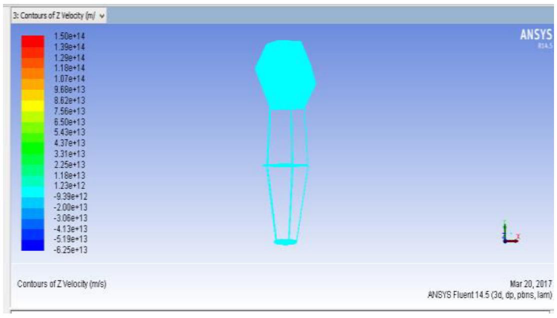


Fig 3.1: Pressure Counter

Fig 3.2: Velocity counter

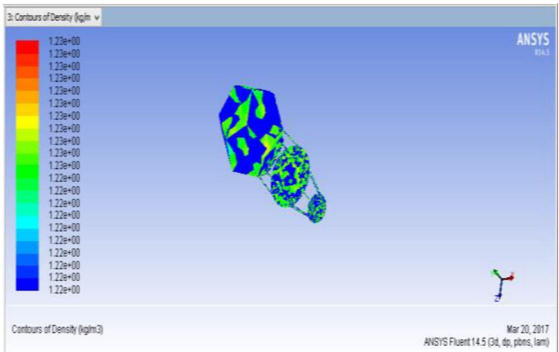


Fig 3.3: Density counter

From figure 3.1, 3.2, 3.3 shows that a velocity 27 m/s the air flow of an aerostat is to increase the lift and to decrease the drag.

Case (2): At velocity 26 m/s

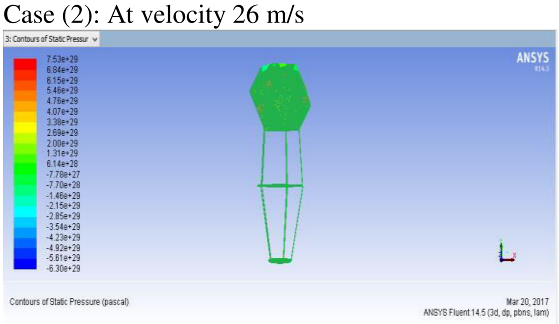


Fig no 3.4 Pressure counter

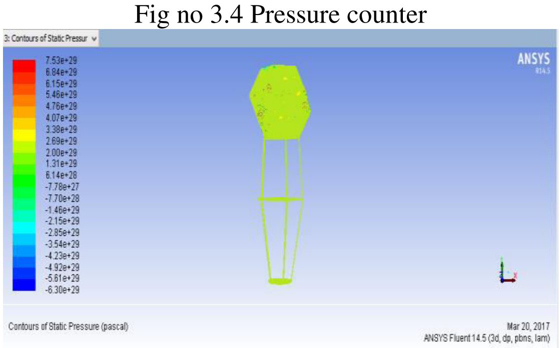


Fig 3.5: Velocity counter

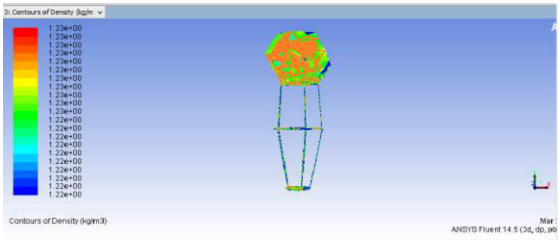


Fig 3.6: Density counter

From fig 3.4, 3.5, 3.6 shows that a velocity 26 m/s the air flow of aerostat is to get disturbance so lift is decrease and drag is increase.

IV. CONCLUSION

The design and analysis of aerostat model when it reaches the velocity at maximum level the drag will be decrease and the lift will be increase.an aerostat model is proposed for the surveillance purpose. This will be proven that increase the performance of air flow of aerostat model.

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