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Design & Development of Fire-Resistant MAV

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ABSTRACT

Nowadays, the number of high-rise buildings and large complex structures are rapidly increasing due to the development of new construction technologies and other economic reasons. Since these urban spaces are densely populated, fire accident could be critical and accessing the situation at early stage is very important in order to suppress the fire and evacuate the residents. An indigenously developed micro air vehicle is used to provide a solution for this problem. The MAV is designed using CATIA software. The frame of the MAV is built using Alumino silicate composite material which is fire resistant . The electronic components used on the micro aerial vehicle is coated with Rust-Oleum heat spray paint to withstand high temperatures upto 800 degree Celsius. which has advantages because of its ability to access to the place that is hard to reach. In this project, we are developing a fire-retardant micro air vehicle platform that can endure the intermittent flame. The MAV can pass through the narrow space through the flames. This project proposes a new fire- resistance mechanism for micro aerial vehicles using carbon reinforced aluminosilicate composite and infrared thermal sensors.

I. INTRODUCTION

This project proposes a new fire- resistance mechanism for micro aerial vehicles using aluminium Composite panel and infrared thermal sensors. MAV are very limited in payload and operating time due to battery technology and limitations of its own flight mechanism. The proposed fire- resistant MAV uses lightweight design using aluminium composite panel infrared thermal sensors. the platform is designed based on micro air vehicle, so that it can pass through collapsed structures in case of fire disaster and wildfires. It can be used for inspection in various high temperature areas such as thermal power plants and space vehicle launch stations.

MICRO AERIAL VEHICLE (MAV)

A miniature air vehicle (MAV), or miniature airborne vehicle, is a class of little UAV's that has a size limitation and might be independent. Current specialty can be pretty much as little as 5 centimetres.

Advancement is driven by business, exploration, government, and military purposes; with bug measured airplane supposedly expected later on. The little art permits far off perception of unsafe conditions difficult to reach to ground vehicles. MAVs have been worked for pastime purposes, for example, ethereal mechanical technology challenges and flying photography. Micro Aerial Vehicle (MAV) is capable of autonomous flight in GPS-denied environments. Micro aerial vehicle (MAV) is able to autonomously carry out an indoor target searching mission with vision-based navigation relying on a monocular camera.

Alumino Silicate (Al2SiO5)

Aluminosilicate are made out of aluminium, silicon, and oxygen, in addition to counter cations. They are a significant segment of kaolin and other mud minerals. Andalusite and sillimanite are normally happening aluminosilicate minerals that have the organization. The triple mark of the three polymorphs is situated at a temperature of 500 °C (932°F) and a pressing factor of 0.4 GPa (58,000 psi). These three minerals are normally utilized as list minerals in transformative rocks. Hydrated aluminosilicate minerals are alluded to as zeolites and are permeable designs that are normally happening materials.

AluminoSilicate composition

The Geopolymer potassium aluminosilicate tar was set up by blending 100 g of a watery silica + potassium oxide arrangement with 135 g of a silica powder having SiO2/AlO2 in a mole proportion of 27/1. The fluid and strong com- ponents were blended briefly at room temperature in a food processor. The as-mixed viscosity of the Geopolymer resin was measured at room temperature (20°C) in a dynamic rheometer (Rheo-metrics RDA-II) using parallel plate mode with 25 mm diameter stainless steel plates. The initial mix viscosity of the Geopolymer resin is about 2 Pa-s (20Poise) and the resin remains workable for about 4-5 hours at room temperature.

Fig 1.1

Advantages of Alumino Silicate

- Low thermal conductivity.
- Low heat storage (volumetric heat capacity).
- Ease of installation.
- Light in weight.
- Thermal shock resistance.
- Good corrosion resistance.

II. LITERATURE REVIEW

FIRE RESISTANT ALUMINO SILICATE COMPOSITES

This paper provides the required information about the fire proof material that is used to fabricate the micro air vehicle. The paper produces the following conclusion. such as maximum temperature capability of the composite material which is (>900) degree Celsius. The geopolymer CRPF composite is unique because of its high temperature structural capability and fire resistance Thus the geopolymer composite is far superior than the other fire- resistant materials listed below in the given table.

MATERIAL	Density kg/m3	Tensile Modulus GPa	Specific Modulus MPa-m3/kg	Flexural Strength MPa	Specific Flexural Strength MPa-m3/kg	Maximum Temperature Capability °C
Fiber-Reinforced Concrete	2300	30	13.0	14	0.006	400
Structural Steel	7860	200	25.4	400	0.053	500
7000 Series Aluminum	2700	70	25.9	275	0.102	300
Phenolic-Carbon Fabric Laminate [13]	1550	49	31.6	290	0.187	200
Phenolic-E Glass Fabric Laminate [13]	1900	21	11.0	150	0.074	200
Geopolymer-Carbon Fabric Laminate	1850	76	41.0	245	0.132	≥ 800

Table 2.1

The performance of the carbon- fiber reinforced Alumino Silicate composite is excellent in high temperatures and sustains its mechanical properties after exposing to high temperature such as (<900) degree Celsius. The given below graph shows the performance characteristics of the CRPF geopolymer composite material.

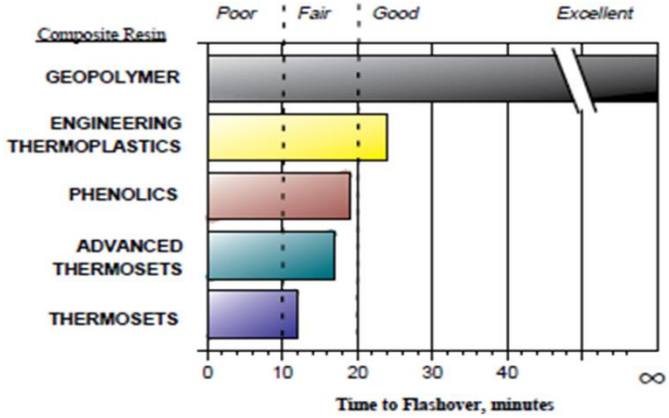

Fig 2.1

Fig 2.2

III. FABRICATION OF MICRO AIR VEHICLE FRAME

Primarily the micro air vehicle is designed using the modeling software CATIA V5R20. All the various parts are designed and assembled digitally first then the model is fabricated according to the drafting of the given measurements of the CATIA model. Abrasive water jet machining method is used to machine the composite material into the micro air vehicles frame.

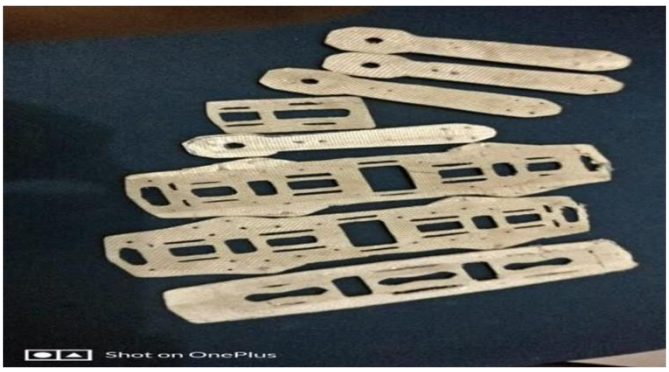

Fig 3.1

This method is used because it is more precise in cutting the material various other machining process is also used such as drilling, grinding and extra to make the desired shapes and contour for the micro air vehicle. Carbon fiber frame is fabricated with laser beam machining with required dimensions as per the CATIA model. We have tested the Alumino silicate fabric using flame torch under 950˚C.We have laminated the carbon fiber frame & aluminosilicate fabric using the epoxy resin. The fabricated frame is installed with required components.

Payload	**0.392Kg**
Structural weight	**0.529Kg**
All up weight	**0.921kg**
Thrust per Motor	**1.2kg(11.7N)**
Propeller Diameter	**5.5 Inches**
Pitch of The propeller	**5.2º (degree)**
Battery Capacity	**3000 mAh**
Battery Discharge Rate	**60 C**
Voltage of the Battery	**11.1 V**
Motor KV (RPM/V)	**2300**

Table 3.1

IV. RESULTS & DISCUSSION

Endurance

The mAh rating (3000 mAh): This tells of the capacity of the battery. What it says is simply that "The amounts of the current that can be withdrawn continuously from an initially fully charged battery to completely discharge it in 1 hour…or 60 minutes. The C rating (e.g. 30C): This gives us the ideal peak current that be withdrawn from the battery, and it depends on the capacity of the battery. The max amperage that can ideally be withdrawn from a 3300 mAh battery of 30C is: 3300 * 30 = 99000 milliamps = 99 Amps (Note that this is an ideal condition, and practically you should keep a safe margin between your ampere requirements and the ampere battery. The ideal flight time of the battery application requires a constant current requirement of 70 Amps, or 70,000 milliamps: So, first of all, we notice that it is well within our battery capacity (which is of 99 Amps) 3.3 Amps continuous gives 1hour => at 70 Amps continuous, we should ideally get a flight time of around (3.3/70) * 60 = 2.82 minutes = 170 seconds. Now that is when you are drawing a continuous current of 70 Amps, but practically, you pull in quite variable, there by somewhat giving you a higher flight times. And find out the motor's max current requirement 2300kv racing quad motors, it is 8 amps, so my max current requirement is 8*4 = 32Amps. Flight time of (3.3/32) *60 = 6.18 minutes (never run the motor always at its extreme capacity), **a flight time of around 15 minutes.**

Range

As specified in the Product Description of FLYSKY (FSi6 Transmitter & Receiver). Size of about 190*80*240mm. Transmitter power: 0.8W Requires 8 AA size batteries Range up to 1km line of sight. Computer programmable Professional and practical 2.4GHz 6-Channel digital transmitter receiver2.4GHz 6-Channel Digital Transmitter Receiver Radio Control System Set. Channels:6 Channels Model Type: Heli, Airplane, Glid. Modulation: GFSK RF Power: Less than 20dbThis is Mode 2: left hand throttle Reliable, interference free 2.4GHz AFHDS 2A signal operation. **Maximum Range** = 1000m (line of sight).

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