Certain investigation on RC aircraft engine to identify the suitability of Methanol and Castor oil Alternative fuel

Yuvaraj S1, Thomas Renald C J2, Senthil Kumar A P3, Sadesh K4, Naveen Promoth D5

1,2,5Department of Aeronautical Engineering, Sri Ramakrishna Engineering College, Coimbatore, 641022, India.
3,4Department of Mechanical Engineering, PSG College of Technology, Coimbatore, 641004, India.

Abstract. In the current age drones are broadly utilized for different applications in pretty much every field. Because of the disturbing expense of the glow fuel utilized in the RC motors, utilization of the equivalent includes a ton of capital. Adding to it, the current fuel brings about intermittent combustion and is in demand of alternate fuel. This paper manages the investigation of existing fuel synthesis and discovering the cost required to dispose of the high capital included, so that considerably more tests and study utilizing the RC Engines 2.5 cc can be completed easily. Methanol and Castor oil combination is considered as an alternate fuel. The approach includes testing of the fuel to decipher the substance parts and their individual pieces through a progression of tests. Followed by the study of possible additives to enhance the performance of the engine without actually altering the timing intervals. The new creation of the fuel showed up is blended in with extraordinary hardware and the equivalent is tried for essential fuel properties viz., Density, Flash point, Fire point, Calorific value, and so forth. The productivity arrangement is made utilizing a pulley instrument and the equivalent is tried for both the energizes. Performance of the R/C aircraft engine was tested with existing glow fuel and the new blend. Results are compared and concluded that the designed blend is a potent alternate fuel for R/C aircraft engines. *Future scope: It can be further tested for its SFC and emission standards. The outcome shows that the new fuel is exceptionally cost productive and the essential substance properties are profoundly improved.

Keywords : RC Planes, Glow fuel, Intermittent Combustion, Fuel blend

1. Introduction
Alcohols are used as fuels since the beginning of the automobile. Fuel ethanol mixtures are positively used in all kinds of vehicles and engines that need gasoline. Hydrogen is an evident alternative to hydrocarbon fuels such as NG, LPG and gasoline. It has numerous potential usages, is safe to production, and is ecologically friendly. Presently much care is fixated on use of alcohols, biodiesel, boron, natural gas, hydrogen, p-series, liquefied petroleum gas, solar, and electricity fuels as another engine fuels. Alternative engine fuels are competitive fuels to petroleum. These fuels are important because they replace petroleum fuels. There are many benefits the environment, economy and consumers in using alternative fuels. In order to overcome cold start problems in extreme winter conditions P series fuels are employed which is the combination of ethanol, methyltetrahydofuron and pentane with butane compounds. It gains a prime focus as they are petrol replacement fuels with environmental, social and economic benefits. A single gallon of these fuels emits 50% fewer CO2, 35% less HC (Hydro carbon) and 15% less CO (carbon monoxide) than petrol with 40% less ozone forming capacity[1]. RDF, BRAM, SIBRCOM, INBRE, PAKOM, etc are some of the fuel processed from common available waste to utilise the chemical energy sustained in the waste products. These wastes (municipal or industrial) are burnt in cement kilns for their large incineration capacity. These alternative fuel helps to reduce the energy costs in cement industry and also as the wastes are utilized

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in fuel production which results in less dumping of the waste material which is ecologically benefit \[2\] . Due to natural transportability, ready accessibility, renewability, biodegradability, higher heat content, lower sulphur content vegetable oils are used as fuel for diesel engines. But still there are some disadvantages like its viscosity is greater than the diesel fuel and hence need some modification, expensive, lesser volatility and the reactivity of unsaturated HC chains. The process like transesterification, decarboxylation, deoxygenation and catalytic cracking can be used to convert vegetable oils into fuels for diesel engines and presently there are 350 oil bearing crops identified \[4\]. The bio-jet-fuel which is a blend of jet fuel with biofuel have much more environmental concern in regards global warming than aviation fuels synthesised by Fischer-Tropsch process which incur negative environmental externality. Yet, the bio-jet-fuel has to go through expensive process before moving a step toward carbon neutral fuel stage \[5\]. Fuel availability and fuel demand remain an unsolved puzzle for a quite long time and this paper brings out choice of fuel for fuel-flexibility vehicle and choice of dedicated alternative fuel for engines. This paper brings out how people react when there is a fuel limit and the results reflected previous studies with 0 to 20% decline in concern with fuel availability \[6\]. Usage of alcohol with fuels is highly beneficial because of its complete burning characteristics due to oxygen but with limitations like corrosion to metallic components. This can be rectified with redesigning of engines or blending additional compounds to the fuel. Catalytic alteration of mixture gas to alcohol is advantageous as this utilizes various renewable and non-renewable resources of carbon. Catalysts like metal promoted alkali-modified molybdenum sulphide is extra attractive to advance Co hydrogenation and making of direct alcohols\[8\]. Aviation kerosene developed from lamp oil with carbon chain C8-C16 which is usually made up of 70 - 80% of paraffins, cyclo paraffins or naphthene and aromatics with small quantities of olefins. The clean burning and high heat to weight ratio is due to high hydrogen to oxygen ratio. The fuel freeze point for higher flying vehicles is managed by reducing the hydrogen to carbon ratio and decrease the heat release per unit weight is achieved by cycloparaffins. Bio-SPK’s are the best example for conventional crude based jet fuel\[9\]. Synthetic natural gas will be made from methanol production by steam reforming and water gas shift reaction. The basic raw material for syn gas production are wet biomass, crude oil, natural gas and coal by hydrothermal gasification and thermo-chemical process. Ethanol is synthesised from starch, cereals, sugar beets, NG, shale oil and cellulosic biomass by fermentation of the resource material and distilled for purification. Hydrogen fuel is also an alternative fuel resource produced from energy sources \[10\]. Ethanol with gasoline has been widely used as an alternative fuel recently because of its green nature which is basically produced from biomass. It has a lesser heating value of 26.9GJ/t, air fuel ratio of 9.0, oxygen content of 34.8%, latent heat vaporization of 842 kJ kg\(^{-1}\) and with octane number 8\[11\]. The alternative fuel for spark ignition engines is decidable over knock resistance which is analysed with the octane number. Iso octane is highly knock resistance with octane number 100 whereas n-heptane is knock susceptible with octane number 0. Adding ethanol with the fuels is greatly known for increasing the knock resistance of the fuel for SI and CI engines which mainly a power source for passenger and commercial vehicle and this ethanol addition technique is been widely used across markets\[12\][13].
2. Materials and methods

2.1 RC Aircraft Engine
The Magnum XLS.61A engine is used for the testing, which is a two-stroke, IC engine that runs on RC aircraft with glow fuel, and 15% nitromethane. Its specification is given in table 1.

| Specifications               |          |
|------------------------------|----------|
| Displacement                 | 2.5 CC   |
| Bore                         | 22mm     |
| Weight                       | 486g     |
| RPM Range                    | 2000 – 17000 |
| Recommended Propellers       | 11 x 6, 11 x 7, 10.5 x 6, 11 x 8, 12 x 6 |
| Break-in propeller           | 10x6     |
| Output                       | 1.63 hp@16000rpm |

2.2 Fuel blend preparation
The technique for setting up the blend begins with exhaustive blending of the multitude of segments in a non-defiling chamber. For instance, to set up a blend sample of M60+L40, 600 ml of Methanol, and 400 ml of castor oil is blended in a measuring beaker and mixed physically for 15 minutes. Correspondingly, the combination is then positioned in the ultra-sonicator for almost 45 minutes. This gives M60 blend with C40 of Castor oil (nomenclated as M60+C40). A similar method with variety in the measure of sample is completed for the leftover samples.

| Samples | Methanol | Castor oil | Nitromethane |
|---------|----------|------------|--------------|
| A       | 60       | 40         | -            |
| B       | 70       | 30         | -            |
| C       | 60       | 25         | 15           |
| D       | 60       | 10         | 30           |
2.3 Determination of chemical properties of the existing fuel

The chemical properties play a pivotal role in determining the performance of the fuel. The chemical properties such as Density, Fire point, Flash point and calorific value are determined using appropriate test equipment tabulated below.

| Chemical Property          | Test Equipment         |
|----------------------------|------------------------|
| Density                    | Hydrometer              |
| Fire point, Flash point    | Cleveland open cup tester |
| Calorific value            | Bomb Calorimeter       |
| Kinematic viscosity        | Formulas               |
| Normal Temperature         | Thermometer            |
| Boiling point              | Thermocouple           |

2.4 Power Output Calculation

BP (Brake Power) measurement involves determination of the torque and angular speed of the engine output shaft. This torque-measuring device is called a dynamometer.

\[
BP = \frac{2\pi NT}{60 \times 1000}
\]

Where N- RPM of the propeller
T- Torque produced

3. Results and Discussions

3.1 Chemical properties in existing fuel

| Properties        | Values  |
|-------------------|---------|
| Density           | 848 g/cu.cm |
| Kinematic viscosity | 0.605 MPa |
| Flash point       | 0.6 C    |
| Fire point        | 1.2 C    |
| Normal temperature| 22 C     |
| Boiling point     | 50 C     |

Table 5. Chemical bonds Present in the fuel

| Data point stretch | Chemical bond Present |
|--------------------|-----------------------|
| 3550 - 3200        | OH                    |
| 2990 - 2850        | CH                    |
| 1570 – 1490        | NO₂                   |
| 1680 - 1740        | CO                    |
| 1040 – 1050        | CO-O/-C-N             |
3.2 Chemical bonds present in the existing fuel

![IR Spectroscopy graph](image)

3.3 RPM Calculation

| Sample          | Trial | Tachometer reading (RPM) |
|-----------------|-------|--------------------------|
| 15% castor oil + 85% methanol | 1     | 6000                     |
|                 | 2     | 5600                     |
|                 | 3     | 5900                     |
| 20% castor oil + 80% methanol  | 1     | 5900                     |
|                 | 2     | 5700                     |
|                 | 3     | 5500                     |
| 25% castor oil + 75% methanol  | 1     | 5900                     |
|                 | 2     | 5800                     |
|                 | 3     | 5650                     |
| 30% castor oil + 70% methanol  | 1     | 5400                     |
|                 | 2     | 5500                     |
|                 | 3     | 5450                     |

For the constant fuel consumption, the engine produced different rpm ranges for different fuel blends as shown in table 6.

3.4 Cost estimation

Cost of the market available fuel = Rs.300 – 350 /litre. Whereas the components of the fuel are as follows,

| S.No | Fuel component | Price per litre |
|------|----------------|-----------------|
|      |                |                 |

Table 7. Cost of the individual Fuel components
Table 8. Cost estimation of the new fuel blends

| Sample | Methanol | Castor oil | Nitromethane | Total cost (per litre) |
|--------|----------|------------|--------------|-----------------------|
|        | %        | Qty | Price | %    | Qty | Price | %    | Qty | Price | Total cost |
| Original | 65 | 650 - | 20 | 200 - | 15 | 150 - | 300-350 |
| 1 | 60 | 600 18 | 40 | 400 50 | 0 | 0 | 0 | 68 |
| 2 | 70 | 700 21 | 30 | 300 37.5 | 0 | 0 | 0 | 58.5 |
| 3 | 60 | 600 18 | 25 | 250 31.25 | 15 | 150 | 25.5 | 74.75 |
| 4 | 60 | 600 18 | 10 | 100 12.5 | 20 | 200 | 34 | 64.5 |

Table 9. Summary of the Paper

| Name of the sample | Description | Decision |
|--------------------|-------------|----------|
| 15% castor oil + 85% methanol | This sample shows a characteristic of good combustion and smooth running of the engine | suitable |
| 20% castor oil + 80% methanol | This sample shown a fluctuation engine speed and produced a slightly less rpm than previous sample. | Not suitable |
| 25% castor oil + 75% methanol | Resulted in smooth running of the engine is found and produced a maximum rpm of 5900rpm and cost effective comparatively. | Highly suitable |
| 30% castor oil + 70% methanol | Produces a less rpm compared with all other blends. | Not suitable |

4. Conclusion
The detailed study of the various fuel properties is carried out and the component that signifies the maximum cost involved is eliminated. Also the chemical bond identification plays a major role in determining the suitable alternative so that the chemical bond and the energy dissipated is unaffected meanwhile the cost is economical. This reduces the manufacturing cost and affords it to the common public. However the major issue faced that is the discontinuous combustion process taking place is not recovered and the suitable blend component that helps in achieving the same is under study. The future works on the same will be addition of the power boosters thus enhancing the power output of the engine. By the same time, the alternatives that are being used will be eco-friendly and pocket friendly. The achievement of the same will result in a massive participation of the general public in the aviation industry that leads to the invention of new stuffs that in turn pays for the development of the nation.

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