

Alternative Fuel for an Aircraft

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ABSTRACT: Generally the fuels used in military aircraft have lowest freezing point in order to increase the efficiency and to withstand the low temperature at certain places. Some additives are added to prevent fuel from icing. Various chemical blends are used currently in military aircraft fuels and also testing on fuels using various blends also going on. Our project proposal is also to produce new type of fuel with different chemical blend. We are going to introduce a new blend (kerosene-power alcohol-gasoline) and find out whether it can be used as a fuel or not. Also have to find the properties of our blend.

KEYWORDS: Fuel, Chemical blend , military fuel.

I.INTRODUCTION

Aviation fuel is a specialized type of petroleum-based fuel used to power aircraft. It is generally of a higher quality than fuels used in less critical applications, such as heating or road transport, and often contains additives to reduce the risk of icing or explosion due to high temperature, among other properties. The most commonly used fuels for commercial aviation are Jet A and Jet A-1, which are produced to a standardized international specification. The only other jet fuel commonly used in civilian turbine-engine powered aviation is Jet B, which is used for its enhanced cold-weather performance.

II.JET FUEL

Jet fuel, aviation turbine fuel (ATF), or avtur, is a type of aviation fuel designed for use in aircraft powered by gas-turbine engines. Jet fuel is a clear to straw-colored fuel, based on either an unleaded kerosene (Jet A-1), or a naphtha-kerosene blend (Jet B). It is similar to diesel fuel, and can be used in either compression ignition engines or turbine engines.

Jet fuel is used for commercial (Jet A-1, Jet A, and Jet B) and military (JP-4, JP-5, JP-8...) jet propulsion; aviation gasoline (avgas) is used to power piston-engine aircraft. They are basically mixtures of kerosene and gasoline (half-&-half for JP-4, 99.5% kerosene for JP-5 and JP-8, 100% kerosene for Jet A-1), plus special additives (1..2%): corrosion inhibitor, anti-icing, anti-fouling, and anti-static compounds. Jet A-1 comprises hydrocarbon chains with 9 to 15 carbon atoms. Jet B (also named JP-4, with composition distribution from 5 to 15 carbon chains), is used in very cold weather, and in military aircraft.

III.EXISTING CHEMICALS IN JET FUEL

3.1 Kerosene

Kerosene is a thin, clear liquid formed from hydrocarbons obtained from the fractional distillation of petroleum between 150 °C and 275 °C, resulting in a mixture with a density of 0.78–0.81 g/cm³ composed of carbon chains that typically contain between 6 and 16 carbon atoms per molecule. It is miscible in petroleum solvents but immiscible in water.

The flash point of kerosene is between 37 and 65 °C (100 and 150 °F), and its autoignition temperature is 220 °C (428 °F). The pour point of kerosene depends on grade, with commercial aviation fuel standardized at –47 °C (–53 °F).

1-K grade kerosene freezes around –40 °C (–40 °F, 233 K). Heat of combustion of kerosene is similar to that of diesel fuel; its lower heating value is 43.1 MJ/kg (around 18,500 Btu/lb), and its higher heating value is 46.2 MJ/kg.

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100% of kerosene is used in jet A-1. Other fuels also contain some % of kerosene as blend. Hence kerosene is the major chemical that energise the aircraft engine.

3.2 Gasoline

The characteristic of a particular gasoline blend to resist igniting too early (which causes knocking and reduces efficiency in reciprocating engines) is measured by its octane rating. Gasoline, as used worldwide in the vast number of internal combustion engines used in transport and industry, has a significant impact on the environment, both in local effects (e.g., smog) and in global effects (e.g., effect on the climate). The density of gasoline ranges from 0.71–0.77 kg/L (719.7 kg/m³ ; 0.026 lb/in³; 6.073 lb/US gal; 7.29 lb/imp gal), higher densities having a greater volume of aromatics. Since gasoline floats on water, water cannot generally be used to extinguish a gasoline fire unless used in a fine mist. Finished marketable gasoline is traded with a standard reference of 0.755 kg/L, and its price is escalated/de-escalated according to its actual density.

3.3 Chemicals added as additives

3.3.1 Dinonylnaphthylsulfonic Acid

Dinonylnaphthylsulfonic acid is a component of Stadis 450 which is an antistatic agent added to distillate fuels, solvents, commercial jet fuels, and to the military JP-8 fuel to increase the electrical conductivity of the fluid. Fluids with increased conductivity more readily dissipate static charges to mitigate the risk of explosions or fires due to Static Discharge Ignitions

Dinonylnaphthylsulfonic acid by itself does not function as an anti-static additive.

Dinonylnaphthylsulfonic acid is prepared by reaction of naphthalene with nonene, yielding diisononylnaphthalene. Diisononylnaphthalene then undergoes sulfonation.

3.3.2(2-METHOXYETHOXY) ETHANOL

2-(2-Methoxyethoxy)ethanol, also known under trade names Methyl Carbitol, is an industrial solvent and is also commonly used as a Fuel System Icing Inhibitor (FSII) in jet fuels. It is a clear, colorless, hygroscopic liquid. Structurally it is an alcohol and an ether, with a formula CH₃OCH₂CH₂OCH₂CH₂OH. At direct contact it causes drying of skin by leaching fats, and is mildly irritating to the eyes. It is flammable.

3.3.3N,N-Disalicylidene-1,2-propanediamine

1,2-Diaminopropane can be converted to *N,N'*-disalicylidene-1,2-propanediamine, a useful salen-type ligand that is abbreviated salpn. The synthesis is achieved by a condensation reaction of the diamine with salicylaldehyde. Salpn is used as a fuel additive as a metal deactivator in motor oils.

IV. ENGINE TESTING FOR NEW BLEND IN MULTI FUEL ENGINE

The newly produced blend will be tested in a multi fuel engine



Fig 4.1 Multi fuel engine



Fig 4.2 Five gas analyser

4.1 DIESEL-ETHANOL-PETROL BLEND

The diesel(60%), ethanol(39.2%) and petrol(0.8%) are mixed in a proposed ratio and tested in a multi fuel engine to check its performance on a engine.

The result of the performance of an engine have been given below

Abbreviations

- IP –Initial point
- BP –Boiling point
- FP -Final point
- SFC-Specific fuel consumption
- IMEP-Indicated mean effective pressure
- BMEP-Brake mean effective pressure
- FMEP-Friction mean effective pressure

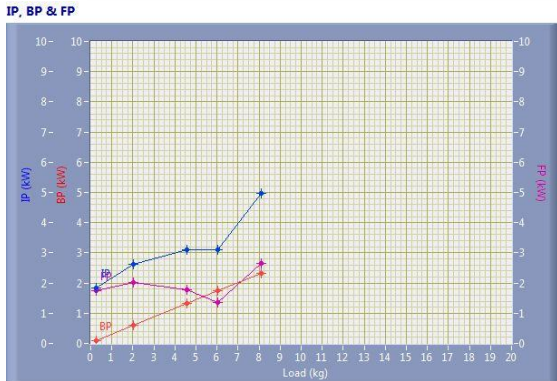


Fig 4.3 load vs (IP, BP & FP)

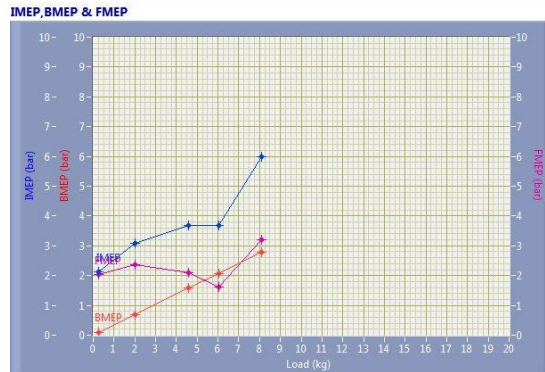


Fig 4.4 load vs (IMEP, BMEP & FMEP)

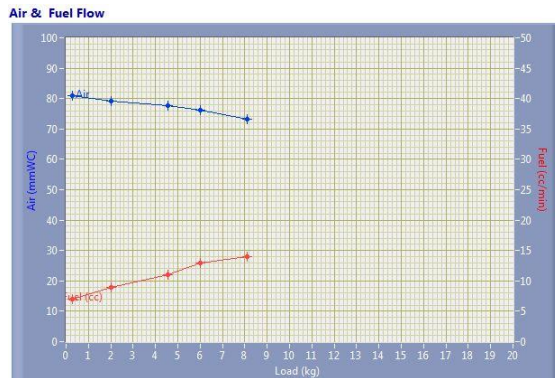


Fig 4.5 load vs (air & fuel flow)

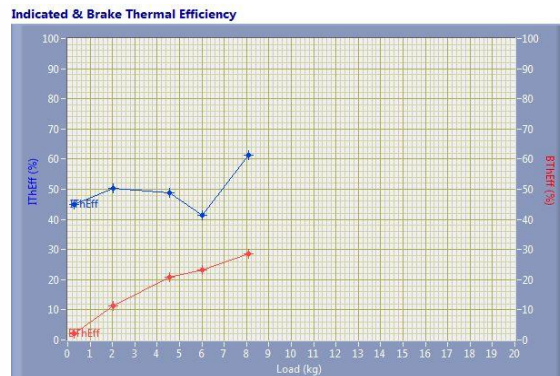


fig 4.6 load vs (indicated & thermal efficiency)



Fig 4.7 load vs (sfc & fuel consumption)

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RESULT DATA 1:

Tab 4.1 result data for fuel efficiency

| Torque (Nm) | BP (kW) | FP (kW) | IP (kW) | BMEP (bar) | IMEP (bar) | BTHE (%) | ITHE (%) | Mech Eff. (%) |
|-------------|---------|---------|---------|------------|------------|----------|----------|---------------|
| 0.50 | 0.08 | 1.74 | 1.82 | 0.09 | 2.12 | 1.99 | 44.84 | 4.44 |
| 3.68 | 0.60 | 2.03 | 2.62 | 0.70 | 3.07 | 11.42 | 50.19 | 22.76 |
| 8.28 | 1.33 | 1.78 | 3.11 | 1.57 | 3.67 | 20.87 | 48.71 | 42.84 |
| 10.92 | 1.75 | 1.36 | 3.11 | 2.07 | 3.69 | 23.21 | 41.24 | 56.29 |
| 14.69 | 2.32 | 2.66 | 4.98 | 2.79 | 5.98 | 28.53 | 61.19 | 46.63 |

RESULT DATA 2:

Tab 4.2 result data for engine performance

| Air Flow (kg/h) | Fuel Flow (kg/h) | SFC (kg/kWh) | Vol Eff. (%) | A/F Ratio | HBP (%) | HIW (%) | HGas (%) | HRad (%) |
|-----------------|------------------|--------------|--------------|-----------|---------|---------|----------|----------|
| 29.32 | 0.35 | 4.30 | 80.58 | 84.10 | 1.99 | 50.97 | 24.84 | 22.19 |
| 28.96 | 0.45 | 0.75 | 80.26 | 64.61 | 11.42 | 43.50 | 27.04 | 18.04 |
| 28.72 | 0.55 | 0.41 | 80.17 | 52.44 | 20.87 | 40.51 | 25.75 | 12.87 |
| 28.41 | 0.65 | 0.37 | 79.55 | 43.88 | 23.21 | 35.62 | 24.80 | 16.36 |
| 27.89 | 0.70 | 0.30 | 79.34 | 40.00 | 28.53 | 27.60 | 25.86 | 18.00 |

4.1 KEROSENE-PETROL-DIESEL BLEND:

The chemicals kerosene(40%),petrol (20%) and diesel (40%) are mixed in a discussed ratio and tested in a multi fuel engine to check its performance using new fuel

The result of the performance of the fuel has been given below

- IP –Initial point
- BP –Boiling point
- FP -Final point
- SFC-Specific fuel consumption
- IMEP-Indicated mean effective pressure
- BMEP-Brake mean effective pressure
- FMEP-Friction mean effective pressure

IP, BP & FP

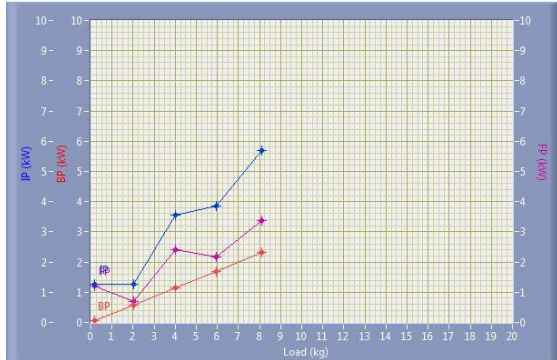


fig 4.8 load vs (IP,BP & FP)

IMEP, BMEP & FMEP

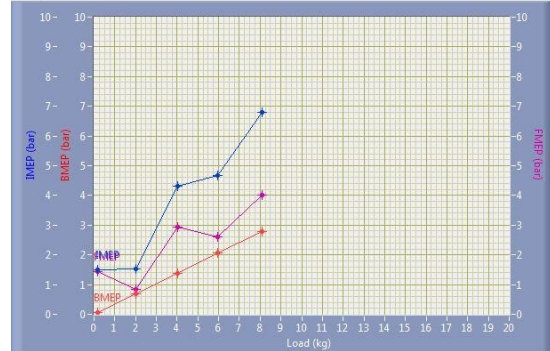


Fig 4.9 load vs (IMEP,BMEP & FMEP)

Indicated & Brake Thermal Efficiency

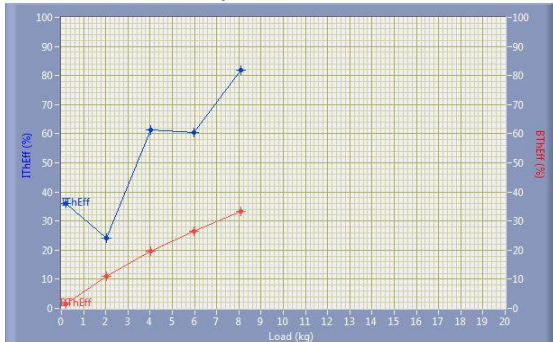


Fig 4.10 load vs (indicated & brake efficiency)

SFC & Fuel Consumption

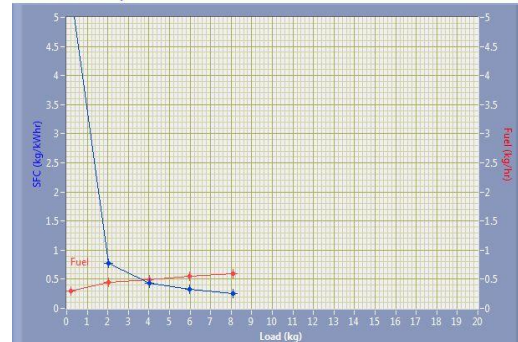


Fig 4.11 load vs (sfc & fuel consumption)

HBP, HJW & HGas

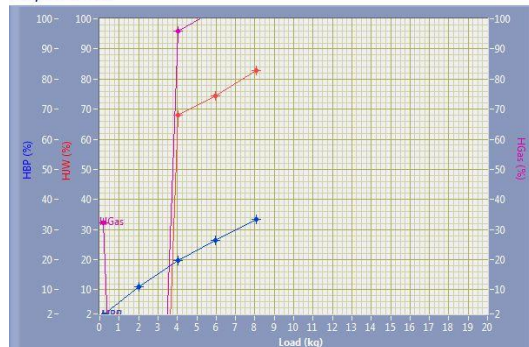


Fig 4.12 load vs (HBP,HJW & HGas)

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RESULT DATA 1:

Tab 4.3 result data for fuel efficiency

| Torque (Nm) | BP (kW) | FP (kW) | IP (kW) | BMEP (bar) | IMEP (bar) | BTHE (%) | ITHE (%) | Mech Eff. (%) |
|-------------|---------|---------|---------|------------|------------|----------|----------|---------------|
| 0.35 | 0.05 | 1.20 | 1.25 | 0.07 | 1.50 | 1.58 | 35.98 | 4.38 |
| 3.66 | 0.57 | 0.69 | 1.27 | 0.70 | 1.53 | 10.99 | 24.22 | 45.35 |
| 7.30 | 1.14 | 2.42 | 3.57 | 1.39 | 4.32 | 19.70 | 61.41 | 32.09 |
| 10.81 | 1.69 | 2.16 | 3.85 | 2.05 | 4.67 | 26.52 | 60.31 | 43.97 |
| 14.67 | 2.33 | 3.36 | 5.70 | 2.79 | 6.81 | 33.48 | 81.74 | 40.96 |

RESULT DATA 2:

Tab 4.4 result data for engine performance

| Air Flow (kg/h) | Fuel Flow (kg/h) | SFC (kg/kWh) | Vol Eff. (%) | A/F Ratio | HBP (%) | HJW (%) | HGas (%) | HRad (%) |
|-----------------|------------------|--------------|--------------|-----------|---------|---------|----------|----------|
| 28.20 | 0.30 | 5.43 | 79.91 | 94.38 | 1.58 | -0.00 | 30.65 | 67.77 |
| 28.02 | 0.45 | 0.78 | 80.36 | 62.52 | 10.99 | -284.74 | 26.55 | 347.20 |
| 28.09 | 0.50 | 0.44 | 80.51 | 56.41 | 19.70 | 48.21 | 28.01 | 4.07 |
| 27.49 | 0.55 | 0.32 | 78.82 | 50.18 | 26.52 | 47.95 | 28.47 | 0.00 |
| 27.87 | 0.60 | 0.26 | 78.75 | 46.63 | 33.48 | 49.37 | 29.98 | 0.00 |

V. PHYSICAL PROPERTIES OF NEW BLEND :

The required physical properties has been found.

Tab 5.1 physical properties of new blend

| PROPERTIES | KEROSENE BLEND | ETHANOL BLEND |
|--|-------------------------|-------------------------|
| Density | 830(kg/m ³) | 830(kg/m ³) |
| Flash point | 54°C | 60°C |
| Fire point | 60°C | 68°C |
| Freezing point before adding additives | -0.08°C | -0.011°C |
| Cloud point | -23 | -20 |
| Calorific value | 42000(kj/kg) | 42000(kj/kg) |
| Sulphur content | 0.09% | 0.03% |

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| | | |
|---------------|-----------------|-------------|
| Smoking point | 58°C | 70°C |
| Colour | Greenish yellow | Pale yellow |
| Cetane number | 38 | 52 |
| Volatility | 162°C | 162°C |

VI. RESULTS

- The given blend has been checked for its engine performance and physical properties. the obtained result has been compared.
- For military aircraft ,some other additives should be added to improve the performance of the fuel at cold places. But those additives should be added and maintained at certain temperature according to ASTM specifications.
- So,those additives cannot be added at room temperature. It needs somespecial requirements
- After adding additives at specified temperature ,the freezing point will be changed and it is the final freezing point.
- Obtained flash and fire point values are comparatively good.

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