# AIRPLANE MATERIALS COMPATIBILITY WITH BLENDS OF FOSSIL KEROSENE JET A1 WITH BIOKEROSENES FROM BABASSU, PALM KERNEL AND COCONUT

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## INTRODUCTION

The aviation companies are facing some problems that argue in favor of biofuels:

- Rising cost of traditional fuel: from 0.71 USD/gallon in May 2003 to 3.09 USD/gallon in January 2012.
- Environmental concerns: direct emissions from aviation account for about 3 % of the EU's total greenhouse gas emissions. The International Civil Aviation Organization (ICAO) forecasts that by 2050 they could grow by a further 300-700 %.
- On December 20th 2006 the European Commission approved a law proposal to include the civil aviation sector in the European market of carbon dioxide emission rights (European Union Emissions Trading System, EUETS).

## OBJECTIVES

The aim of this work is to study the compatibility of three types of materials present in the modern airplanes with blends of biokerosene based in fatty acid methyl esters (FAMEs) and Jet A-1.

## CONCLUSION

All the biokerosene samples evaluated show a good compatibility with the tested materials, polymers, metals or composites, therefore the blends can be used in the presence of these materials without putting at risk the flights.

**Blends***
Coconut biokerosene CBK20
Babassu biokerosene BBK20
Palm kernel biokerosene PBK20

→

**Tested materials**
Polymers
Metals
Composites

→

**Results and discussion comparing with the standards**


*Coconut, babassu and palm kernel oils were produced via basic transesterification process. To obtain the adequate kerosene fraction of the FAMEs a vacuum destilation process was carried out. The three biokerosenes were blended with commercial Jet A-1 in a ratio 80 (v/v) Jet A-1, 20 (v/v) biokerosene.

## RESULTS AND DISCUSSION

***POLYMERS***

**Tensile test:** the following table specifies the differences found between the samples mix with Jet A-1 and BBK20 and a sample of material not mixed with the fuel.

| **Standard UNE 53510** | **Jet A-1** | | **BBK20** | |
|---|---|---|---|---|
| **PVC** | Difference | | Difference | |
| | Δ | % | Δ | % |
| Stress at maximum load (MPa) | 12.78 | 2.80 | -16.50 | -3.61 |
| Strain at maximum load (%) | 1.68 | 50.60 | 1.68 | 50.60 |
| **PP** | Difference | | Difference | |
| | Δ | % | Δ | % |
| Stress at maximum load (MPa) | -31.20 | -9.63 | -40.76 | -12.58 |
| Strain at maximum load (%) | 0.84 | 12.54 | 1.67 | 25.08 |
| **PE** | Difference | | Difference | |
| | Δ | % | Δ | % |
| Stress at maximum load (MPa) | -75.32 | -21.01 | -95.29 | -26.58 |
| Strain at maximum load (%) | 3.34 | 50.15 | 6.67 | 100.15 |
| **SBR** | Difference | | Difference | |
| | Δ | % | Δ | % |
| Stress at maximum load (MPa) | -1.16 | -12.75 | -0.44 | -4.86 |
| Strain at maximum load (%) | -18.34 | -8.94 | -15.00 | -7.32 |
| **VITON** | Difference | | Difference | |
| | Δ | % | Δ | % |
| Stress at maximum load (MPa) | 0.46 | 11.39 | -0.02 | -0.50 |
| Strain at maximum load (%) | -35.01 | -42.86 | -26.67 | -32.66 |

- The performance of the samples tested with Jet A-1 or BBK20 is very similar.
- The thermoplastic polymers (PVC, PP and PE) tend to increase the strain at maximum load while the elastomeric polymers (SBR and VITON) have the opposite effect.
- The most affected parameter is the deformation or strain. For example in the case of VITON it got reduced nearly a 50 %.

**Hardness test**: big difference occurs in VITON when it is in contact with Jet A-1, causing a decrease of 10 %. The rest of the materials have minimal changes.

**Dimensional linear variation:** PVC, PP and PE polymers do not show any change in size during the tests. It is remarkable the variation in the size of VITON which approximately changes a 10 % in the linear lengths and near 8 % in the thickness.

**Mass variation:** PVC, PP and PE polymers have zero variation in their mass during the tests. There is a strong increase in the mass variation of VITON, probably because of the absorption of fuel during the test.

***METALS***

In the silver strip corrosion test every sample was given a level of "0" according to the scale of the standard IP 227 while in the copper strip corrosion test all the samples had a level of "1a" according to the standard ASTM D130.

In accordance with the results obtained in the tests it can be said that both metals, silver and copper, have a perfect compatibility with the fuel and do not have problems of corrosion.

***COMPOSITES***

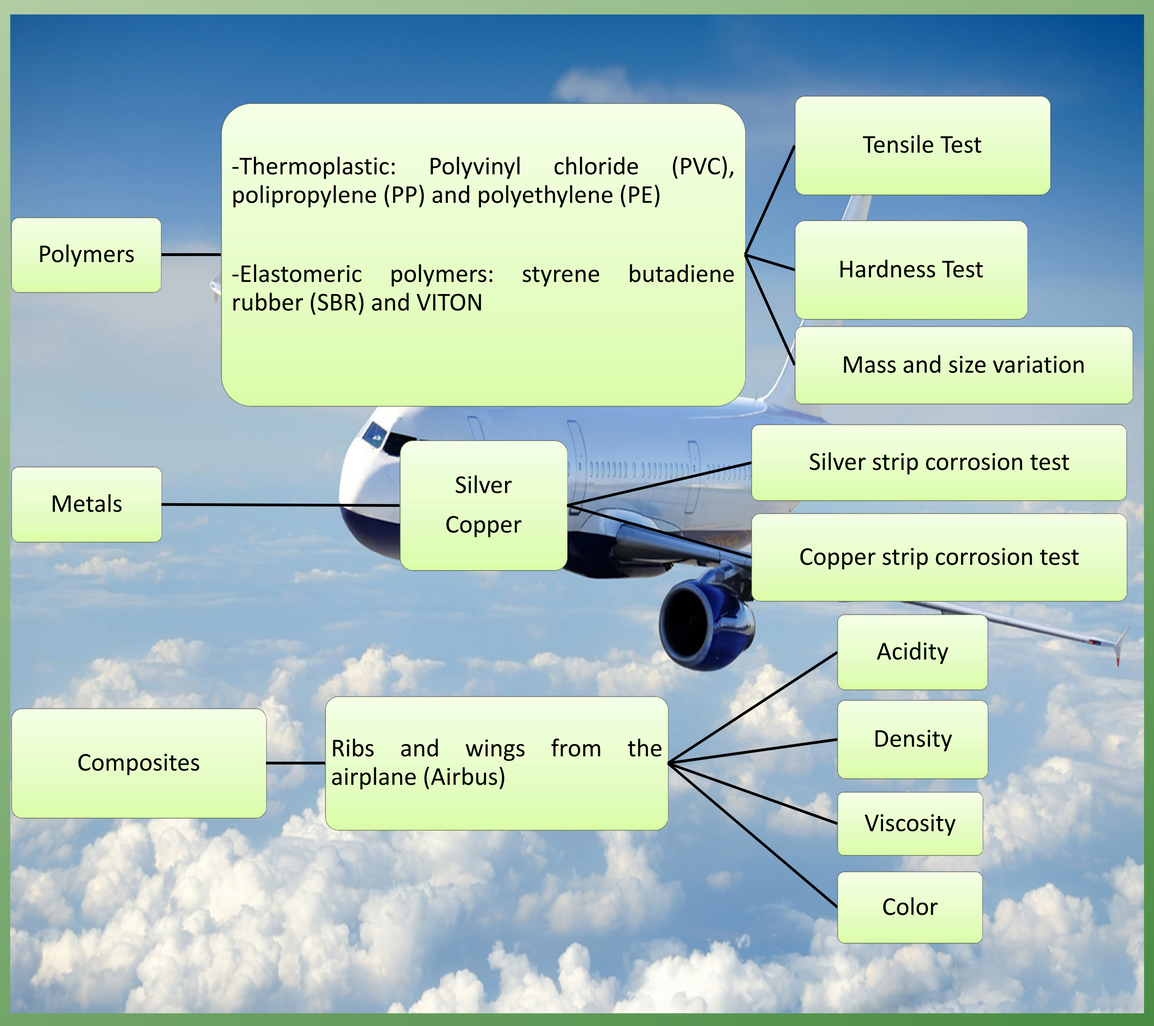
| **Acidity** | Before | After | Difference | |
|---|---|---|---|---|
| | TAN (mg KOH/g) | TAN (mg KOH/g) | Δ | % |
| Jet A-1 | 0.01 | 0.06 | 0.04 | 395.5 |
| CBK20 | 0.02 | 0 | -0.02 | -100 |
| BBK20 | 0.03 | 0 | -0.03 | -100 |
| PBK20 | 0.01 | 0.05 | 0.04 | 438 |
| **Density** | Before | After | Difference | |
| | Density (kg/m$^3$) | Density (kg/m$^3$) | Δ | % |
| Jet A-1 | 788.4 | 788.5 | 0.1 | 0.01 |
| CBK20 | 812 | 814.5 | 2.5 | 0.31 |
| BBK20 | 814.9 | 814.7 | 0.2 | -0.02 |
| PBK20 | 811.8 | 814.8 | 3 | 0.37 |
| **Viscosity** | Before | After | Difference | |
| | Viscosity (mm$^2$/s) | Viscosity (mm$^2$/s) | Δ | % |
| Jet A-1 | 1.03 | 1.07 | 0.04 | 4.01 |
| CBK20 | 1.19 | 1.38 | 0.19 | 15.75 |
| BBK20 | 1.32 | 1.32 | 0.002 | -0.13 |
| PBK20 | 1.27 | 1.39 | 0.12 | 9.11 |

Regarding to the acidity no sample exceeds the maximum given by the standard ASTM D1665 which is 0.1 mg KOH/g. It is remarkable that the acidity even decreases when the composite is submerged in CBK20 and BBK20.

The density is also between the values of the standard which are 775-840 kg/m$^3$ and it is worth mentioning that all the samples have more density than the Jet A-1.

Values of viscosity merely change after the test and all of them are far beyond the maximum given by the standard ASTM D1655 (8 mm$^2$/s).

## MATERIALS AND METHODS

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