International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 09 Issue 2 Series I || February 2020 || PP 78-81

Performance of Alternative Aviation Fuel and Compatibility of Elastomeric Seals

Ashwini Kumar
Asst. Professor
Department of Engineering, School of Engg. & IT,
ARKA JAIN University, Jharkhand.

ABSTRACT
Petroleum products have consistently been the favored transportation fuels since they offer the best combination of energy content, performance, accessibility, simplicity of taking care of and cost. However, the new expansion in the cost of oil has prompted the business to look at alternatives. National concerns about energy security and the concern about the continued accessibility of petroleum, the "top oil" banter, are also important issues.
Other than cost, other factors should be considered while considering alternative fuels. Of course, protected and solid operation of the motor and airplane should not be compromised in any capacity. The environmental impacts of any alternative fuel should also be considered. This incorporates both emissions from the motor and furthermore life-cycle impacts associated with the production and utilization of an alternative fuel. The current paper highlights the performance of alternative aviation fuel and compatibility of elastomeric seals.
KEYWORDS: *Aviation, Fuel, Elastomer*

I. INTRODUCTION

Almost all jet fuel today is made from petroleum (raw petroleum). A moderately little rate is produced using oil sands, fundamentally those from Canada and Venezuela. There are other fossil fuel sources that could potentially be utilized to make jet fuel, specifically, gaseous petrol, shale oil and coal. A few regions of the world have exceptionally huge stores of these materials. The total energy content of these other fossil fuels is assessed to be bigger than that of petroleum.

Assuming viable and economical conversion processes can be developed, these shale and coal stores could provide substitute sources for jet fuel that would be basically as old as, petroleum-inferred jet fuel.

Biomass is by and large progressively considered as an alternative natural substance of transportation fuels. Ethanol and biodiesel have been utilized lately as mix components for gasoline and diesel fuel separately, and this utilization is probably going to continue to grow because of government commands in numerous countries and a longing to expand energy sources.

Most ethanol today is produced by maturing corn or sugar stick. Conversion of cellulosic biomass to ethanol is a space of dynamic review. Cellulose cannot be matured to produce ethanol like the sugars found in corn, so an alternate conversion process should be developed. It very well might be possible to grow crops explicitly for ethanol production or waste biomass could be utilized. This has the promise of being a more effective process and might be the up and coming generation of ethanol production. Notwithstanding the source, the properties of the ethanol are something similar.

Ethanol contains about 35% oxygen by weight, so it has lower gravimetric energy content than conventional jet fuel. Ethanol is altogether more volatile than jet fuel and boils at a solitary temperature (78˚C). Jet fuel boils over the scope of approximately 150˚ to 300˚C. Ethanol has an altogether higher heat of vaporization than hydrocarbons because of its intermolecular hydrogen bonding. These properties are identified with fuel atomization and vaporization in the combustor.

Ethanol is a strong solvent and its impact on fuel system materials would need to be explored. Ethanol and water are miscible (ready to be blended), in contrast to hydrocarbon fuels and water, which are basically immiscible.

Utilization of 100% ethanol as an aviation fuel would require a separate storage and distribution system from conventional jet fuel. Mixes of ethanol with conventional jet fuel also pose problems as a result of the altogether unique physical and compound properties of ethanol and jet fuel.

Biodiesel has been in the information lately as a possible alternative to conventional, petroleum determined diesel, and is being considered as an aviation fuel too. In everyday utilization, the term biodiesel covers an assortment of materials produced using vegetable oils or creature fats. Various crops are utilized in various regions of the planet to make biodiesel.

The gravimetric energy content of biodiesel is somewhat lower than that of conventional jet fuel. It has good lubricity properties and contains basically no sulfur or aromatics. Biodiesel is biodegradable, yet this property might prompt expanded biological growth during storage.

II. PERFORMANCE OF ALTERNATIVE AVIATION FUEL AND COMPATIBILITY OF ELASTOMERIC SEALS

The essential concern with the utilization of biodiesel is its low temperature properties. Biodiesels have freezing points close to 0˚C, a lot higher than the most extreme freezing point of jet fuel, - 40˚C. Fuel is exposed to extremely low temperatures at voyage height, and it should stay liquid to be siphoned to the motor. Indeed, even mixes of biodiesel with jet fuel have a lot higher freezing points than jet fuel. Added substances could potentially improve low temperature operability of biodiesel mixes, yet only by a couple of degrees Celsius. Any new added substance would need to be subjected to a broad approval process.

Hydrogen from inexhaustible resources is positioned as the fuel of things to come. We are beginning to see hydrogen utilized in fuel cells both for stationary power generation and to power ground vehicles. More than the vast majority of hydrogen produced today is generated by reforming flammable gas, methane, into hydrogen and carbon dioxide.

While satisfying today's modern hydrogen needs, the overall proficiency of this process for the production of transportation fuels should be questioned as it fundamentally converts one fuel into another and generates carbon dioxide, a greenhouse gas. Before hydrogen will uproot fossil fuels as a major source of energy, a proficient and economical process will be expected to generate hydrogen from water and other sustainable resources, for example, solar or biomass.

In addition to its essential function as a source of energy, fuel is utilized to absorb overabundance heat, it is utilized as a pressure driven operating liquid in motor control systems, and it fills in as an ointment in motor control systems and siphons.

Alternative fuels would need to be inspected for their capacity to perform these functions just as conventional fuels do. Fuel should be thermally steady to absorb overabundance heat from the motor and not corrupt. Fuels with poor thermal security will leave deposits in the motor fuel system which will debase performance and require more continuous support. This is an extremely intense necessity for jet fuel and may become significantly more so later on. Additionally, any new fuel for flow airplane would also must be compatible with each of the materials found in airplane fuel systems, including various metals, epoxy-type coatings and elastomeric seals.

Global efforts to diminish CO2 emissions and to handle the problem of draining petroleum resources have animated the exploitation of alternative fuels in the aviation business. One essential perspective amongst others is to research the compatibility of alternative fuels with elastomeric materials at present utilized in gas turbine motors. However, little knowledge about this has been understood so far for commercial airplanes under genuine motor conditions.

The kerosene fraction of unrefined petroleum has consistently been the favored source of aviation fuel since it offers the best combination of performance, energy content, accessibility, simplicity of dealing with, and cost. As the aviation business is anticipated to grow by up to 5% each year sooner rather than later, concerns over the environmental effect and supply of fossil fuels have prompted the development of aviation kerosene from alternative sources.

Amongst other specialized prerequisites which alternative fuels need to fulfill, one of the essential "fit-for-purpose" properties is their compatibility with elastomeric seals most commonly O-rings, in a gas turbine motor. O-rings are an elastomeric material which is crushed between two mating appearances of a fuel system. The material deforms into the hole between the countenances, and hence provides a seal between them.

However, the O-rings that are utilized, especially the nitrile Orings makes a good seal since they enlarge within the sight of kerosene. At the point when some alternative fuels are utilized, the O-rings either shrivel or no longer swell to the volume that could provide a good seal. As the utilization of an alternative fuel should not make any change a motor's component, it should therefore also be completely compatible with the current O-rings to forestall any fuel spillage, which could prompt catastrophic consequences.

The aviation business requests the most from elastomeric materials, which requires the O-rings should be developed to meet specific specifications, like resistance to fuel, heat and outrageous temperatures. The various kinds of elastomeric materials can be addressed by nitrile (older airplane), fluorocarbon (presently broadly utilized) and fluorosilicone (the modern and future choice). Nitrile is the most broadly utilized elastomer in the seal business because of its good balance of beneficial properties, high wear resistance and economic productivity. The major limitations of nitrile are its poor climate resistance and moderate heat resistance.

Fluorocarbon has amazing resistance to high temperatures (up to 204 degC) and a broader scope of synthetics compared with some other elastomer; however, its fixing performance under low temperatures is also not favorable. Fluoro silicone combines most qualities of silicone which provides fantastic performance at low temperatures (down to - 73 degC) and good resistance to petroleum oils and fuels; yet its poor actual strength and abrasion resistance limit it to static seals.

III. DISCUSSION

It has been discovered that changing between a petroleum inferred fuel and an engineered fuel can cause elastomeric materials in the fuel system to contract, prompting potential fuel spills. A drop from just 16% to 13% has been known to cause spillage. This topic of examination is especially hard to concentrate as there are many sorts of alternative fuels and elastomeric materials utilized in fixing systems. With standard aviation kerosene their normal enlarging properties are 20% (nitrile O-rings), 6-9% (fluoro silicone Orings) and 0.1-0.4% (fluorocarbon O-rings) individually. However, they are altogether dependant on the aromatic content of the fuel.

The primary driver for O-ring expanding is the capacity of the fuel to penetrate into the O-ring material and stay there between the molecular designs; which builds the distance among them and makes enlarge. By and large, the enlarging capacity of a material increments with expanding polarity and hydrogen bonding and diminishing molar volume.

The paraffinic molecules in the FT fuel are generally huge and idle; however, aromatic compounds of comparative molecular weight have both polar and hydrogen bonding and a more modest molar volume, which improve the volume enlarge qualities of a polymer. This is also the reason why a base proportion (commonly 8%) of aromatic compounds must to be added into current engineered fuels, as fuels got from FT process contain no or follow aromatics.

Muzzell et al found that enormous swings in enlarge occurred for nitrile elastomers when exchanging between engineered aviation fuels with and without aromatics. The swell volume expanded with expanding the concentration of aromatics and was impacted by the aromatic kinds. Another evaluation of elastomer compatibility with Sasol Completely Manufactured Jet Fuel (FSJF) conducted by Moses and Roets recommended nitrile O-rings were more touchy to fuel science than fluorocarbon and fluorosilicone O-rings, as they displayed the biggest changes in mass, volume and hardness subsequent to soaking in FSJF mixes for a specific period of time.

It is intriguing to notice that although none of the singular pinnacle region changes showed straight relationship with the force changes, the combination of them were exceptionally correlated with the force relaxation. This could possibly show that the force relaxation of an O-ring isn't dictated by any single synthetic design change yet is subject to the combined effect of all the construction changes.

Amongst these compound designs, however, some specific changes might be more powerful than others. For example, the region changes at 1350 and 1282 cm-1 may be more compelling on fluorocarbon Orings' performance than those at 1041 and 874 cm-1, as their weights in the model equation are a lot greater than the others'. More tests are expected to acquire unwavering quality in these outcomes. Once certain synthetic components which have negative impact on the performance of specific O-ring material could be distinguished, efforts can be made to wipe out or substitute these components during the material manufacturing process.

Fluorocarbon O-rings showed the best compatibility with every one of the alternative fuels tested in the stress relaxation tests amongst the three O-ring materials. Minimal physical or synthetic changes were observed, demonstrating its magnificent dependability.

IV. CONCLUSION

Fluorosilicone O-rings were also compatible with each of the fuels tested with the exception of hexanol. Because of the critical changes in the fluorosilicone O-rings when utilized with hexanol, concern should be brought when utilizing it up in an environment containing alcohols. Nitrile O-rings appear to be more handily impacted by the composition changes of fuels, particularly the aromatic content of the fuels.

Changes of specific synthetic designs in an O-ring directly affect its stress relaxation process. Specific construction changes may be more persuasive than others relying upon the various materials of the O-rings.

REFERENCES

[1]. Nygren, E., Aleklett, K., and Hook, M., 2019, “Aviation Fuel and Future Oil Production Scenarios,” Energy Policy, 37, pp. 4003-4010.
[2]. American Society for Testing and Materials - ASTM D7566 - 09 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons.
[3]. Shell Aviation press release - World's first commercial passenger flight powered by fuel made from natural gas lands in Qatar.
[4]. Whitlock, J., and EPM, Inc., 2014, The Seal Man’s O-ring Handbook, EPM, Inc., USA.
[5]. Graham J., et al., 2016, “Swelling of nitrile rubber by selected aromatics blended in jet fuel,” Energy and fuels, 20, pp. 759-765.
[6]. Link D., et al., 2018, “Potential additives to promote seal swell in synthetic fuels and their effect on thermal stability,” Energy and fuels, 22, pp. 1115-1120.
[7]. Gormley R., et al., 2019, “Interactions of jet fuels with nitrile O-rings: Petroleum-derived vs. synthetic fuels,” Energy and fuels, 23, pp. 857-861.

[8]. Hemighaus, G., et al., 2016, "Alternative Jet Fuels, Addendum 1 to Aviation Fuels Technical Review (FTR-3/A1)," Chevron Global Aviation, Houston, USA.

[9]. Parker O-Ring Handbook, Parker Hannifin Corporation, O-Ring Division, Lexington, KT, 2017, pp. 2-3, 2-5 and 3-13.

[10]. Moses, C. A. and Roets, P. N., 2018, "Properties, characteristics and combustion performance of Sasol Fully Synthetic Jet Fuel", Proceedings of ASME Turbo Expo 2008, Sasol Technology (Pty) Ltd.