УДК 811.111

ALTERNATIVE JET FUELS

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Key words: Jet fuels, Gravimetric energy content

The primary function of fuel is to provide a source of energy to propel the an aircraft. A turbine engine converts chemical energy stored in fuel into the mechanical one, providing thrust for powered flight. The chemical energy of fuel is released by combustion, a rapid reaction with oxygen at high temperature. The energy released during this reaction is called combustion heat. The amount of heat released depends on whether water formed by the reaction is in the gaseous state (lower or net heat of combustion) or condensed to a liquid (higher or gross heat of combustion). Since engines emit water as a vapor, the net heat is the appropriate value to use.

Some potential alternative fuels contain oxygen, for example, alcohols or esters. These fuels have lower energy content because oxygen in a fuel molecule does not release any energy during combustion. Energy is released by breaking carbon-carbon and carbon-hydrogen bonds in hydrocarbons and converting them into carbon-oxygen and hydrogen-oxygen bonds; starting with carbon-oxygen bonds in the molecule it does not gain anything. It is like carrying a little air into the fuel instead of all the oxygen needed for combustion would come from air, some of the oxygen is already in the fuel molecule. As a result, such fuels have lower energy content than hydrocarbon fuels, that can lead to reduced flight range. It is desirable to minimize both the mass and volume of fuel on an aircraft, so both the gravimetric and volumetric energy content of the fuel are important. Aircraft are rated at maximum take-off weight (MTOW), which includes the weight of fuel, passengers and cargo. If an aircraft reaches MTOW before its fuel tanks are full, fuel with a higher gravimetric energy content (specific energy) will allow more passengers and cargo on a given route, or carry the same passenger and cargo load a longer distance. Figure 1 lists specific energy (based on the lowest or net energy content), density and energy density of potential alternative fuels along with conventional Jet A/ Jet A-1 for comparison. Figure 2 is a plot of the mass of fuel required to give a certain amount of energy to the volume of the same fuel to give the same amount of energy. The amount of energy, 100 MJ, provides common

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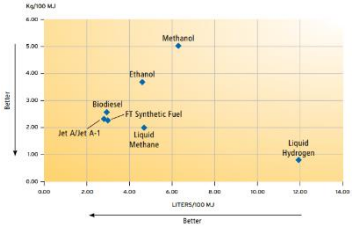
basis for comparison. Lower values are preferred on both axes. Gravimetric energy content is the amount of energy per unit mass (weight) of fuel. It is also called the specific energy of the fuel. SI units are megajoules per kilogram (MJ/kg), common units are British thermal units per pound (Btu/lb). 1 MJ/kg = 429.9 Btu/lb.

Fuel	Specific Energy, MJ/kg	Density 15°C	Energy Density MJ/l
FT Synfuel	44.2	0.759	33.6
Jet A/Jet A-1	43.2	0.808	34.9
Liquid Hydrogen	120	0.071	8.4
Liquid Methane	50	0.424	21.2
Methanol	19.9	0.796	15.9
Ethanol	27.2	0.794	21.6
Biodiesel (typical)	38.9	0.87	33.9



Hydrogen has the highest gravimetric energy content, but the low density of the liquid results in a very low volumetric energy content. Similarly for liquid methane, the high gravimetric energy content is offset by low density. The gravimetric energy content of the alcohols and biodiesel reflects their oxygen content. Biodiesel is closer to conventional jet fuel because oxygen represents a smaller percentage of the fuel mass. FT synthetic fuels have slightly higher gravimetric energy content than conventional jet fuel, but correspondingly slightly lower volumetric energy content.

УДК 908

РОЛЬ КЛАССА ЭППА В ОСНОВАНИИ КОЛОНИИ МЕННОНИТОВ АЛЬТ-САМАРА

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Ключевые слова: меннониты, Класс Эпп, история Самарской губернии

Во второй половине XIX века произошло последнее крупное переселение меннонитов на территорию Российской Империи. Если прошлые волны эмиграции меннонитов происходили в достаточно благоприятных условиях для обеих сторон, то переселение

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