



17-osios jaunujų mokslininkų konferencijos „Mokslas – Lietuvos ateitis“ teminės konferencijos  
**TRANSPORTO INŽINERIJA IR VADYBA,**  
vykusios 2014 m. gegužės 8 d. Vilniuje, straipsnių rinkinys

Proceedings of the 17th Conference for Junior Researchers 'Science – Future of Lithuania'  
**TRANSPORT ENGINEERING AND MANAGEMENT**, 8 May 2014, Vilnius, Lithuania

Сборник статей 17-й конференции молодых ученых «Наука – будущее Литвы»  
**ИНЖЕНЕРИЯ ТРАНСПОРТА И ОРГАНИЗАЦИЯ ПЕРЕВОЗОК**, 8 мая 2014 г., Вильнюс, Литва

## **ECOLOGICAL PROPERTIES OF CONVENTIONAL AND ALTERNATIVE JET FUELS. FUELS SUSTAINABILITY**

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**Abstract.** World use of fuels was analyzed with taking into account ecological properties of aviation and biofuels. Impact of biofuel and aviation fuel use on the state of environment and its comparative characteristic was investigated in the article. The dependence of environmental pollution from the use of annual growth of air transport in the world was carried out. Aspects of fuel sustainability were analyzed and main standards of fuel sustainability were given. The article was excavated issue of increasing fuel efficiency. Examples of standards governing the production and use of alternative fuel in the world, such as Europe and America were given.

**Keywords:** aviation, environmental pollution, fuel sustainability, biofuel, jet fuels, emissions.

### **Introduction**

Until recently, the impact of aviation on the environment and people's health took a small portion of the general discussion on the problems of environmental protection. But public awareness of the importance of environmental issues and concerns with respect to their solutions caused the adoption by governments of many countries relevant policy measures aimed at reducing the impact of aviation on nature. Therefore, recent environmental issues in air transport processes attract others much more attention than it did before. It is noted sincere desire to maintain and improve the level achieved to date environmental quality.

In the face of objective threat of exhaustion of natural resources as a source of fuel for mankind ever more urgent need to address the problem of finding alternative sources to meet energy needs. Among the solutions to this problem is a brilliant production of biofuels.

### **Modern state in air transportation industry**

Aviation plays an important role in the modern world, providing a quick way to carry more than 2 billion people and more than 40 million tons of cargo annually, making a significant contribution to social and economic welfare of the inhabitants of the whole world.

Improved fuel efficiency has always been a priority of aviation engineering. Improved engines and then

double-circuit appeared turbofan engines. Compared with the first mass passenger jets late 50 s and 60 s modern airliners became more economical by almost 70 %.

Now, the average estimates for the main fleet of new aircraft fuel consumption are about 3.5 liters per passenger per 100 kilometers. And for the A380 – 787 this figure may be reduced to 3 liters. That is, in general, these aircraft fuel consumption is possible in a certain sense, compared with the family car.

However, despite all the progress in improving the technology, fuel is very much. For example IL-96 (PS-90A) in flight can spend up to 8000 kg of kerosene per hour of flight (Terentjev *et al.* 2011).

The volume of air traffic has grown by an average of 4 % per year between 2001 and 2008. It was projected that in 2009 the volume of international air flow, in terms of passenger-kilometers had decreased by about 4 %. This forecast reflects the worse economic prospects, since it is assumed that world GDP will decline by about 1,7 %. As a result of improving economic conditions moderate stabilization occurred in 2010 with a positive annual growth of about 3,3 % and further increase by about 5,5 % in 2011. It is expected that an average of 2025 air flow volume will increase by 4,6 % each year. At present, the world consumption of liquid fuels is 3917 megatons (Mt ) per year. 0,02 Mt of this amount is biofuel, only a small amount of which is consumed by the international aviation (Zaderienko 2008).

## Role of aviation in global environmental pollution

The notion of favorable environmental conditions began to worry humanity last thirty years. At the dawn of turbojet engine nobody thought and only few people care what goes into the atmosphere with the jet exhaust gases.

This are carbon monoxide and unburned hydrocarbons, carbon dioxide and nitrogen oxide, sulfur dioxide and various charms even in smaller concentrations and, of course, everyone knows carbon dioxide CO<sub>2</sub>, directly affecting the climate change on the planet.

However, if you observe justice, it is worth mentioning the fact that the share of air transport in the world's emissions SO<sub>2</sub> in atmosphere is only 2 % today. However, this is about 650 million tons (total emissions are approximately 34 billion tons). Besides, first, these emissions are produced mostly in the upper most sensitive to changes in the troposphere (and also in the stratosphere).

And, secondly, we know that the annual increase in air traffic in the world is about 5 % and in this connection there is an annual increase in emissions to the atmosphere SO<sub>2</sub> by aviation is 2–3 %.

If these rates continue in the near future, to share 2050 world air transport of 2 % outgrow to 3 %. For the atmosphere in general is a lot. And if we take into account the global climate change on the planet, it is clear that measures are needed to reduce emissions and improve the environmental performance of aircraft engines. However, it has long been a well-known fact.

## Alternative fuels as a measure for environmental pollution reduction

The bulk of the fuel, used in systems of direct combustion, which emit carbon dioxide (CO<sub>2</sub>) in the amount directly proportional to the volume of fuel combusted (Iakovlieva *et al.*). According to preliminary estimates of the Committee on Environment protection from the impact of aviation ICAO (CAEP) is expected to increase fuel economy in international air transport approximately from 200 Mt in 2006 to 450-550 Mt to 2036. As a result of increasing efficiency and technology development in sphere of aviation, CO<sub>2</sub> emissions will increase from 632 Mt in 2006 to 1422-1738 Mt to 2036 (excluding the impact of alternative fuels).

Environmental properties of fuel are properties of fuels and lubricants, which are manifested in the interaction of lubricants or their combustion products with the environment. These include: toxicity, fire and explosion hazards, storage stability, etc.

The greatest impact on operational and environmental properties of gasoline, jet, diesel, fuel oils is made by group chemical composition of the fuel.

Group chemical composition of distillate fuels (gasoline, jet and diesel fuels) describes the content of different classes of compounds and is defined as the composition of the petroleum feedstock and fuel production technology. Therefore, the group chemical composition of different types of fuels varies greatly. Of hydrocarbon and non-hydrocarbon composition operational properties of fuels

depends: anti-oxidation, anti-corrosion, low-temperature, anti-wear, chemical and thermal stability, etc.

That's just based on these two above-mentioned aspects and measures of a certain character in the aviation industry in many countries. Improving airport equipment, systems and approach procedures, air traffic control systems with a view to possibly reduce the time "idle hovering" aircraft in the air.

However, recently more and more gaining momentum efforts to find and use alternative types of fuel for aircraft. Using, for example, LNG (liquefied natural gas) is used to reduce emissions of CO<sub>2</sub> by 17 % without losing engine power. Use of a liquid hydrogen increases the possibilities.

However, cryogenics, unfortunately, requires a fairly serious alteration of the aircraft structure as compared with the existing classical circuit. In addition to a profound change also needs infrastructure of airports. This is one of the reasons why in recent years increasingly to the forefront out use of biofuels for aircraft engines, the use of which, as it turns out, is not so revolutionary (Medvedeva, Boichenko 2010)

Determination of such biofuels – fuels from either vegetable or animal sources, or from industrial wastes (organic course), or the waste products of living organisms. Aviation biofuels becomes a substitute (really full) of kerosene.

Application of alternative fuels was proposed as a way for solving number of environmental problems. Among various alternative fuels available, biofuel is seemed to be the most appropriate one. It is considered to be environmentally friendly and sustainable kind of fuel that may contribute to reduction of greenhouse gases emissions.

In our research we investigate oil-derived compounds that can be used as components of jet biofuel. These components are fatty acids ethyl ethers of rape oil purified under certain technology. The peculiarity of this kind of component is that it is produced from natural renewable feedstock. Plants, used for production consume atmospheric CO<sub>2</sub> and thus do not disturb total content of CO<sub>2</sub> in atmosphere.

Except that use of oil-derived components in jet fuels allow significant decreasing of toxicity of aircraft exhaust gases. This is explained by that fact that investigated biocomponents possess almost zero sulfur content and no aromatic compounds, which are the main contributors to the toxicity of aircraft exhaust gases.

Moreover, it reduces carbon formation in the fuel system and a spark plug, which leads to an increase in their service life. Of the disadvantages is the lack of information about how this affects the fuel to the engine for long term use, and most importantly – increased consumption of such gasoline (Nesteruck 2008).

This product has two main advantages over conventional hydrocarbon fuel oil. First, it is produced using renewable sources. Fuel oil, unfortunately, that cannot boast, as the dynamics of their prices.

Secondly, the percentage of harmful emissions into the atmosphere is much lower with biofuel using. Specif-

ically, for example, sulfur emissions are low enough. That is fed into the atmosphere, sulfur dioxide SO<sub>2</sub>, one of the most harmful components of conventional jet combustion fuels.

This allows us to reduce pollution due to the active work of the engines almost zero. True, it is the share of CO<sub>2</sub>, which is introduced into the atmosphere during the production of biofuels. This is the manufacturing process and quality (refining), transport and storage.

Abovementioned clearly shows the importance of studying the problem of aviation and biofuels use, development of methods for forecasting of their influence on environment in order to limit negative consequences.

### Fuel sustainability standards

Sustainable aviation fuel (SAF) is the name given to advanced aviation biofuel types used in jet aircraft and certified as being sustainable by a reputable independent third-party (Iakovlieva et al.). This certification is in addition to the safety and performance certification, issued by global standards body ASTM, that all jet fuel is required to meet in order to be approved for use in regular passenger flights.

Several countries and regions have introduced policies or adopted standards to promote sustainable biofuels production and use, most prominently the European Union and the United States. The 2009 EU Renewable Energy Directive, which requires 10 percent of transportation energy from renewable energy by 2020, is the most comprehensive mandatory sustainability standard in place as of 2010. The Directive requires that the lifecycle greenhouse gas emissions of biofuels consumed be at least 50 percent less than the equivalent emissions from gasoline or diesel by 2017 (and 35 percent less starting in 2011). Also, the feedstocks for biofuels “should not be harvested from lands with high biodiversity value, from carbon-rich or forested land, or from wetlands” (Nesteruck 2008).

As with the EU, the U.S. Renewable Fuel Standard (RFS) and the California Low Carbon Fuel Standard (LCFS) both require specific levels of lifecycle greenhouse gas reductions compared to equivalent fossil fuel consumption. The RFS requires that at least half of the biofuels production mandated by 2022 should reduce lifecycle emissions by 50 percent. The LCFS is a performance standard that calls for a minimum of 10 percent emissions reduction per unit of transport energy by 2020. Both the U.S. and California standards currently address only greenhouse gas emissions, but California plans to “expand its policy to address other sustainability issues associated with liquid biofuels in the future” (Velichko 2002).

In 2009, Brazil also adopted new sustainability policies for sugarcane ethanol, including “zoning regulation of sugarcane expansion and social protocols”.

In 2008, the Roundtable for Sustainable Biofuels released its proposed standards for sustainable biofuels. This includes 12 principles (Bazarov 2001):

1. “Biofuel production shall follow international treaties and national laws regarding such things as air

quality, water resources, agricultural practices, labor conditions, and more.

2. Biofuels projects shall be designed and operated in participatory processes that involve all relevant stakeholders in planning and monitoring.

3. Biofuels shall significantly reduce greenhouse gas emissions as compared to fossil fuels. The principle seeks to establish a standard methodology for comparing greenhouse gases (GHG) benefits.

4. Biofuel production shall not violate human rights or labor rights, and shall ensure decent work and the well-being of workers.

5. Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities.

6. Biofuel production shall not impair food security.

7. Biofuel production shall avoid negative impacts on biodiversity, ecosystems and areas of high conservation value.

8. Biofuel production shall promote practices that improve soil health and minimize degradation.

9. Surface and groundwater use will be optimized and contamination or depletion of water resources minimized.

10. Air pollution shall be minimized along the supply chain.

11. Biofuels shall be produced in the most cost-effective way, with a commitment to improve production efficiency and social and environmental performance in all stages of the biofuel value chain.

12. Biofuel production shall not violate land rights.

In April 2011, the Roundtable on Sustainable Biofuels launched a set of comprehensive sustainability criteria – the “RSB Certification System.” Biofuels producers that meet to these criteria are able to show buyers and regulators that their product has been obtained without harming the environment or violating human rights.

### Conclusions

Accelerated development of alternative types of aviation technology is a universal problem that cannot tolerate delay, because, according to international experts, we should expect further price increases in hydrocarbon fuels. Development of efficient production technology of motor fuels from bioresource and particularly jet fuels is an objective necessity and urgent now.

It should be noted that biofuels made from natural renewable resources, which in its development, absorbing carbon dioxide from the air. The combustion of biofuels is still bioresource absorbed carbon dioxide is returned to the air. The combustion of fuels are made from non renewable resources, carbon dioxide, standing out in the atmosphere, it increases its content. Therefore, synthetic fuel from bioresource considered environmentally preferable.

Fuels influence environment and human, so they should strictly require the set of world standards before get in use.

Application of renewable or sustainable fuels may also contribute to minimization of negative anthropogenic not only provides us with alternative energy resources but impact on environment.

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