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PERSPECTIVES OF ALTERNATIVE JET FUELS PRODUCTION AND IMPLEMENTATION IN UKRAINE AND POLAND

Iakovlieva A.V., National aviation university, Kyiv, Ukraine
Vovk O.O., National technical university of Ukraine «Kyiv polytechnic institute», Kyiv, Ukraine
Boichenko S.V., Politechnika,Rzeszowska im. Ignacego Lukasiewicza, Rzeszów, Poland

ПЕРСПЕКТИВИ ВИРОБНИЦТВА ТА УПРОВАДЖЕННЯ АЛЬТЕРНАТИВНИХ АВІАЦІЙНИХ ПАЛИВ В УКРАЇНІ ТА ПОЛЬЩІ

Яковлєва А.В., Національний авіаційний університет, Київ, Україна
Вовк О.О., доктор технічних наук, Національний технічний університет України «Київський політехнічний інститут», Київ, Україна
Бойченко С.В., доктор технічних наук, Жешувська політехніка, Жешув, Польща

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Яковлева А.В., Национальный авиационный университет, Киев, Украина
Вовк О.А., доктор технических наук, Национальный технический университет Украины «Киевский политехнический институт», Киев, Украина
Бойченко С.В., доктор технических наук, Жешувская политехника, Жешув, Польша

Introduction

Today application of alternative energy sources in various spheres of human activity becomes more and more popular all over the world and in Eastern European countries as well. Possibilities of traditional oil-derived motor fuels substitution with biofuels derived from plant feedstock are actively discussed [1]. Today such fuels include: bioethanol, used as alternative to motor gasoline and biodiesel, derived from plant oils and used in automobile diesel engines.

Along with development and implementation of alternative motor fuels, scientists around the world study perspectives of partial or total substitution of traditional jet fuels with their alternative analogues. Following the world tendencies we see the need to consider potential in development and application of alternative jet fuels in such countries as Ukraine and Poland [2].

Literature overview

Modern civil aviation is developing constantly. According to the data of Commercial Aircraft Corporation of China (COMAC) today modern civil aviation operates 18 202 aircrafts. According to the forecasts number of aircraft will increase in two time till 2031 and will be equal to about 37 thousand [3]. The world volume of aircraft transportation increases on 4 – 5%. As a result during last decade consumption of fuels for air-jet engines has increased on 21%. As it is stated in [4] about 5.5 thousand barrels of jet fuel is produced and consumed in the world daily. According to the data of State statistics Service of Ukraine 129,465 thousand tons of fuels for air-jet engines were used in Ukraine in 2013. At the same time Polish air fleet during the 2012 had used 1156 thousand tons of jet fuel. Statistics of the world’s jet fuel consumption is presented at figure 1 [4].

Thus, today aviation is one of the most significant consumers of oil-derived jet fuels [2]. Oil and other fossil fuels used for production both jet and other kinds of fuels are exhausted irreversible. Oil deposits are estimated at about 40 years, natural gas – 70 and coal – 230 years. As a result, constant increase of process for energy resources and jet fuel mainly is observed [5]. According to the data of International Air Transport Association the price for air-jet engine fuel in February 2013 was about 1100$ per ton. Except the forthcoming crisis in sphere of energy resources supply, the world community is concerned about worsening state of environment in a result of aviation activity.

CO_2 emissions accompanying processes of fuel production and use, stipulate increase of greenhouse effect, and therefore global warming on the planet [5, 6]. Intergovernmental Panel on Climate Change and International Energy Agency state that modern aviation is a source of about 2% of the world’s total CO_2 emissions (fig. 2). As it is known, 71.5 kg of CO_2/km is emitted into the atmosphere during aircraft flight.

Besides CO_2 aircraft exhaust gases contain number of other components that negatively influence on the state of environment: SO_x, NO_x, CO, CH_4, soot, and others [7].

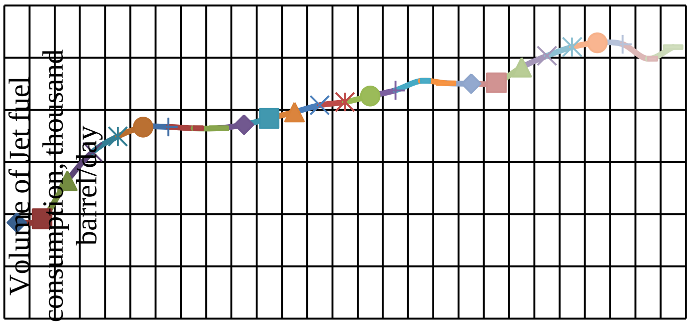

Fig.1. Statistics of the world’s jet fuel consumption

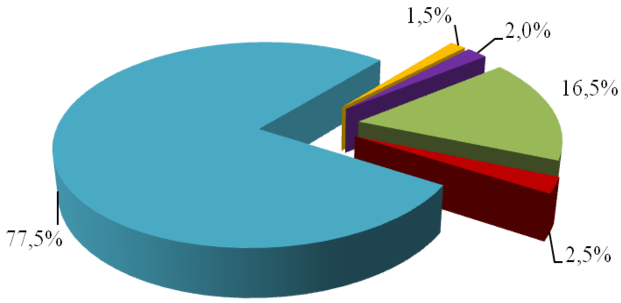

Fig. 2 The share of CO_2 emissions from aviation comparing to other kinds of transport:
1,5% – world aviation, 2% – sea transport, 16,5% – motor transport, 2,5% – other kinds of transport, 77,5% – other kinds of energy resources

Such situation promoted strengthening of ecological requirements to quality of jet fuels [2, 7]. For example For example, the European Parliament resolution on reduction of impact of aviation on climate change (INI/2005/2249) clearly states that: “The European Parliament promotes introduction of aviation biofuels, thereby reducing the effects on climate change”. Number of influential organizations took measures on prevention of aviation negative impact on environment. International Air Transport Association (IATA) has set up the task to reduce the level of CO_2 emissions from air transport by 50% by 2050. In addition, European Commission in 2011 has set a policy target of achieving a 60 % reduction of CO2 by 2050. Low-carbon fuels in aviation should reach 40 % by 2050 [8]. During the ICAO Conference on aviation and alternative fuels held in Rio-de-Janeiro, governments were recommended “to work promptly on development and implementation of ecologically friendly alternative fuels for aviation”.

During last years European authorities adopted number of documents that talk about the necessity of implementation and use of alternative fuels in aviation. Among these documents are: Directive 2009/28/EC of the European Parliament and the Council on 23.04. 2009 “On stimulating the use of energy from renewable sources”; The agreement of the European Commission on 08/02/2006 “EU Biofuel Strategy” that determines seven strategic directions for development and production of biofuels by the member countries and developing countries; Directive 2009/30/EC of the European Parliament and the Council on 23.04. 2009, “On the technical requirements to gasoline, diesel and gas fuels, and introduction of a mechanism for monitoring and reduction of greenhouse gases emissions” (Directive on fuel quality).

Modern situation in sphere of jet fuels production

Traditionally fuels for aircraft engines are produced from crude oil [9]. The most part of existing technologies is still intended for processing of crude oil and some other fossil fuels, such as coal, natural gas, oil sands and oil-shales [12]. Technologies used for processing of these types of feedstock allow obtaining of high-quality fuel, with the possibility to vary certain parameters if required. However, these technologies are quite energy-intensive and difficult for realization. Refining of base kerosene oil fractions requires hydrotreating and various destructive methods; at the same time, obtaining of basic fractions from non oil-derived feedstock, in addition to mentioned stages, needs pyrolysis, FT-synthesis, gasification etc.

Thus, limitation of the world’s oil deposits and other fossil fuels promotes development of alternative technologies for jet fuels production today new normative documents and changes to existing ones are already adopted. This allows large-scale application of modern alternative fuels for air-jet engines.

Today numbers of foreign organizations pay much attention to investigation of existing and newly appeared technologies for alternative jet fuels production. Among variety of technologies for jet fuels production several groups are determined according to the feedstock used [5, 9, 11]:

1. Derived from conventional oil;
2. Derived from unconventional oil (oil sands and oil shale);
3. Derived synthetically from natural gas, coal, or combinations of coal and biomass via the FT-process;
4. Derived from renewable oils (biodiesel, biokerosene, hydroprocessed renewable jet – HRJ or Hydrotreated Vegetable Oil – HVO);
5. Derived from alcohols (ethanol and buthanol). However, they are suitable for motor transport but not for aviation.

Among the mentioned above technologies the most perspective are fuels derived from plant feedstock or biomass – the so called biofuels. Today the share of biofuels comparing to conventional oil-derived fuels is the USA is 6–7%, Brazil – 15%, China – 2,5%, EU countries up to 5–6%. International Energy Association forecasts that till 2030 world production of biofuels will increase up to 150 mln ton of oil energy equivalent. Annual temps of production growth are about 7 – 9%. Thus, the share of biofuels in total balance of fuel in transport sector will reach 4–6% till 2030 [15]. According to other data [16] the share of biofuels in total energy resources balance will be about 10 – 12%.

If to talk about the state of biofuels production in Ukraine, it should be mentioned that general level of biofuels branch development is significantly lower than in EU countries. According to [17] the total supply of primary energy sources in Ukraine is more than 130 mln ton of oil equivalent, but amount of biofuel is just 1.48 mln ton that is 1.13% in structure of energy supply. At the same time in EU countries this index reaches 6.72%. The total supply of primary energy in EU countries is estimated at 1759 mln ton of oil equivalent with the share of biofuels of 118 mln ton (Fig. 3 *a* - *c*).

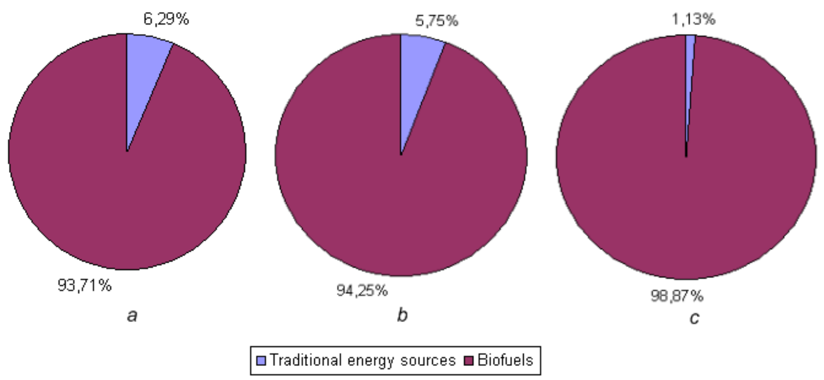

Fig. 3. Share of biofuels in structure of energy supply *a* – in EU countries, *b* – in Poland, *c* – in Ukraine

As it was mentioned previously, application of biomass as a feedstock for alternative jet fuels production has two general aims: minimization of negative impact on environment and decrease of the dependence on exhausting oil deposits (mainly in transport sector). It should be also mentioned that different kinds of plant (natural) feedstock differ from each other [13]. The main difference is determined by their chemical nature: biomass containing lignocelluloses, biomass with high content of oil (plant oils and animal fats), biomass with high content of sugars and starch (potatoes, corn, sugar beetroot, etc.). Thus there is a big variety of biomass processing technologies; some of them are already popular, some are still being developed [9, 13].

State and perspectives of jet biofuel production in Ukraine and Poland

Despite well-developed biofuel sphere in motor transport sector, both Poland and Ukraine still doesn’t have practical experience in application of alternative jet fuels [10]. These countries as well as other European states are characterized by deficiency of oil deposits. However, use of alternative fuels in aviation is commonly accepted in Europe and other developed states [17, 18].

Ukraine consume about 130 mln ton of fuel-energy resources annually, satisfying its need in energy resources on around 53%. It imports 75% of natural gas and 85% of crude oil and oil products [19]. In order to satisfy needs of civil aviation Ukraine requires about 400 thousand ton of aviation kerosene [12]. Comparing to 2011 consumption jet fuels in Ukraine had increased on 23%. At the same time sphere of jet fuels production is characterized by opposite situation. Production of aviation kerosene at Ukrainian enterprises in 2011 decreased on 16.6% comparing to previous year up to 282 thousand ton [12].

The final energy consumption for transportation purposes in Poland in 2005 was 10,27 Mtoe. Dynamics of jet fuels consumption in Ukraine and Poland are shown at (fig. 4) [4].

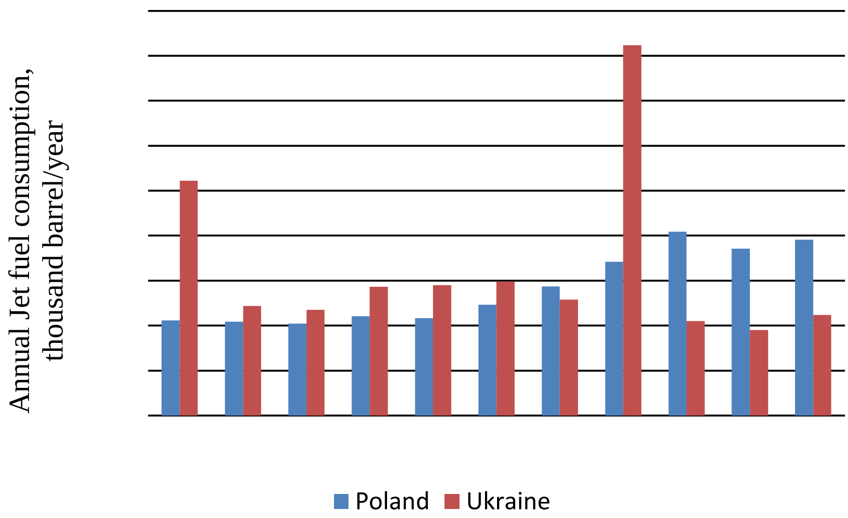

Fig.4. Statistics of Jet Fuel consumption in Poland and Ukraine

Generalizing the world's experience in alternative jet fuels development we have concluded that the most optimal kind of aviation biofuels is biokerosene, which is derived from renewable oils. The technology of bikerosene manufacturing is seemed to be the most rational for both Ukrainian and Polish conditions. This kind of biofuel is obtained via processing of oil plants [7, 10]. Biokerosene is a mixture of traditional kerosene, produced from crude oil and biocomponents in certain concentrations. The percentage of biocomponent can reach 50%. Biocomponent is a methyl or ethyl ether of fatty acids that are contained in vegetable oils. These compounds are successfully used as components of biodiesel fuels and have great potential for application in jet fuels [7, 10]. Today technology of biokerosene production is seemed to be the most optimal for such developing countries as Poland and Ukraine. It is explained by number of factors, such as availability of feedstock, maturity of technology, presence of necessary equipment, satisfactory physical-chemical and exploitation properties of such kind of biofuel and also its ecological safety [12]. Let's consider these factors in details.

Feedstock base for jet biofuels production

Feedstock for biocomponents production is oils, obtained from seeds of various agricultural oily plants: rape, sunflower, jatropha, canola, palm oil, etc. [16]. Camellina is also seemed to be quite perspective. The following factors should be taken into account while choosing the necessary feedstock: volumes of certain kind of oil production (cultivated areas fertility of the culture, main consumers of products, content of oil in plant, potential of its cultivation), and also it s physical-chemical characteristics. Today there is a great experience all over the world in growing and processing of various oily plants. The main factor for feedstock selection is surely geographical and climatic conditions typical for country-producer and optimal for certain oily plant cultivation [13, 17]. The most widespread plant in the USA is soy, in Canada – canola (kind of rape). During recent years camellina oil is actively investigated in used in these countries. Palm oil is popular in Mexico as well as jatropha that is considered as a weed and can grow on the poorest soils. Countries of the Asia region, such as Indonesia, Philippines, Malaysia use to produce palm and coconut oil, India – jatropha, Africa countries – jatropha, soy, Brazil – castor oil [5, 13]. Base of European biofuel industry is rape and during last years – camellina. Production of biofuel is seemed to be quite beneficial. For example, cultivation of rape on 1 ha territory requires about 170 l of diesel fuel; at the same time, yield from this area can be processed into 1.2 – 1.5 ton of biofuel [20].

Ukraine and Poland are traditionally agricultural countries with well-developed oil production branch [5]. Due to this they have a great potential for development of jet biofuels manufacturing. The most typical oil cultures in Ukraine are sunflower, rape, soy; camellina and corn are less popular (fig. 5).

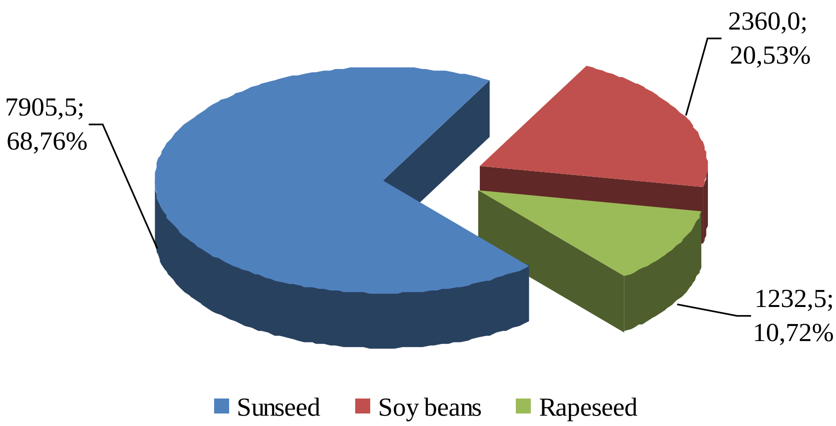

Fig. 5. Production of main oily plants in Ukraine in 2012 (thousand ton)

Due to the large area of agricultural terrains, Poland has a great potential to use renewable energy [33]. The main renewable energy source in Poland is biomass. Today Poland is one of the most promising countries in EU concerning biofuel feedstock production. The most typical oil cultures in Poland are sunflower and rape (fig. 6) [34]. Such plants as soy, camellina, etc are still not cultivated in industrial scales. However, comparing to Ukraine, only rape oil is considered to be used as a feedstock for biofuels production.

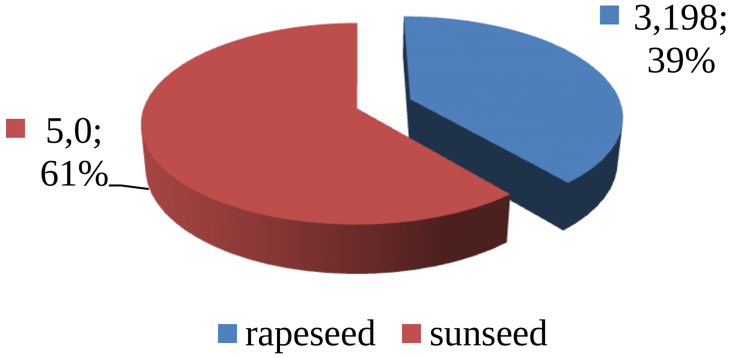

Fig. 6. Production of main oily plants in Poland in 2014 (thousand ton)

During last 10 – 15 years volumes of oily plants production are constantly growing. According to [18] during 1990 – 2011 cultivating areas under oily plants have increased in 3.7 times: in 1990 they were 5.7% of all agricultural territories, and in 2011 already 21%. In general such strong development of the industry is explained by stably-high profitability of mentioned cultures, annually growing demand for feedstock both in food industry, animal farming and biofuel industry. Fig. 7 presents dynamics of main oily plants production in 1990 – 2011 [18].

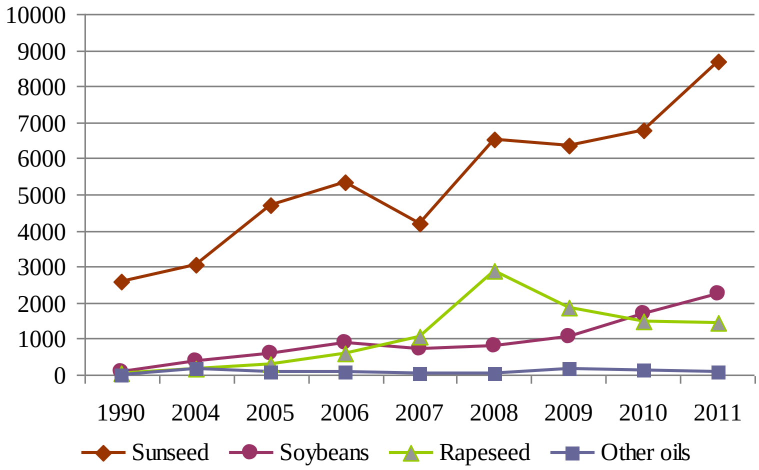

Fig. 7. Dynamics of oily plants production in Ukraine (thousand ton)

Sunflower is a main oily plant cultivated in Ukraine. Its part in total yield is about 70% (fig. 5) [19]. Seeds of ordinary breeds contain 50 – 52% of oil, while selected breeds contain up to 60% [20]. Comparing to other oily plants, sunflower allows production of quite high volume of oil – 952 l/ha (890 – l/ha on average in Ukraine) [20]. Last years are characterized by significant growth of sunflower production (fig. 8). Mainly it is stipulated by increasing of cultivating areas and also increasing fertility. Today sunflower fertility is about 18.4 centners per ha, that is much higher comparing to 2002 – 2004 years (about 11 – 13 centners per ha).

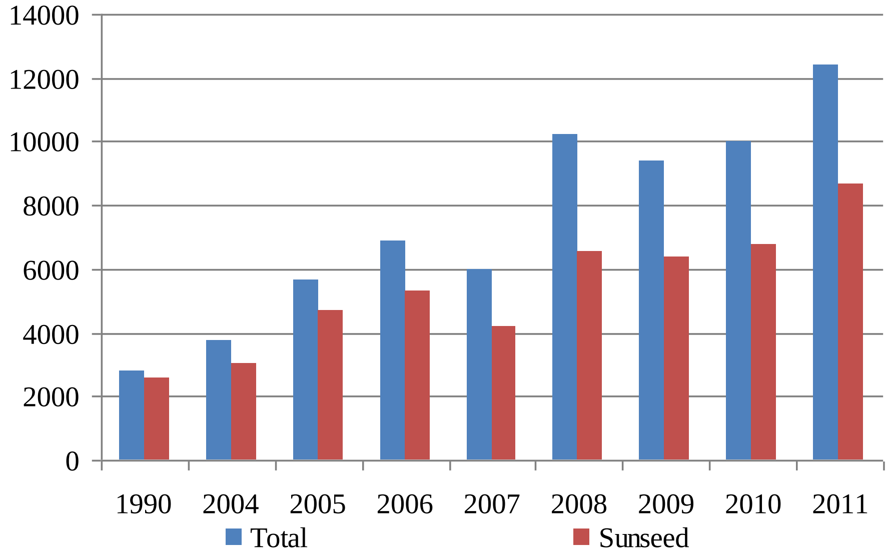

Fig. 8. Dynamics of sunflower production in Ukraine and its share in total volume of oily plants cultivation (thousand ton)

Main part of sunflower is used for food industry, production of high-protein forage, oil meal and other technical needs. Except that, significant amount is exported that makes a valuable income for country. Thus, despite so huge production volumes, it is not rational to consider sunflower as a feedstock for biofuel industry, mainly manufacturing of jet biofuel.

Another oily plant – rape is known for a long time in Ukraine. However, it is being cultivated in industrial volumes only during last 8 – 10 years. It is explained by strong world’s demand on rape oil for biofuels production [21]. The most active rape production in Ukraine was observed during 2004 – 2008 years (fig. 9).

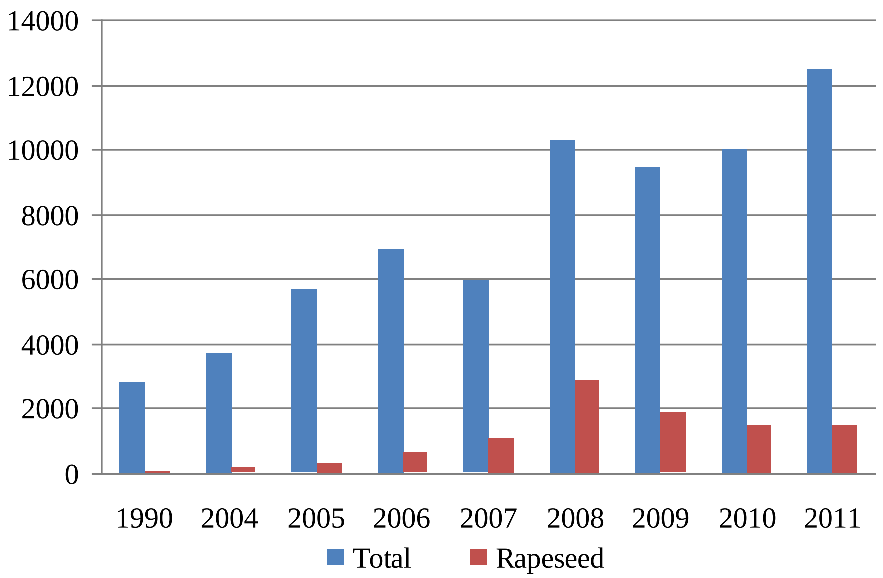

Fig. 9. Dynamics of rape production in Ukraine and its share in total volume of oily plants cultivation (thousand ton)

Seeds of winter rape contain 45 – 50% of oil, 24 – 31% of proteins and 6 – 12% of fiber. Two forms of rape are cultivated in Ukraine: spring rape and winter rape that is dominant in our country. Cultivating areas of winter rape were more than 1 mln ha in 2011; spring rape was grown on around 100 thousand ha. Such inequality is explained mainly by significantly higher fertility of winter rape. According to [22], today fertility of winter breeds is about 15 – 17 centners per ha, while spring rape gives around 7,4 centners per ha. At the same time rape fertility in France and Germany is more than 30 centners per has, in Czech Republic and Poland – more than 24 centners per ha. Average yield of rape oil is around 1190 l/ha. Comparing to sunflower oil, rape oil doesn’t need preparatory purification from various related components. That is why it is considered to be more appropriate for biofuels production. Moreover, certain rape breeds with low content of erucic acid have been already selected; that is one more positive factor for production of biofuels. Several years ago rape was cultivated in Ukraine with the aim of export only. Its internal processing was almost absent and didn’t exceed 10%. However, comparing to previous years, in 2011 a significant increase in volumes of internal processing was observed [21, 22].

Another widely popular culture is soy. Comparing to rape, during recent years high rates of soy production are observed in Ukraine. Dynamics of soy production and its share in total structure of oily plants production is shown at fig. 10. Today national producers provide not only internal needs in soy, but also made Ukraine a significant exporter of this culture [23].

Soy belongs to leguminous plants. Its average fertility is about 15 – 20 centners per ha with comparatively low oil yield – 446 l/ha. Content of oil in soy seeds is about 16 – 27%. Soy oil is characterized by high content of unsaturated fatty acids (86 – 87%); this makes a certain impact on its physical-chemical properties. At the same time it contains 40 – 50% of high-quality proteins. Due to this soy culture is widely used for production of food oil, protein concentrates and various food products [21]. By-products of soy processing are widely used in animal breeding as forage. It should be mentioned that soy production requires significant resources and material-technical base for its cultivation is much more complicated comparing to other plants. Soy is quite difficult culture, especially in seed grains quality, fertilizers use, and maintenance of cultivation technology. All these factors significantly influence on soy price, and consequently biofuels made of soy. Moreover, as it was already mentioned, the main consumer of this culture is still food industry.

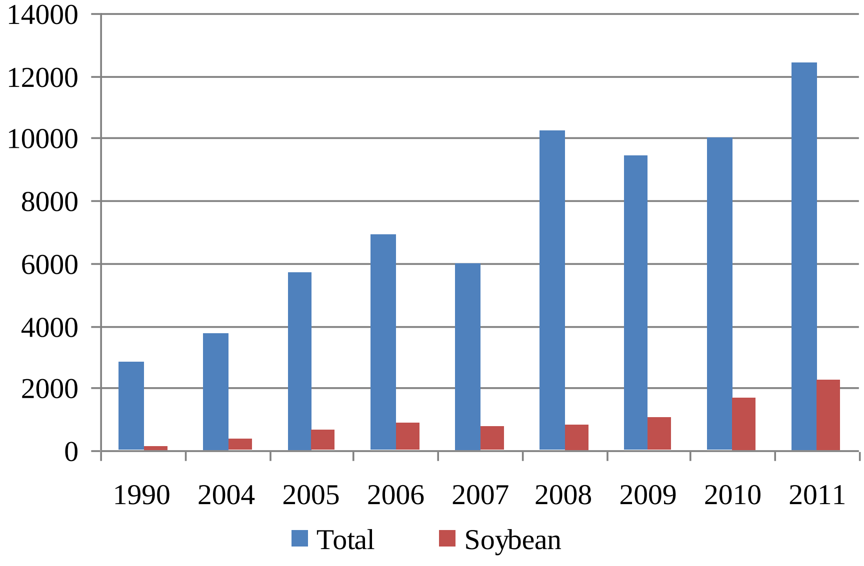

Fig. 10. Dynamics of soy production in Ukraine and its share in total volume of oily plants cultivation (thousand ton)

Camellina culture is grown in Ukraine not for a long time – just since the second part of XX century. Till that time it was considered as a weed. Today camellina is cultivated on some territories of North-West and Central Europe. Camellina is a spring one-year grass plant that belongs to Brassicaceae family. It is easily grown on unfertile soils, undemanding to external conditions, resistible to low temperatures and dry weather. Plant has short vegetating period; this allows growing other cultures after harvesting camellina [20]. It is quite fertile culture. When grows naturally its yield is 10 – 12 centners per ha on average. If certain agrochemical conditions are maintained the yield can reach 20 and even 30 centners per ha [20, 23]. Camellina seeds contain 40 – 50% of oil and oil yield is about 1250 l/ha. Taste properties of camellina are very poor. In food industry it is used for confectionery production, preserves, etc. Camellina seeds are usually used for technical needs: chemical, textile industries and metallurgy. Due to its special content of fatty acids and vitamins camellina is popular in medicine.

During recent years application of camellina oil in technical purposes become more and more popular, mainly as a feedstock for biofuels production. In the USA camellina is one of the main cultures used for jet biofuel manufacturing. In Europe rape oil is rapidly changed with camellina one [13, 17]. In Ukraine camellina oil production is still developing. This culture is technical, so biofuel production will not compete with food industry. In Poland camellina is still not considered as a biofuel feedstock, however, taking into account world and European tendencies in particular, we may predict that camellina production in Poland and Ukraine will be increasing rapidly.

During last years, Poland has become one of the leading countries within the EU, with regard to biofuels production. Having an area of 18.3 million ha devoted to agricultural production and 8.9 million ha of forest area, Poland presents biomass opportunities from agricultural residues, harvesting or processing, wood and wood wastes from forestry and industry in addition to important prospects for energy crops grown specifically for energy applications [33]. Today Poland is treated as one of the main rapeseed producing countries (fig 11). As a result, the new capacities in the country are being installed, mainly encouraged by the incipient growth of domestic consumption.

The biofuels sector in Poland is mainly driven by the European incentives and directives aiming at considerably increasing biofuels production and use. Along with other European states, Poland has to increase the use of renewable energy in transport to 5.75 per cent by 2010 - a goal established in the Biofuels Directive of 2003 (table 1). Furthermore, according to recent European regulations, the mandatory target for 2020 has been set at a minimum level of 10 per cent biofuel component in transportation fuels.

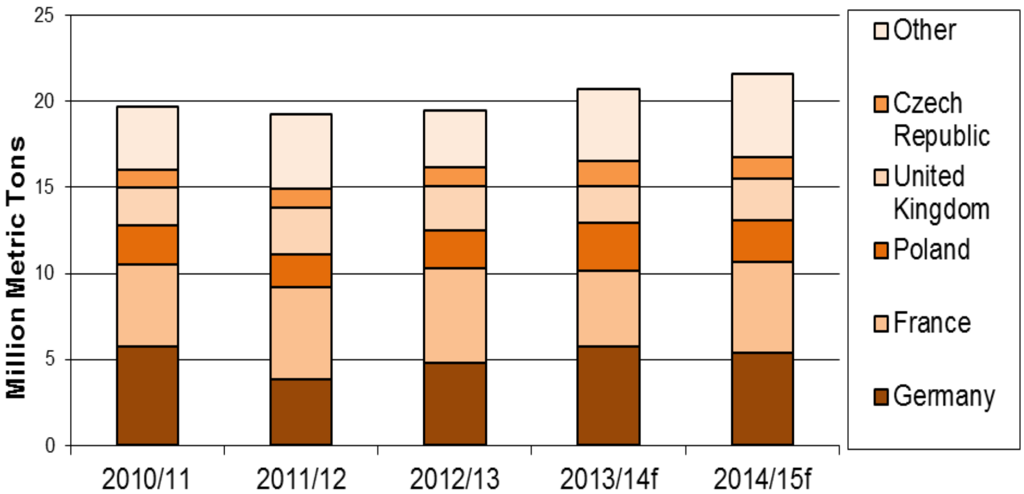

Fig. 11. Dynamics of rape production in Poland comparing to other European producers.

Considering the Poland case the potential of rape cultivation should be determined. More specifically, in Poland, the production of rapeseed increased sharply from 0.7 in 2003 to 1.25 million tons in 2004.

Table 1 - National indicative targets on biofuels for transport sector in Poland

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2020**
Poland indicative target, %	3,45	4,60	5,75	6,20	6,65	7,10	10

In recent years an increasing trend in biofuels production and consumption can be seen. Consumption is rising significantly faster than production, which means that much of the lacking bio-components must be covered by the increased imports. The figure 12 and table 2 confirm trend in biofuels production and consumption. In 2011, in Poland there were registered 20 producers of biofuels made of rape oil [35, 36].

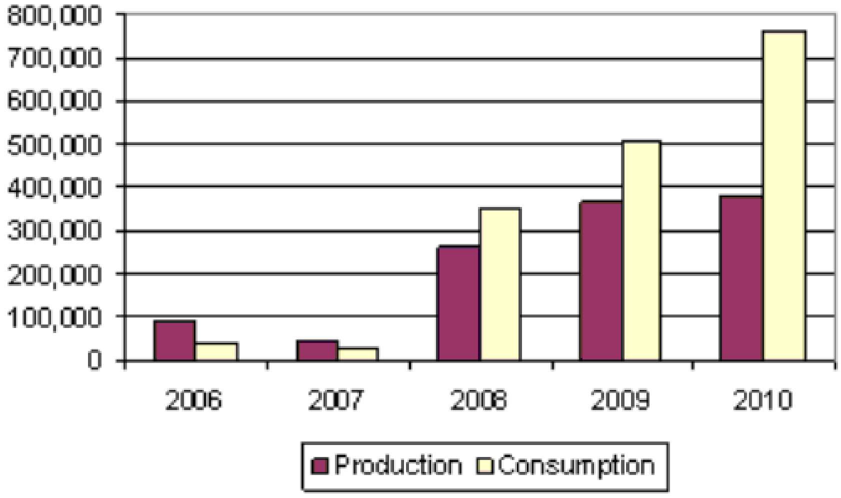

Fig. 12. Production and consumption of rape oil derived biofuels in Poland

Table 2 - Balance of rape oil derived biofuels in Poland during 2006 – 2010 (tons)

Biofuel	**2006**	**2007**	**2008**	**2009**	**2010**
Production	89,126	47,447	263,729	364,832	379,802
Import	142	0	94,094	151,535	397,689
Export	51,528	19,440	0	8,343	13,060
Consumption	39,022	27,900	350,415	510,416	760,963

Thus the most perspective cultures for biofuels production at the territory of Ukraine are: sunflower, rape, soy and camellina. Tables 3 present summary data about the potential of mentioned culture as a feedstock for jet biofuel manufacturing.

Table 3 - Potential of plant oils production in Ukraine

Index / Culture	**Yield per unit of area, centners per ha**	**Oil content in seeds, %**	**Oil yield per unit of area, l/ha**	**Volumes of production in 2012, th. ton**
Sunflower	18 – 20	50 – 60	952	7905,5
Rape	25 – 30	45 – 50	1190	2360,0
Soy	15 – 20	16 – 27	446	1232,5
Camellina	20 – 30	40 – 50	1250	Data are absent

Scientists’ calculations prove that production of jet biofuel from rape oil today is the most perspective variant for provision energy needs of Ukrainian and Polish civil aviation. For example, one ton of rape can be processed into 300 kg of rape oil and then about 270 kg of biofuel [23]. In such way rape produced in 2012 could be easily processed into 637 thousand ton of biofuel.

Physical-chemical, exploitation and ecological properties of jet biofuels

Oils derived from the mentioned above plants have different physical-chemical properties, however these differences are not significant. That is why, the main factor, determining choice of feedstock is still its availability and abundance on the territory of country-producer [24]. As properties of plant oils significantly differ from properties of fuels for air jet engines, it is rational to use products of oils processing – ethyl and methyl ethers.

Such biofuel surely possesses number of advantages comparing to traditional oil-derived jet fuel. Due to chemical composition biofuel is characterized by high lubricating properties; this allows increasing of aircraft details lifespan. Moreover, application of biofuel produced according to the mentioned technology doesn’t require additional reequipment or modernization of engines and their systems. Exclusively low sulfur content in biofuels due to its natural origin may allow significant decreasing of toxicity of aircraft exhaust gases, thus minimizing negative impact on environment. Another quite important factor that determines interest to jet biofuels is its ability to decompose easily in natural environment without doing harm to living objects [28].

3. Technology of jet biofuel production

Technology of ethyl (methyl) ethers production is quite simple and similar to process of biodiesel manufacturing. Basis of the process in reaction of etherification of fatty acids containing in plant oils using methanol or ethanol and basic catalyst. After purification of obtained substances ether of plant oils (biofuel) and glycerine are obtained [7].

Today this technology of biofuel production is quite popular and mainly used for manufacturing of biodiesel fuel. This technology is realized successfully both in laboratories and industrial; enterprises [26]. Taking into account experience of European countries, biofuel manufacturing in Ukraine can be organized at the following types of installations and factories: low-tonnage installations (local level for certain enterprises) with productivity 300 – 3000 ton/year, regional factories, producing 10000 – 30000 ton/year and large-scale industrial factories [23].

Technological process of jet biofuel production from plant oils is significantly simpler comparing to crude oil refining and profitability of the process in two-three times higher. Except that, plant feedstock is a renewable resource and thus it is comparatively unlimited. Ecological advantages of alternative fuel for air jet engines are also obvious and are proved by the world practice. For example, biofuel producing factories in Germany are able to provide almost waste-less production, using closed water cycle [27].

Conclusion

In general Ukraine and Poland among other countries have considerable resource potential for jet biofuel production from plant oils due to its favorable natural climatic conditions, availability of feedstock base and relatively cheap human resources. The main advantage of feedstock cultivation in Poland is a presence of high level of governmental support to biofuel producing industry. This support is regulated and based on European biofuel implementation programs. However, Poland’s potential in biofuel feedstock production is not realized completely. Today only rapeseed is cultivated for providing feedstock for biofuels production; at the same time the biofuel potential of sunflower, soy or camellina oils for biofuel production is not realized. The opposite situation is observed now in Ukraine. With no or almost absent governmental support Ukrainian producers develop oil production from traditional oily plants for satisfying biofuel industry needs. Being one of the leading countries in Europe by volumes of rape and sunflower production Ukraine is still one of the top rapeseed exporters to EU. At the same time Ukrainian oil producers promote growing of new biofuel cultures, such as camellina, soy and some others. If to speak in general, these countries have all possibilities for jet biofuel manufacturing for satisfaction of its own needs and for export also.

In order to conclude it should be said that implementation of biofuels derived from plant feedstock surely has potential and perspective for its future development. Special issue is that application of biofuels should be totally is the scope of sustainable development principles and doesn’t do harm to food industry [25]. As it was aid by the President of ICAO, alternative kinds of fuels derived from camellina, jatropha oils help to significantly reduce CO_2 emissions and do not concur with food agricultural plants in questions of land and water resources.

In future application of alternative jet fuels will have the following positive results:

- Availability of feedstock, that is especially important for countries, which don’t possess it own deposits of fossil fuels;
- Conservation of exhaustible natural energy resources;
- Decreasing of CO_2 and other greenhouse gases emissions and also toxicity of aircraft exhaust gases, thus protection of air quality in lower atmosphere layers;
- Comparative simplicity and cost of jet biofuel production process;
- Significantly low price for biofuel comparing to traditional oil-derived kerosene;
- Stimulation of agricultural complex development in countries-producers of biofuels.

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ABSTRACT

Iakovlieva A.V., Vovk O.O., Boichenko S.V. Perspectives of alternative jet fuels production and implementation in Ukraine and Poland. Visnyk National Transport University. Series “Technical sciences”. Scientific and Technical Collection. - Kyiv. National Transport University, 2015. - Issue 2 (32).

The present-day situation in civil aviation is discussed. Taking into account limitation of crude oil resources for jet fuel production and worsening of ecological situation, tendency to transition to alternative fuels is presented. Today application of alternative energy sources in various spheres of human activity becomes more and more popular all over the world. Possibilities of traditional oil-derived motor and jet fuels substitution with biofuels derived from plant feedstock is discussed in the article. Special attention is paid to the constant development of modern civil aviation and worsening of environment in a result of aviation activity. Today modern aviation is a source of about 2% of the world’s total $CO_{2.}$ Besides CO_2 aircraft exhaust gases contain number of other components such as SO_x, NO_x, CO, CH_4, soot, and others. As a result the ecological requirements to quality of jet fuels have been strengthened significantly and 60 % reduction of CO_2 must be reached by 2050. The general characteristics of the world biofuel industry are revealed in the article showing that today the share of biofuels comparing to oil-derived fuels in the USA is 6–7%, Brazil – 15%, China – 2,5%, EU countires up to 5–6%. Ukraine’s and Poland’s potential in development, production and application of alternative jet fuels is figured out. The most typical oil cultures in these countries are sunflower, rape, soy, camellina and corn. The experience and dynamics of each of the mentioned crops is discussed. Basing on the comprehensive analysis of favourable natural climatic conditions, availability of feedstock base and relatively cheap human resources Ukraine and Poland among other countries have considerable resource potential for jet biofuel production. The general technology of jet biofuels production and brief description of their physical-chemical properties have been presented in the given article. Advantages of plant oil-derived biofuels production and application comparing to conventional jet fuels are discussed. One of the strongest factors that help to develop biofuel sector in Poland is governmental support and European biofuel implementation programs. The opposite situation with no or almost absent governmental support is observed now in Ukraine. One of the leading countries in Europe by volumes of rape and sunflower production Ukraine is still one of the top rapeseed exporters to EU. At the same time Ukrainian oil producers promote growing of new biofuel cultures, such as camellina, soy and some others. Generally, Ukraine and Poland have all possibilities for jet biofuel manufacturing for satisfaction of its own needs and for export also.

KEY WORDS: JET FUEL, ALTERNATIVE JET FUELS, BIOFUELS, PLANT OILS, SOY, RAPE, SUNFLOWER, BIOCOMPONENT

РЕФЕРАТ

А.В. Яковлєва. Перспективи виробництва та упровадження альтернативних авіаційних палив в Україні та Польщі / Яковлєва А.В., Вовк О.О., Бойченко С.В. // Вісник Національного транспортного університету. Серія “Технічні науки”. Науково-технічний збірник. – К.: НТУ, 2015. - Вип. 2 (32).

У статті обговорюється сучасний стан цивільної авіації. Беручи до уваги вичерпні запаси нафтових ресурсів, що використовуються для виробництва реактивних палив, а також погіршення екологічної ситуації, у даній роботі розглядаються тенденції до переходу на альтернативні види палива. Сьогодні застосування альтернативних джерел енергії в різних сферах людської діяльності набуває все більшої і більшої популярності у всьому світі. В статті обговорюються можливості заміщення автомобільних та авіаційних палив з традиційної нафти біопаливами, отриманими з рослинної сировини Особлива увага приділяється постійному розвитку сучасної цивільної авіації та погіршенню стану навколишнього середовища в результаті її діяльності. Сьогодні сучасна авіація є джерелом викидів близько 2% від загального світового об’єму CO_2. Крім CO_2 відпрацьовані гази літаків містять ряд інших компонентів, таких як SO_x, NO_x, CO, CH_4, сажі та інших. Як результат, екологічні вимоги до якості палива для реактивних двигунів були значно посилені, а до 2050 року має бути досягнуто скорочення викидів CO_2 на 60%. У статті подано загальну характеристику світової біопаливної промисловості У статті наведено дані, що сьогодні частка біопалив у порівнянні з паливами нафтового походження в США становить 6 – 7%, Бразилії – 15%, Китаї – 2,5%, країнах ЄС до 5 – 6%. Детальна увага приділяється питанню розкриття потенціалу України та Польщі в сфері розроблення, виробництва та застосування альтернативних видів реактивного палива. Найбільш типовими олійними культурами для цих країн є соняшник, ріпак, соя, рижій та певною мірою кукурудза. Розглядається статистика та динаміка виробництва кожної з зазначених культур. Грунтуючись на комплексному аналізі сприятливих природно-кліматичних умов, наявності сировинної бази та відносно дешевих трудових ресурсів, показано, що Україна та Польща на ряду з іншими країнами мають значний ресурсний потенціал для виробництва авіаційних біопалив. У статті подано загальний опис технології виробництва біопалива для повітряно-реактивних двигунів та стислий огляд їх основних фізико-хімічних властивостей. Обговорюються переваги, виробництва та застосування біопалива отриманих з рослинних олій у порівнянні з традиційними авіаційними паливами нафтового походження. Один з найвагоміших чинників, що сприяють розвитку біопаливної галузі у Польщі є державна підтримка та Європейські програми з упровадження біопалив. Протилежна ситуація з відсутньою або майже відсутньою державною підтримкою спостерігається наразі в Україні. Будучи однією з провідних країн світу за обсягами вирощування ріпаку та соняшнику, Україна є одним з головних експортерів ріпаку в країни ЄС. У той же час українські виробники олій намагаються підтримувати галузь та вирощувати нові культури для виробництва біопалива, такі як рижій, соя та деякі інші. Загалом, Україна та Польща сьогодні мають усі можливості для виробництва авіаційних біопалив у об’ємі, достатньому для задоволення власних потреб та їх експорту.

КЛЮЧОВІ СЛОВА: АВІАЦІЙНЕ ПАЛИВО, АЛЬТЕРНАТИВНІ АВІЦІЙНІ ПАЛИВА, БІОПАЛИВА, РОСЛИННІ ОЛІЇ, СОЯ, РІПАК, СОНЯШНИК, БІОКОМПОНЕНТ

РЕФЕРАТ

А.В. Яковлева. Перспективы производства и внедрения альтернативных авиационных топлив в Украине и Польше / Яковлева А.В., Вовк О.А., Бойченко С.В. // Вестник Национального транспортного университета. Серия "Технические науки". Научно-технический сборник. – К.: НТУ, 2015. - Вып. 2 (32).

В статье обсуждается современное состояние гражданской авиации. Принимая во внимание исчерпывающиеся запасы нефтяных ресурсов, используемых для производства реактивных топлив, а также ухудшение экологической ситуации, в данной работе рассматриваются тенденции к переходу на альтернативные виды топлива. Сегодня применение альтернативных источников энергии в разных сферах человеческой деятельности приобретает все большую и большую популярность во всем мире. В статье обсуждаются возможности замещения автомобильных и авиационных топлив, получаемых из традиционной нефти биотопливами, производимыми из растительного сырья Особое внимание уделяется постоянному развитию современной гражданской авиации и ухудшению состояния окружающей среды в результате ее деятельности. Сегодня современная авиация является источником выбросов около 2% от общего мирового объема CO_2. Кроме CO_2 отработанные газы самолетов содержат ряд других компонентов, таких как SO_x, NO_x, CO, CH_4, сажи и других. Как результат, экологические требования к качеству топлива для воздушно-реактивных двигателей были значительно усилены, а к 2050 году должно быть достигнуто сокращение выбросов CO_2 на 60%. В статье представлена общая характеристика мировой биотопливной промышленности В статье приведены данные, что сегодня доля биотоплива по сравнению с топливами нефтяного происхождения в США составляет 6 – 7%, Бразилии – 15%, Китае – 2,5%, странах ЕС до 5 – 6%. Особое внимание уделяется вопросу раскрытия потенциала Украины и Польши в сфере разработки, производства и применения альтернативных видов реактивного топлива. Наиболее типичными масличными культурами для этих стран являются подсолнечник, рапс, соя, рыжик и в определенной степени кукуруза. Рассматривается статистика и динамика производства каждой из указанных культур. Основываясь на комплексном анализе благоприятных природно-климатических условий, наличия сырьевой базы и относительно дешевых трудовых ресурсов, показано, что Украина и Польша на равне с другими странами имеют значительный ресурсный потенциал для производства авиационных биотоплив. В статье представлены общее описание технологии производства биотоплива для воздушно-реактивных двигателей и краткий обзор их основных физико-химических свойств. Обсуждаются преимущества производства и применения биотоплива полученных из растительных масел по сравнению с традиционными авиационными топливами нефтяного происхождения. Один из наиболее значимых факторов, способствующих развитию биотопливной отрасли в Польше является государственная поддержка и Европейские программы по внедрению биотоплив. Обратная ситуация с отсутствующей или почти отсутствующей государственной поддержкой наблюдается сейчас в Украине. Будучи одной из ведущих стран мира по объемам выращивания рапса и подсолнечника, Украина является одним из главных экспортеров рапса в страны ЕС. В то же время украинские производители масел пытаются поддерживать отрасль и выращивать новые культуры для производства биотоплива, такие как рыжик, соя и некоторые другие. В общем, Украина и Польша сегодня имеют все возможности для производства авиационных биотоплив в объеме, достаточном для удовлетворения собственных нужд и для их экспорта.

КЛЮЧЕВЫЕ СЛОВА: АВИАЦИОННОЕ ТОПЛИВО, АЛЬТЕРНАТИВНЫЕ АВИАЦИОННЫЕ ТОПЛИВА, БИОТОПЛИВА, РАСТИТЕЛЬНЫЕ МАСЛА, СОЯ, РАПС, ПОДСОЛНЕЧНИК, БИОКОМПОНЕНТ

АВТОРИ:

Яковлєва А.В., асистент, Національний авіаційний університет, e-mail: pinchuk_anya@ukr.net, Україна, 03058, Київ, просп. Космонавта Комарова, 1.

Вовк О.О., доктор технічних наук, доцент, Національний технічний університет України «Київський політехнічний інститут», e-mail: o.a.vovk@mail.ru, Україна, 03056, Київ, вул. Борщагівська, 115.

Бойченко С.В., доктор технічних наук, професор, Жешувська політехніка ім. І. Лукашевича, e-mail: chemmotology@ukr.net, Польща, 35-959, Жешув, вул. Повстанців Варшави, 8.

АВТОРЫ:

Яковлева А.В., асистент, Национальный авиационный университет, e-mail: pinchuk_anya@ukr.net, Украина,03058, Киев, просп. Космонавта Комарова, 1.

Вовк О.А., доктор технических наук, доцент, Национальный технический университет Украины «Киевский политехнический институт», e-mail: o.a.vovk@mail.ru, Украина, 03056,Киев, ул. Борщаговская, 115.

Бойченко С.В., доктор технических наук, профессор, Жешувская политехника им. И. Лукашевича, e-mail: chemmotology@ukr.net, Польша, 35-959, Жешув, ул. Повстанцев Варшавы, 8.

AUTHORS:

Iakovlieva A.V., assistant, National aviation university, e-mail: pinchuk_anya@ukr.net, Ukraine, 03058, Kyiv, Kosmonavta Komavora ave. 1.

Vovk O.O., Dr. Sc., associated professor, National technical university of Ukraine «Kyiv polytechnic institute», e-mail: o.a.vovk@mail.ru, Ukraine, 03056, Kyiv, Borshchagovska str. 115.

Boichenko S.V., Dr. Sc., professor, Politechnika,Rzeszowska im. Ignacego Lukasiewicza, e-mail: chemmotology@ukr.net, Poland, 35-959, Rzeszów, Powstancow Warszawy str. 8.

РЕЦЕНЗЕНТИ:

Запорожець Олександр Іванович, доктор технічних наук, професор, директор Інституту екологічної безпеки, Національний авіаційний університет, м. Київ, Україна

Посвятенко Едуард Карпович, доктор технічних наук, професор кафедри виробництва, ремонту та матеріалознавства, Національний транспортний університет, м. Київ, Україна

REVIEWERS:

Zaporozhets Olexander I. Dr. Sciences, professor, director of the Institute of Ecological safety, National Aviation University, Kyiv, Ukraine.

Posviatenko Eduard K., Dr.Sc., professor of the department of Production, Repair and Material Science, National transport university, Kyiv, Ukraine.