POLITECHNIKA
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Monografia
pod redakcją naukową
KAZIMIERZA LEJDY

Nr 10

Seria: TRANSPORT

SYSTEMY I ŚRODKI TRANSPORTU SAMOCHODOWEGO

PROBLEMY EKSPLOATACJI I DIAGNOSTYKI

WYBRANE ZAGADNIENIA

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RECENZENT: prof. dr hab. inż. Mirosław WENDEKER

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SPIS TREŚCI

1. MODERN TRENDS IN TECHNOLOGIES FOR AIR TRANSPORT RECYCLING AND UTILIZATION

BOICHENKO Sergii, IVANCHENKO Oksana, YAKOVLIEVA Anna

The work is devoted to problems of utilization and recycling of decommissioned aircraft and its components. Features of proper handling of aviation industry vehicles are considered. The analysis of existing methods and technologies aimed on the rational and correct handling of the worked out aircrafts is carried out. The necessity of introduction of the system of complex utilization of aviation equipment is substantiated. The ecological and economic problems connected with utilization and recycling of aviation vehicles, and their units are considered. The relevance and feasibility of introducing recycling programs in the field of aviation industry waste management is substantiated.

INTRODUCTION

Today, the problem of utilization and recycling of aircrafts' components, which worked out their resource, is one of the main for the entire aerospace industry. Every year more and more aerospace equipment is accumulated on different platforms, occupying and polluting large areas of land. Therefore, the issue of proper handling of air transport, which has been decommissioned, via introducing of utilization and air transport recycling processes is becoming more and more relevant. The purpose of this work is to analyze existing methods and technologies, which are aimed to the rational and proper handling of spent aviation transport means; determination of the world trends and substantiation of the prospects for implementation of utilization and recycling programs in the aviation industry.

LITERATURE OVERVIEW

In recent years, a number of research papers on the effectiveness of recycling programs have been published, as well as the papers on environmental, ethical, economic, technical and technological aspects of this issue.

Since the 1980s, the problem of aviation transport means handling has become increasingly relevant as a result of the accumulation of a large number of old aircrafts, storage of which is associated with additional costs for conservation and land lease. The risk of emergencies is sharply increased with the expiration of the term of storage of potentially dangerous types of aircrafts, which complicates the process of its' further proper handling [3, 4, 5].

In the world market, according to forecasts made by the Airbus company, the number of air transport units that have to be recycled during the period from 2009 to 2028 will rich 8453. Based on the report made by Boeing company, the potential market for aircraft utilization will be about 6,000 units.

MAIN MATERIAL

Aircraft industry as a type of economic activity is seemed to be innovatively-oriented. However, since the activity of aviation enterprises is associated with pollution of the environment, the aircraft and aircraft repair industry is considered to be environmentally hazardous.

Like any product, the airplane is devaluated over time. Costs reduction arises from a variety of factors, including an increase in the cost of maintenance, repair and modernization in accordance with the legislation. In many cases, old airplanes contains valuable components and parts that can be returned into service through the secondary market of spare parts or the introduction of aviation recycling and complex recycling of aircraft equipment [1, 2].

Thus, the utilization of the medium class aircraft gives about 60–70% of aluminum and its alloys from its total weight, 10–15% of steel, 10% of composite materials and precious metals, including titanium. The cost of utilization is significantly lower than the cost of new metals and materials.

The world leader in decommissioned aircraft management is the Aircraft Fleet Recycling Association (AFRA), which was founded in 2006. AFRA has developed a special dismantling procedure that allows quick distinguishing of valuable alloys and metals. According to their procedure, the disassembly of the aircraft takes place in three stages. At first liquids and gaseous substances, many of which are very toxic are removed from different reservoirs. Then dismantling of the equipment is performed in order to isolate all the parts that can be reused. Finally, the plane is completely divided, but before this parts which contain valuable metals and alloys are removed.

We can distinguish the following main stages in the life cycle of an aircraft (the path that passes the aircraft during its existence) (Fig. 1):

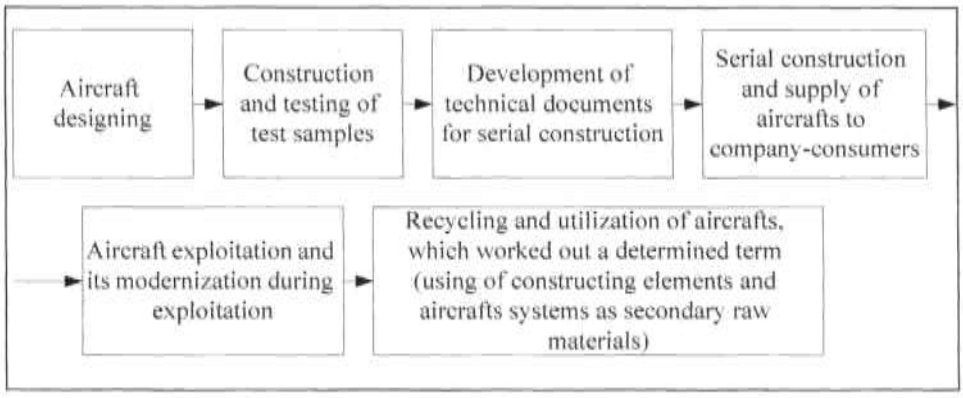

Fig. 1. The main stages of aircraft lifecycle

Each stage of aircraft's life cycle forms a certain area, where this stage is realized. The operation phase of the aircraft is a key stage for its entire life cycle. Stages of aircraft's recycling and utilization make the system closed, and thus provide not only its "sustainability" (full value), but also the development of the system itself.

The problem of proper handling of air transport vehicles, which came out of service that arose relatively recently, has been encountered by all developed countries.

The decisions on the taking out of aircraft from operation in many states are not unambiguous. So, in the United States, most of the aircrafts launched after the Second World War are in a state of preservation, many of them are ready for exploitation. European government bodies are trying to develop such a system of relations with utilization and recycling companies, which would make these processes economically viable for all participants. Today, China, foreseeing a rapid change of the current air transport park, invests $ 2 billion in a plant that can process 50 units of aircrafts per year. Domestic specialists and industry leaders disagree on choosing the only way to use aircrafts that worked their resources. Hundreds of aircrafts continue to operate, despite the extreme degree of wear. Some part of aircrafts has been modernized over the past years: they have been replaced by power units, updated electronic and software fillings. Re-equipment mainly affected military aircrafts. A passenger air fleet that does not comply with the EEC (European Economic Community) standards has to be utilized completely since 2002 [3].

An aircraft, like any other technical object of machine building, is the object of design and is a complex technical system with a developed hierarchical structure. With a systematic approach, solving problems of a certain hierarchy level, requires construction of the entire hierarchy of the system. Therefore, it is necessary to consider systems and subsystems of aircraft of higher hierarchical levels, for example, the transport system and its subsystem – the aviation-technical complex. In its turn, the aircraft is considered as an initial (base) subsystem, where it is possible to allocate subsystems such as glider, power plants, equipment, avionics, chassis system, etc. Each of these subsystems is subjected to decomposition when designing, that is divided into a number of even smaller subsystems (components), elements, aggregates and nodes. Graphically, the hierarchical structure of the aircraft on arranged aggregates can be depicted in the form of a graph tree (Fig. 2).

The aircraft consists of millions of components (parts) that after the aircraft is canceled, must be further processed. In other words, the plane is a huge amount of metal and composite parts that have to fly simultaneously at a speed of 900 km/h (0.85 from the speed of sound is a typical speed of Boeing 787 Dreamliner) at an altitude of 10 km. That is, a couple of millions of parts are manufactured and going into one product – and the plane flies, providing comfort to passengers and profit to owners. However, when the aircraft is out of service, the aircraft itself and its parts become waste. Some of its materials are utilized by automated systems, some require a large amount of manual labor. Part of aviation waste is sent to landfills forever. Some waste is temporarily stored in anticipation of the emergence of appropriate technologies. And such technologies are aircraft recycling and utilization.

The description of the utilization technology begins at the airport of the parking lot or at the base of storage of aviation equipment. Here, the aircraft is a part (a component, element) of a complex transport aviation system in the aviation-technical complex.

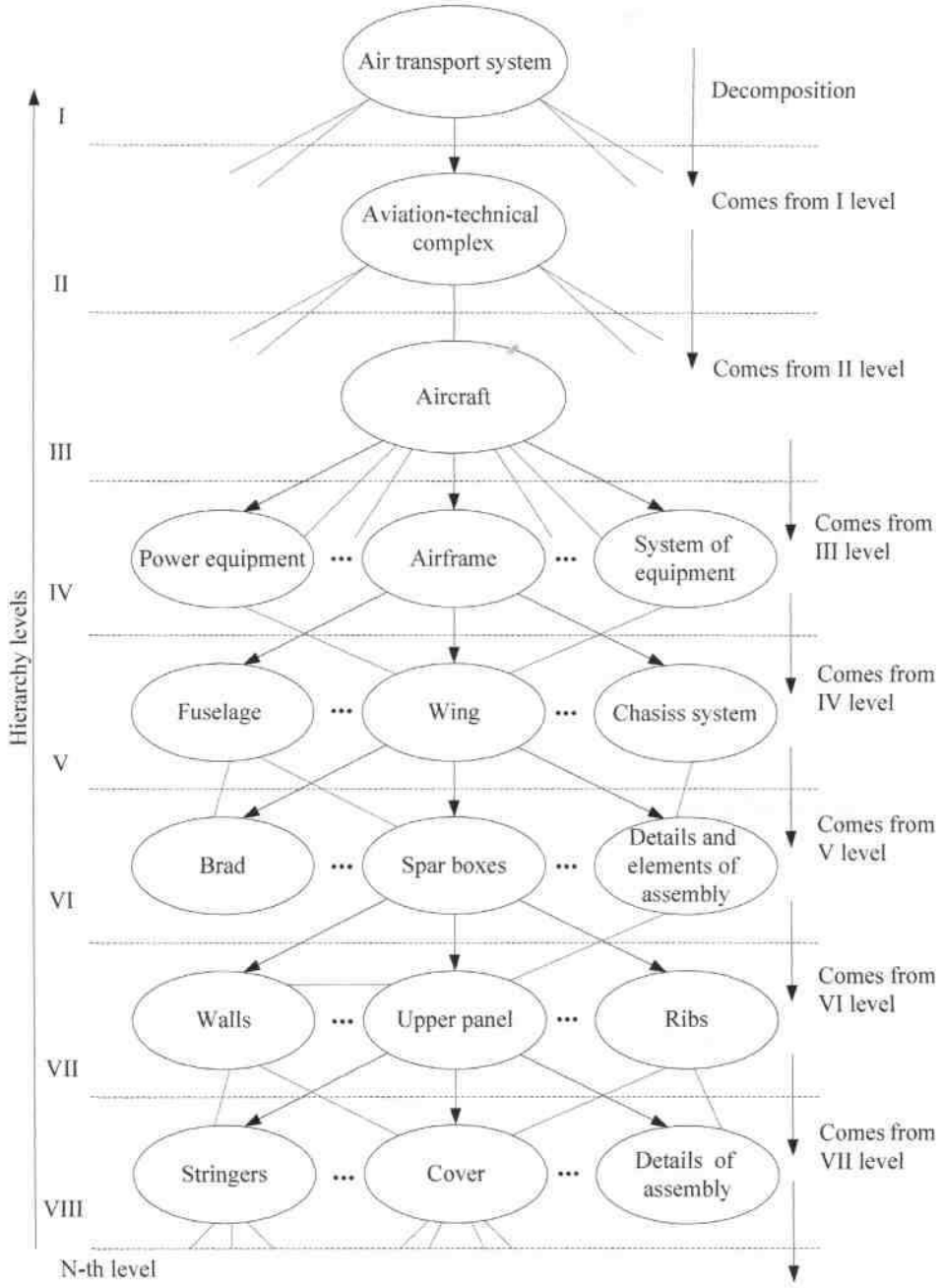

Fig. 2. Fragment of a graph-tree of the hierarchy structure of an aircraft

First of all, the following components are removed from the aircraft (Fig. 3):

- the remaining of fuel that could not be completely drained from the fuel tanks,
- technical fluids used in various systems of aggregates,
- catapult explosive devices,
- technological electronic devices,
- passenger equipment,
- plastic sheathing, lining, etc.,
- auxiliary technological equipment – wires, power and transmission devices of chassis drives, ailerons, flaps, steering controls – hundreds of nodes.

Further processing is individual for each group of materials. Fuselages of aircraft arrive to workshops where black (25%) and non-ferrous metals (more than 70%) are obtained during the process of re-melting. Devices, boards, radio elements are sent for processing to other enterprises.

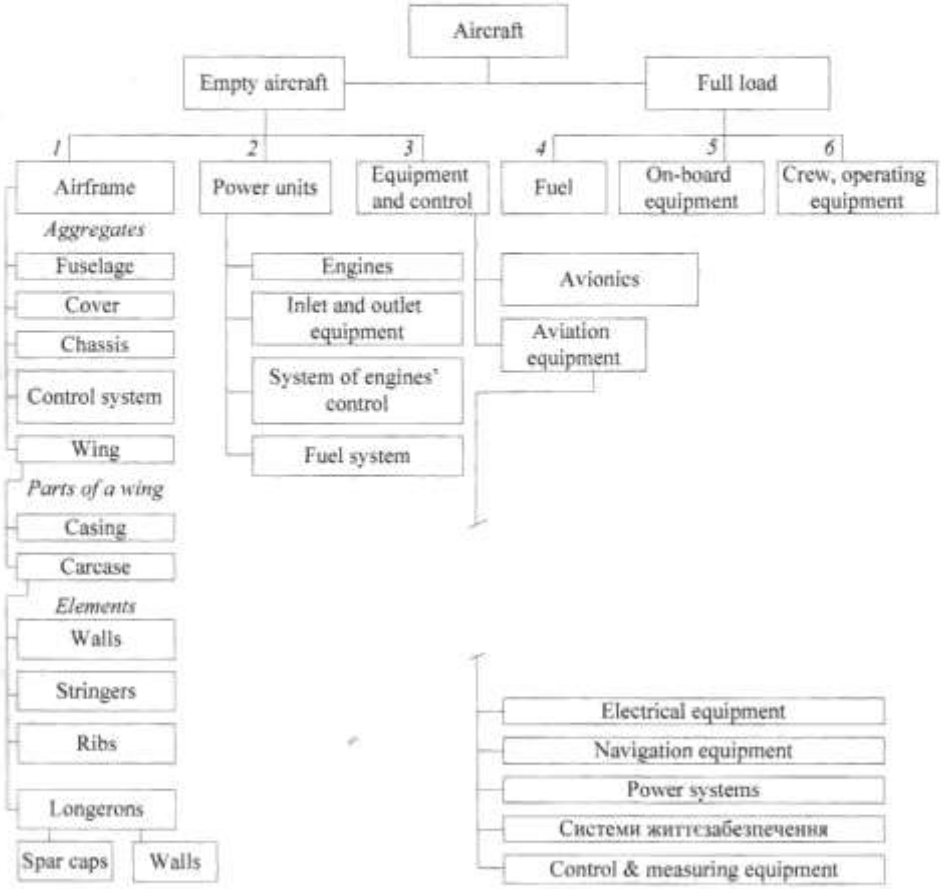

Fig. 3. Morphological composition of aircraft waste

The purpose of processing is to receive copper, tin, silver, gold and platinum from the parts of the write-off computers, navigation equipment, communication facilities. The remnants of the equipment are first handled and sorted out. At the second stage, chemical processing of materials is carried out in technological lines. However, despite of a certain technological level of disposal of aircraft wastes in the world today, in the near future, other technologies are needed for its implementation: instead of metal, the proportion of composite materials increases, and no precious metals are used in such devices. Composite materials consisting of reinforcing carbon fiber mesh and polyamide (polystyrene) fillers in the process of recycling are subject to dissolution.

Utilization of aircrafts apart from the process of their creation is economically unjustified. The cost of materials extracted from the aircraft, in comparison with the costs necessary for its disassembly: the brigade of specialists and equipment must be delivered to the aircraft abandoned at a remote aerodrome; dismantling of aircraft equipment is not only time-consuming, but also related to compliance with the high standards of sanitary safety of the works, collection, storage and export of many (often toxic) materials; further sorting, logistics and recycling are quite costly measures. According to estimates by leading world air transport corporations, by 2030 it will be necessary to update about 35 thousand liners. Each machine requires about 50 tons of metal, hundreds of kilograms of polymers. At the same time, more than 500 aircrafts are annually written down in the industry – the same thousands of tons of aluminum, nickel, steel and polymers.

Aircraft producers have an important task: to optimize the circulation of materials, turning the scope of production and use of the air fleet in a closed loop. Proceeding from the world-wide situation over the past decades, the use of aircraft cycling and utilization processes is an alternative source for obtaining the required airborne parts and components of the aircraft.

Two factors can be traced recently in order to purchase spare aircrafts, maintain its' composition, and also to form price for them. On the one hand, existing spare parts for repairing relatively newly built airplanes and aviation engines continue to decrease, on the other, the same aircraft and engines increasingly deal with spare parts. Both of these phenomena allows air carriers reducing costs without compromising the technical availability of parks.

The prospect of the economic benefits of more efficient use of aviation components leads to a reduction in the budgets for the purchase of spare parts. Details taken from disassembled copies of newer types of aircrafts become cheaper, the cost of newly disassembled spare parts for aircrafts substations has decreased by 10–20%. Today, airlines will continue to get rid of their own stock of air transport components and are increasingly beginning to use pools [5].

CONCLUSIONS

Today, the world and national economy faces an urgent problem of waste recycling in the transport sector. As the trend for the decommissioning of resource aircraft is gaining strength, the industry comes to the need to establish standards for the processing and reuse of materials and components.

Of course, the application of air transport recycling and utilization processes requires highly qualified personnel, necessary equipment, energy costs, territories and

special equipment, but without economic support and subsidies from the state it will be impossible to implement them on their own. Therefore, in our opinion, one of the possible options for solving this problem is the introduction of state recycling programs.

REFERENCES:

[1] Tierney J.: Recycling is garbage. New York Times, № 6, 1996, p. 24–29.

[2] Van Heerden D.-J., Curran R.: Aircraft Disposal and Recycling. Encyclopedia of Aerospace Engineering, John Wiley & Sons, 2010 (on-line access: http://onlinelibrary.wiley.com/doi/10.1002/9780470686652.eae355/pdf).

[3] Ribeiro J. S.: Gomes J. O.: Proposed Framework for End-of-life Aircraft Recycling. Procedia CIRP, vol. 26, p. 311–316, Elsevier B.V., 2015 (DOI: 10.1016/j.procir.2014.07.048).

[4] Brand R., Karvonen A.: The ecosystem of expertise: complementary knowledge for sustainable development. Sustainability: Science, Practice & Policy, vol. 3(1), p. 21-30, 2007.

[5] Green Sky, Aviation and the Environment (2010). Retrieved from http://www.afraassociation.org/NewsDocs/10_GreenSky.pdf.

WSPÓŁCZESNE TRENDY W TECHNOLOGIACH RECYKLINGU I UTYLIZACJI W TRANSPORCIE LOTNICZYM

Streszczenie

Praca poświęcona jest problemom związanym z wykorzystaniem i recyklingiem samolotów wycofanych z eksploatacji i ich elementów. Uwzględniono cechy właściwej obsługi środków transportu lotniczego. Przeprowadzono analizę istniejących metod i technologii, których celem jest racjonalna i poprawna obsługa złomowanych samolotów. Potwierdzono konieczność wprowadzenia systemu kompleksowego wykorzystania sprzętu lotniczego. Uwzględniono problemy ekologiczne i ekonomiczne związane z utylizacją i recyklingiem środków transportu lotniczego i ich jednostek. Znaczenie i wykonalność wprowadzenia programów recyklingu w dziedzinie gospodarki odpadami przemysłowymi zostały właściwie uzasadnione.