REQUIREMENTS ON FUEL SUPPLE FOR CIVIL TRANSPORT AIRCRAFT

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The article is devoted to the issue of aviation fuel.It ounlines a system of fuel distribution and ways of filling them into resorvoirs and aircraft tanks. Also dealt with are the sorts of aviation fuels, alternative fuels as well as protection of the living environment.

K e y w o r d s : fuel, oil, distrribution

1 INTRODUCTION

As human beings need energy for their life, means of transortations alike need various sorts of energy for thir movements. The basic energy for thes movements are found in propellants, which are needed by all types of means of transportation from different aspects. The article is focused first of all on kinds of fuels and comparison or the various sorts in terms of quality, characteristics, distribution, storage, exact procedures of aircraft refuelling, development and also evironmental issues. One of the requirements of aviation fuels is in their resistance to low temperatures. The ability to withstand freezing temperatures depends mostly on the additives preventing it from freening and also complements improving the quality of aviation fuel.

2 BASIC SORTS OF AVIATION FUEL

Dependingon the aviation engine used, fuel is classified into : fuel on aviation kerosene – JET A, JET A-1, JET B, TS-1 and those on the basis of automobile perol or gasoline – Aviation Gas (Avgas).

All the fuel based on aviation kerosene is manufactured by direct distilling of crude oil added by the necessary additives as per the various types of fuel. Among the additives are materials that help achieving thermal stability, required conductivity, lubricatnts, anti-oxidants and non-freezing agents. Fuel on the basis of petrol (Avgas) i sused currently in several types and are divided by octane rating. Older types of aircraft make use of the Avgas of 91 and 80 class and latest types already the Avgas 100LL with a low lead contents and also the Avgas 100.

2.1 Aviation fuel based on aviation kerosene

Aviation fuel is mostly used by modern jet-engines It is similar to light petrol engine, which i sused in the arctical climate, the parameters of which, must, however, meet the strict operational requirements. It also is subjected strict cjheck, as aircraft safety is priority number one, and one cannot afford a malfuction caused by inadequate quality of fuel.

Requirements in terms of the kerosene based aviation fuel quality can be divided into several groups. Assessed are the characteristics such as viscosity, purity, low-temperature characteristics, stability, and contamination with undesired additives. There are lots of specification applicable to aviation fuel, but the most used specification is marked as the JET A-1 (AVTUR) under the title of Aviaton Fuel Quality Requirements for Jointly Operated Systems, which represents the requirements as set by ASTM D 1655 a DEF STAN 91-91. Aviation fuel is added by suitable additives, like the anti-static additive, anti-oxidants, freezing-related liquids and lubrication as well asll anti-corrosion agents.

2.2 Aviation fuels based on automobile petrol

The difference between aviation fuel and automible petrol is relatively small. There are avaition fuels that do not comprise anti-detonation additives with. Octane rating at such engines are no less than 80 or the types having it over 100 containing lead. Several years ago came the introduction of petrol based fuel with MM octane rating over 91, having the same contents as the one of containing lead and marked as 100LL.

As it has been already mentioned, aviation fuel, compared to automobile petrol, is not defferent so much, however, there are facts that make that difference, namely the lower viscosity of aviation petrol and higher beginning of the distilling and its end going lower. Extremely strict are the requirements post on purity. Aviation petrol with octane rating around of 80 is designed mostly for smaller and less performing engines. Pewtrol with lead is used for modern high-performance aviation engines of small propeler-driven aircraft.

In past lead content in lead-based petrol was at 2,11 g/kg. Currently, the maximum range of lead contents is at about 0,75 g/kg. And are labelled as Avgas 100LL. Apart from the octane rating also the performance number, for those of higher octane fuels labelled with 100LL, where the number must be a t a minimum of 130.

3 CHARAKTERISTICS OF AVIATION FUEL JET A-1 AND QUALITY REQUIREMENTS

The JET A-1 aviation fuel is the mixture of carbo-hydrates with boiling point up to 300°C. JET A-1 is a colourlless, but sometimes slightly yellow and odour. JET A-1 is added by various additives improving its quality. The kind and contents of these additives is given by the manufacturer on agreement with the user-customer. It belong to the Class II. In terms

of danger as a flammable liquid by ČSN 65 02 01 and also belongs to Class II.B in terms of bilogical efficiency, as laid down by the guidlines on „Protection of health when working with oil products".

3.1 Hydrokit test

The aim is to check the presence of water in aviation fuel. This is performed by a set of small pots also an extraction vessel, vacuum probe and the reacting whit powder. This test is recording the amount of water higher than 0,0003 percent, which is the maximum allowable amount.

3.2 Milipore test

The aim of this test is to ensure purity of fuel in a storing reservoir. As well as on filling cisterns and checks for filter reliability. The test is performed at the regular cleanings of automobile cisterns, at changes of filtering elements in fuel stores, before and after filtration. It is evaluated and done by the customer designated to perform cleaning and revisions. By comparing the results at the various levels of the filtering chain, one is capable of detecting the source of fuel contamination. Then a written document is developed regarding the results and is held as mandatory part of the cistern documentation. The maximum allowable value of contamination is 0,28 mg/l.

3.3 Conductivity test

Another important is checking fuel conductivity. To this purpose the SICK MLA 900 measurement device i sused. The fuel sample is extracted from the reservoir and is subsequently measured. At thyis type of testing, i tis important to make sure the electric connector is net wet while the lowering of the testing probe into fuel. By submerging it into fuel, the display will show the values of conductivity in pS/m as well as the temperature of the measured sample. Allowable values are between 50 and 600 pS/m.

3.4 Visual checks of the product

The sample is always and regularly taken from the sedimented fuel. It is poured into a clear glass bottle and one is to make visual evaluation of the contents for mechanical impurities. If the sample is contaminated, then it comes to finding the sources of it. The contaminated sample or the results of testing must be reported to the senior official, who then decides on the steps to be taken thereupon.

3.5 Mesuring density and temperature

This type of check is performed with a measuring device called aerometer, which operates on the principle of Archimedes´ law. It is submerged into the tested liquid and density is stated therupon. When measuring density and temperature, one has to determine the referential density at 15 ℃ and then it is compared to the actual data in the reservoir. When receiving new fuel, maximum allowable difference between the densities is 2 $kg.m^{-3}$. If the difference is larger, the fuel is not suitable and the senior official should be notified on the findings obtained.

4 DISTRIBUTION OF AVIATION FUEL, STORAGE AND FILLING INTO AIRCRAFT

Fuel transport to storages is realized with cisterns carried by automobile or railways, on ships and fuel pipelines. Ideally, small airports are best supplietd by automobile cisterns, either from economic or efficiency points of view. The same form is used for providing fuel to the Košice Airport.

Supplying fuel though a fuel pipelines is most suitable for large airports, i fit is close enough to refineries. This way, it reduces the need to build fuel reservoirs directly on the airport. This form is used to supply airports such as Gatwick, Standted and Heathrow in London. The fuel pipeline is efficient in cases of transporting fuel even at greater distances, e.g. delivery of JET A-1 to the Säo Pauolo Cumbica airport from the Säo José dos Campos refinery. The second, most widely used solution is distribution by sea or train. Prague airport makes use of the railway tranasport. Frankfurt airport is supplied by aviation fuel with tankers with capacity of 2200 m^3 on a daily basis.

Fig.1 Automobile tank

Fig. 2 Railway tank

Fig. 3 Tanker


Fig.4 Fuel pipeline

4.1 Storage of fuel

Throughout the year, demand on fuel is oscillating. In summer, with high intesity of traffic, fuel consumption is higher by roughly 50% as it is in winter. Depending on the facts mentioned, it is reasonable to state the storage capacity at airports. When determining the number of storage units, one has to take into account the technological reserve of fuel, daily rush hour consumption and the reliabiolity of fuel supply.

When storing fuel, it is important to observe technological and structural measures, in terms of safety, dangers and threats to surface or ounderground water, rock structure and soil. Aviation fuel is stored either in overground or underground tanks. The decision which tank to build is to be based on concrete facts and results of several studies.


Fig. 5 Over ground tank

Fig. 6 Underground tank

4.2 Filling fuel into from storages into aircraft

There are two possible ways, namely b automobile tanks or stabile hydrant-based systems. In the beginning, let me give an account of the many of the advantages of the latter system. They are built into the ground, directly on the handling area. Stable systems can be moved by several meters in a night, if necessary.

Both ways are used depending on the size of the airport and the amount of the fuel supplied. For example, it is more advantageous to install a stablesystem on small airports, where there is a great number of aircraft, which will be able to go directly to the site on their own. The hydrant-based system is of advanatge also on heliports with several stands on the apron. However at all the systemsinuse i tis issential to cut costs of acquisition, operation and foremostly improving safety at filling the fuel. At airports such as Airport Košice, fuel is exlcusively distributed by automobile tanks due to the low number of aircraft. Stable systems are most frequently installed at large airports, wwith large number of aircraft, with respect to economic advantage and operational faktors.

Dispenzer is a small and light vehicle, which is fed by a hydrant-base distribution system. I tis equipped with instruments for reduction of the operational pressure of fuel in the system. Pressure of fuel at filling an aircraft is the maximum of 2 MPa. Average pressure of filling is 0,35 MPa. Further instruments housed in the dispenzer include gauges of the fuel amount, filters and also a vertically adjustable platform. When filling fuel via the dispenzer, installed in the connecting elementis a Deadman type safety valve, which is to ensure, in case of malfunction, immediately stop the fuel delivery. Aircraft designed for mostly for long-haul aircraft, in need of supplying fuel from four, up to five tanks. Of great importance are the procedures applicable to filling an aircraft, so that no tanks could hinder the entire process of aircraft technical handling actvities.

At airportrs it is mandatory to properly decide as to which system of fuel filling is to be adopted. Cost can increase also depending on the length of distributionlines or the number of stands installed on the airport. To airport management, the most important indicator is the time or return on financial assets. Costs of building andinstalling the hydrant-based systems are much higher in the beginning, compared to those incurred with the purchase of automobile tanks. For this

reason it is important to have a suitable project developed covering the process of building.

4.3 Iveco Stralis- Stakota Automobile tank

The automobile tank is to ensure pumping fuel from and into storage tanks. I tis designed to deliver fuel into large or small aircraft. The automobil chassis carries a tank containing 25 000 litres of fuel. Such a mobile fuel filling station is capable of filling aviation fuel into aircraft either from the upper or the lower side of the wing.

Fig. 7 Iveco Stralis- Stakota Automobile tank

5. ALTERNATIVE FUELS

Crude oil has alwys been the source of aivation fuel, as it had the properties suitable for propelling aviation engines. It also offers an advantageous combination of performance, availability, energy content and price. In view of the fact that crude oil belongs to exhaustible sources of fuel, its price keeps rising, pressing the fuel industry to re-orientate itself and look for alternative sources of fuel. At the same time, one has to take into account that safety and reliability of aircraft engines are to be provided at the highest possible level. Protection of the living envrionment when using alternative fuels is also of primary importance. Among the sources of alternative fuels are aviation fuels from fossil sorurces, bidodiesiel fuels and derivatives of bio-jet fuels.

5.1 Aviation fuel from fossil resources

As stated above, every sort of fuel is currently manufactured from crude oil, however only some percentage is made of oil sands mostly available in Venezuela and Canada. Fossile resources are the ones sucha s coal or earth gas, which can alo be used as fuel. If the resources obtain positive evaluations from both practical and economic aspects, then they can be regarded as sources of aviation fuel.

5.2 Bio-diesel fuels

Bio-diesel fuels are also considered as an alternative source of fuel, containing some animal fat,oils of plants and also fruits. The world is different in term of application, e.g. Asia uses coconut oils as a resource, Europe it is the Swede olejná and the USA is oriented on soya bean oil, which is regarded as the greeates source in this areas. Recent years started research into water algae also tested as a potential source of bio-oil. Animal fat and phytogenic oils in themselves are not resources of oil, however, if added by metylalcohol during thew process, called as pre-esteriphification, then yes. Bio-oil is demand, as it can be used at low temperatures. Fuels for aircraft freeze between from -40℃ to -47℃, however, at bio-oil, this value is close to zero.

5.3 Derived bio-jet fuels

Bio-mass is aslo considered as an alternative source of fuel. Its disadvantage is that its structure contains lots of oxygen. Etanol and bio-diesel were mixtures of components for petrol and crude oil. In most countries, its use is expected to rise due to governmental licences to diversify sources of energy. In a jet engine, chemical nenergy is changed into mechanical work, so as to case the aircraft to move and take off. Energy released by way of combustion at high temperature with the reaction of oxygen, is termed as a chemical reasction. Energy relaeased in this process is called the combustion heat. Derivative fuels palivá have lower lower contents of energy than carbo-hydrates, thus flight range might be shorter as a result.

6. PROTECTION OF THE LIVING ENVIRONMENT

Already a small amount of fuel leakage may have serious consequences. Small spillages are more frequent, and often escaping attention. Yet a small amount can cause big damages, to water, and also combining water and fuel may bring about strong pollution of water, thereby deteriorating quality of water and limiting its for further use.

Separator of oil products is used to prevent leakage of fuel into public sewerage. canalization. Torrential water is saved by canalization system feeding into a retention tank. The outlet of the tank can be closed, if fuel leakage occurs. The fuel layer from the surface is separated and water gets refiltered. Rain water sewerage is the most critical part of the aircraft handling area, where fuel is often mixed and drained away. Outflow of fuel may prove dedly to fish, living creatures and rastlinstvo..as itaviation fuel is poisionous. If its gets into water, it causes oxiygen contents to reduce, killing all the living creatures and–If fuel is spilled over, the spot is covere by and absorbent, of which the VAPEX i sused most frequently.

Fuel leakage mgiht occur also as a result of bad technical condition of equipment, lacking regular maintenance and checks. At every airport, the staff is responsible for carrying ou regular maintenance and repair to all equipment so as to ensure safet, reliability

and minimize leakage of course. Regula mantenace and repair of aircraft can be performed only at areas designated to that purpose, namely in hangars equipped with separator in case of fuel leakage.

7. CONCLUSION

It is said that „fuel is the blood of aviation". Well, despite of the rich sources of this „blood" there has been found nothing tha cannot be exhausted. Knowledge of the issue has lead me to state that improving alternative sources of fuel remains inseparable part of the industry of transportation. Testing synthetic liquids, manufactured from earth gas performed in Touluse has only confirmed that use of alternative fuels in future is more than problable.

Basic requirements to fuel supply are in ensuring purity, economy and efficiency of delivery for aircraft at high level of safety, ensuring proportionate supplies in storage tanks and protection of the living environment. Fuel should not be harmful to agricultural products,nor water, nor soil. One of the main motivations is economic awareness and striving for the preservation of the quality of our environment.

A great number of different tests have been performed on alternative fuels only to confirm the fact that traditional aviation fuel remain too expensive and insufficient. However, despite of all, it can be assumed that aviation kerosene will remain the most used aviation fuel even in the years to come.

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