

**TRANSPORT. AVIATION TRANSPORT**  
**TRANSPORTS. AVIĀCIJAS TRANSPORTS****INFLUENCE OF THE QUALITY OF OPERATIONAL LIQUIDS FILTRATION SYSTEM ON THE SAFETY AND RELIABILITY OF HYDRAULIC SYSTEM****DARBA ŠĶIDRUMA FILTRĀCIJAS KVALITĀTES IETEKME UZ HIDRAULISKĀS SISTĒMAS LIETDERĪBU UN DROŠUMU****Māris Hauka**

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*Keywords: hydraulic system, fluids, pollutants influence***Introduction**

Civil aircraft is based and operated in different conditions, which depend on geographical location and atmospheric state of the particular location. These conditions determinate specific features of aircraft's technical maintenance.

**Description and classification of the climatic zones**

Atmospheric state and its saturation with organic and non-organic compounds is subjected to climatic zone of the terrestrial globe. Each zone's climate can be described using following factors:

- Aerial circulations and flows;
- Circulation of humidity and warm;
- Afflux and reflux of solar energy;
- Saturation with non-organic vapors and compounds;
- Presence of organic compounds.

Climatic areas can be classified as follows:

- Polar zone;
- Temperate zone;
- Dry steppe zone;
- Half-desert, desert zone;
- Humid torrid zone;
- Subtropical zone.

**Safety and reliability of hydraulic system**

Safety and reliability of the hydraulic systems assemblies are subjected to operating conditions. Safety of hydraulic system is subjected to well timed technical maintenance and monitoring.

The quality of operational liquid does not necessarily proportionate to time these assemblies have been operational, rapid aggravation of the quality of operational liquids can be caused by

different overloads, cavitations, deviant temperature rate, admittance of alien materials in liquid, wear-out of assemblies.

Thereby it is essential to constantly monitor the state of operational liquid. It is achieved, for example, by equipping hydraulic system with differential pressure indicators, which flags switch if pressure difference in intake and discharge ports is out of range.

### Fineness of operational liquid

To ensure safety and reliability of hydraulic system, it is being equipped with fine fining filters.

Filters can manage with mechanical inclusions by blocking them and holding them inside filter, but filters can't manage chemical inclusions and their compounds.

Harmful effects of chemical inclusions are being neutralized by improvers in operational liquids composition, but these improvers have limited ability to neutralize and hold back those chemical inclusions. Operational liquids must be replaced before it becomes too aggressive and saturated with chemical inclusions.

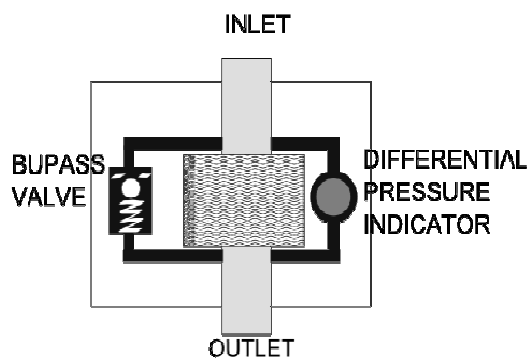


Fig. 1. Filter

### Analysis of filtering precipitations

Analysis of aircraft's filtering precipitations shows, that main pollutants of operational liquid are quartz and different metal oxides (up to 80%), organic inclusions do not exceed 20- 25%.

Main portion of non-organic pollutants are atmospheric dust and components of anti-friction paste. These inclusions mainly consist of quartz and feldspar dust. The rest are oxides of iron, aluminum and other metals. Pollutants also contains large amount of highly dispersed spent of metal products and their compounds, rubber, plastic, different fibers and other fractional inclusions. The component parts of this dust have heightened hardness.

### Filter of operational liquid

The objective of operational liquid's filters is to detach mechanical inclusions.

Filter's main component is the filtration element, which can be made of metal, frilled synthetic fibers wickerwork or made of specialized paper.

Any filtering material possesses collateral hydraulic resistance, which proportionate viscosity of operational liquid and its temperature and is especially high if the temperature is very low or the filter is much polluted.

Filter can create sufficient resistance in hydraulic system which greatly affects flow of operational liquid. To avoid such occurrences, filters are equipped with safety valve, which opens if pressure difference between filtering element's inlet and outlet exceeds set parameters.

Filters can be equipped with a peripheral differential pressure control device which, similarly as safety valve, monitors difference of operational liquid's pressure on filtering element's inlet and outlet. The control device is constructed as a button which pops out and stays in this position even

after pressure rate changes. The objective of this device is to inform technical staff of filter's condition.

### **The influence of polluters**

Unstrained polluters (dimension 2,5- 1,5  $\mu\text{m}$ ) gets into joints of paired parts of assemblies and their rotating operational areas and causes increase of frictional forces or even seizing of some assemblies. With increasing wear-out, the inner leakage of operational liquid also increases, which further more decreases the entirety of hydraulic system and causes exigency of frequent charging of hydro-accumulator (turning on its pumps), thus further more overloading hydraulic system's pipelines and assemblies and can cause their break-down.

Presence of polluters can cause blocking of jets and pipelines. Polluters deteriorate the quality of oil coat, but rupture of oil coat intensifies wear-out of paired assembly parts and their warm-up due to friction, which, for its part, causes even more rapid deterioration of oil quality.

Factors of exploitation, like pollutants in operational liquid, cavitations, choking of operational liquid, has great influence on operational liquids temperature, which can be particularly dangerous, if hydraulic system runs near its highest marginal rate ( $\sim 20\text{-}25\text{ }^\circ\text{C}$  below highest marginal value).

Thus even a small increase of temperature rate can cause considerable malfunctions in hydraulic system.

### **Features of airborne hydraulic system**

Closest to airborne hydraulic system type is so very wide spread car's hydraulic braking system. Yet technical performance and responsibility of those two systems differs radically.

Aircraft's hydraulic system is assigned to execute control over aircraft- it's steering, braking, lifting and lowering wheels and operating nearly all most liable tasks.

Failure of hydraulic system is inadmissible; in case of a general failure air crash is inevitable.

This explains complicity of airborne hydraulic system, which technologically ensures compensation of breakdown in different assemblies using up to three parallel backup circuits. Larger amount of backup circuits would make system too complex, unreliable and heavy. This build-up maximally decreases chance of a general failure without excluding failure as such, for complete exclusion of possibility of a failure is impossible.

### **Influence of a computer-managed control over hydraulic system's load**

Computer managed hydraulic system of flight control and stabilization can give multitude various commands to control booster in short span of time to, for example, decrease vibration on wing, which will cause sufficient increase of load on hydraulic system. On the other hand- computer managed hydraulic system of flight control and stabilization precludes dangerous flight rates and conditions.

### **Aircraft hydraulic liquids**

Most common petroleum-based hydraulic liquids:

- Mil-H-5606: Mineral base, flammable, fairly low flashpoint, useable from  $-54\text{ }^\circ\text{C}$  to  $135\text{ }^\circ\text{C}$ , color – red;
- Mil-H-83282: Synthetic hydrocarbon base, higher flashpoint, self-extinguishing, backward compatible to Mil-H-5606, color- red;
- Mil-H-87257: Developed from Mil-H-83282 liquid to improve its low viscosity at low temperatures.

Phosphate-ester:

- Skydrol- is an advanced fire resistant aviation hydraulic fluid. There are various lines of Skydrol including Skydrol 500B-4, Skydrol LD-4, and Skydrol 5. Not compatible with petroleum-based fluids, will not support combustion, color- light purple.

Special, stringent care is required when handling aircraft hydraulic fluid as it is critical to flight safety that it stay free from contamination. It is also necessary to strictly adhere to authorized references when servicing or repairing any aircraft system.

## Conclusion

Hydraulic system is one of the most liable systems in an aircraft, and therefore its technical condition must be monitored with special caution.

Hydraulic system is very complex and it contains vast amount of mechanical assemblies- springs, flow dividers etc, the possibility of failure of these elements is comparatively high. Furthermore- weight of each of these elements must be minimal and with minimal failure possibility

A very strong influence on the safety and reliability of hydraulic system has operating liquid. The quality of operating liquid can drastically affect reliability and safety of all hydraulic system.

### ***Hauka M. Darba šķidrums filtrācijas kvalitātes ietekme uz hidrauliskās sistēmas lietderību un drošumu***

*Hidrauliskā sistēma ir viena no lidaparāta svarīgākajām sistēmām, kas realizē tai uzticēto lidaparāta vadības nodrošināšanas funkciju. Svarīgi ir, lai tā būtu vislabākajā stāvoklī, sistēmas sarežģītība pieprasa kvalificētus cilvēka resursus. Darbā tiek izskaidrota hidrauliskās sistēmas atbildība, un kvalificēta apkalpojošā personāla nepieciešamība. Šķidrums filtrācija nepieciešama, lai nodrošinātu hidrauliskās sistēmas nevainojamu darbību, tāpēc šajā darbā tika apskatīta darba šķidrums filtrācijas kvalitātes ietekme uz hidrauliskās sistēmas lietderību un drošumu. Tika aplūkots, kā klimatiskie apstākļi un svešķermeņu tipi ietekmē hidrauliskās sistēmas darbību un kādas ir iespējamās šīs ietekmes izraisītās problēmas. Svešķermeņi var radīt daļēju, pilnīgu sistēmas atteici, kā arī radīt neparedzētus bojājumus citās sistēmās. Secīgi, darba šķidrums kvalitāte jāpaaugstina. Šajā nolūkā, paaugstinot darba šķidrums kvalitāti, tiek izmantoti dažāda tipa filtrējošie elementi (pamatā izdala 2 divus elementu tipus – papīra un metāla), kuri ļoti veiksmīgi filtrē mehāniskos piemaisījumus, bet nespēj ietekmēt ķīmisko kvalitāti. Gadījumā, ja darba šķidrums ir eļļa, tās ķīmisko kvalitāti nevar mainīt mehāniski ar filtrāciju un nākas to periodiski nomainīt.*

### ***Hauka M. Influence of the quality of operational liquids filtration system on the safety and reliability of hydraulic system***

*Filtration of operation liquids is needed to ensure systems flawless operation. This term paper inspects influence of filtration quality of operation liquids on safety and reliability of hydraulic system. Also includes examination of influence of climatic conditions, types of inclusions in operational liquid and threats, caused by it, and influence of other conditions on hydraulic system's safety, reliability and wear-out. Mechanical inclusions can cause systems full or partial failure and cause fault to other systems. Was inspected use of filters to increase quality of operation liquid and types of filtering elements (these are paper an metallic) which protects hydraulic system of mechanical inclusions in operational liquid, thus increasing operational liquid's mechanical quality. Was inspected presence of improvers in operation liquid which protects hydraulic system of chemical inclusions, which mechanical filers are unable to affect, thus increasing operational liquid's chemical quality. Was inspected exigency of qualified technical personnel due to high liability of aircraft's hydraulic system.*

### ***Хаука М. Влияние качества фильтрации рабочей жидкости на полезность и надёжность гидравлической системы***

*Гидравлическая система является одной из важнейших систем самолета, поскольку обеспечивает его управление. Сложность системы диктует необходимость привлечения только квалифицированного персонала для ее обслуживания. Фильтрация рабочей жидкости необходима, чтобы обеспечить нормальную работоспособность гидравлической системы. В работе рассмотрено влияние качества фильтрации рабочей жидкости на полезность и надёжность гидравлической системы. Проанализированы действие и влияние климатических зон и примесей на объект исследования, поскольку примеси способны привести к частичной или к полной потери работоспособности гидравлической системы. Для того, чтобы повысить качество рабочей жидкости, использовались элементы фильтрации разного типа, которые очень успешно справляются с механическими примесями разных видов, но бессильны против химических соединений.*