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Toxic And Microbial Environmentin The Aircraft Fuel Tank For The Human Factor

Maria-Giorgiana KHAN GAINA*
**"POLITEHNICA" University of Bucharest, Doctoral School of Aerospace Engineering,*
Polizu Street 1-7, sector 1, Bucharest 011061, Romania,

Abstract: *This paper focuses on the dangers assoicated with entry into aircraft fuel tank for the human factor. The risk of contamination with harmful substances and bacteria it is very high.After detailed analysis of the working environment to which a mechanic is exposed in the aviation world, it has come to light that the aircraft fuel tank is very dangerous and may affect human health.*

Key Words: *Kerosen, Bacteria, Identification, Control, Human factor, Aircraft fuel tank.*

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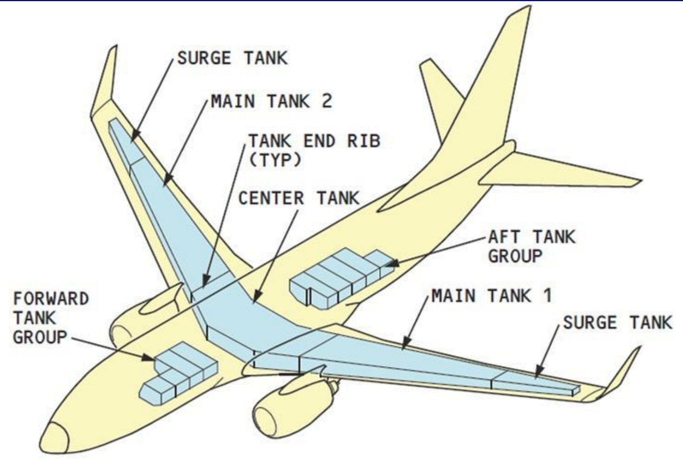
I. Aircraft Fuel Tank

A large number of inspections and modifications of the aircraft's fuel tanks (fig.1) as well as their adjacent systems must be made inside them [6],[7]. The necessary maintenance and repair tasks must be performed by technical personnel, who must physically enter the fuel tank, where it is exposed to many environmental risks. These potential risks include: fire and explosion, toxic and irritating chemicals, oxygen deficiency, and the limited nature of the fuel tank. To prevent associated injuries, maintenance organizations as well as operators need to develop specific identification and control procedures to eliminate hazards.



FUEL TANK CAPACITY		
	LB	KG
MAIN TANK 1	8630	3915
MAIN TANK 2	8630	3915
CENTER TANK	28,803	13,066
TOTAL	46,063	20,896

NOTE: FUEL DENSITY
6.7 POUNDS PER US GALLON
0.8029 KILOGRAMS PER LITER

Fig. 1 - Aircraft fuel tanks [6]

Maintenance and repair personnel entering the aircraft's fuel tank to carry out inspections or modifications are closely related to various and many potential hazards. These are: exposure to toxic and flammable chemicals, atmospheric conditions with potentially harmful health and the limited configuration of the tank. Operators and repair stations can protect technical personnel from these hazards by developing safety procedures [6], [7].

In order to successfully prevent associated accidents, both operators and technical staff must take into account:
→ possible accidents / dangers in the fuel tank;
→ preparation to enter the fuel tank;
→ the conditions necessary to enter the fuel tank;
→ emergency response plan.

II. Hazards In The Fuel Tank

The most common and recognized danger of the tank is the fuel itself. Fuel is a flammable liquid that can ignite under certain environmental conditions, temperature and vapor concentration. The temperature at which the vapors of a flammable liquid can "ignite" is known as the flash point. A hazardous concentration of vapor is present when a fuel vapor reaches a level known as the Lower Flammability Limit (LFL) or Lower Explosive Limit (LEL). These limits are usually expressed as a percentage of the volume. Fuels below LFL / LEL (Lower Flammability Limit / Lower Explosive Limit) are considered too weak to burn. If the fuel vapor concentration exceeds the upper flammability limit or the upper explosion limit, the fuel is considered too rich to burn. A concentration of fuel vapor between these two limits is considered to be in its flammable range, it will ignite and burn in contact with an ignition source. One of the best ways to control unwanted fires and explosions is to to keep the fuel vapor concentration below the LFL / LEL (Lower Flammability Limit / Lower Explosive Limit), thus preventing it from reaching its flammability range [6], [7].

Other flammable chemicals may also be present during maintenance and repair work in the fuel tank. Chemicals with a low flash point (less than 70 ° F (21 ° C)), such as methyl kenone (MEK), are more dangerous than fuel in the tank, so their use must also be be strictly controlled [6], [7].

Chemicals, including fuel, can also present a toxic or irritating hazard. In high concentrations, the fuel together with other hydrocarbons can affect the nervous system, causing headaches, dizziness and lack of coordination. Chemicals can cause chronic health problems, which can affect the liver and kidneys, skin irritations if left unchecked.

The physical characteristics of the fuel tank can create fire, explosion and toxicity hazards. The entrance is through an elongated hole that is less than 2 ft (0.6 m) long and 1 ft (0.3 m) wide. Although the interior dimensions of the fuel tanks vary considerably with the central wing tank, which is the largest, all fuel tanks have a limited volume. A relatively small amount of a chemical inside one of these enclosures can create significant levels of flammability or toxic fumes [6], [7].

The wing tanks usually have a single access hole between each frame of the section. The inner part of the wing fuel tank provides sufficient clarity for the technical staff, who have access from the waist up, leaving their feet outside the access hole. The tank becomes smaller as it advances towards the outside of the wing, the access being significantly reduced, and the technical staff can only enter with their head and arms. The central tank can be large enough to allow full access for technical staff.

III. Kerosene

Kerosene is the fraction of crude oil that distills between 150 - 275 ° C [8]. It is a clear liquid, made up of hydrocarbons containing between 6 and 16 carbon atoms in the molecule. It has a density of 780 - 810 kg / m^3.The flash point is between 37 - 65 ° C, and the self-ignition temperature is 220 ° C [8].The lower calorific value is 43.1 MJ / kg, and the upper 46.2 MJ / kg [8].Kerosene is not miscible with water, but is miscible with petroleum solvents [8].

TABEL 1.*Compositional Data on Representative Kerosene-Range Materials [9]*

	8008-20-06	64742-81-0	JET A	JP-8	91770-15-9	1013116-80-7
API gravity	41,8 – 44,9	39 – 45,5	37,2– 46,1	37,0 – 46,7	45,3	43,8
Aromatic content, vol.%	15,5 – 19,6	18 – 21,4	11,6- 24,0	13,6 – 22,1	18	19,3
Olefin content vol%	1,3 – 2,5	1,0 – 1,66	0,0-4,1	0,6-3,0	1,0	1,7
Saturates content	79 – 82	77,2 – 82	71,9-88,4	74,9-85-8	81	79
Distillation, °F						
10%	320 - 377	329 – 406	294 – 394	333 - 390	332	368
Final	468 - 538	451 – 568	404 – 910 (90%)	419 – 474 (90%)	495	550

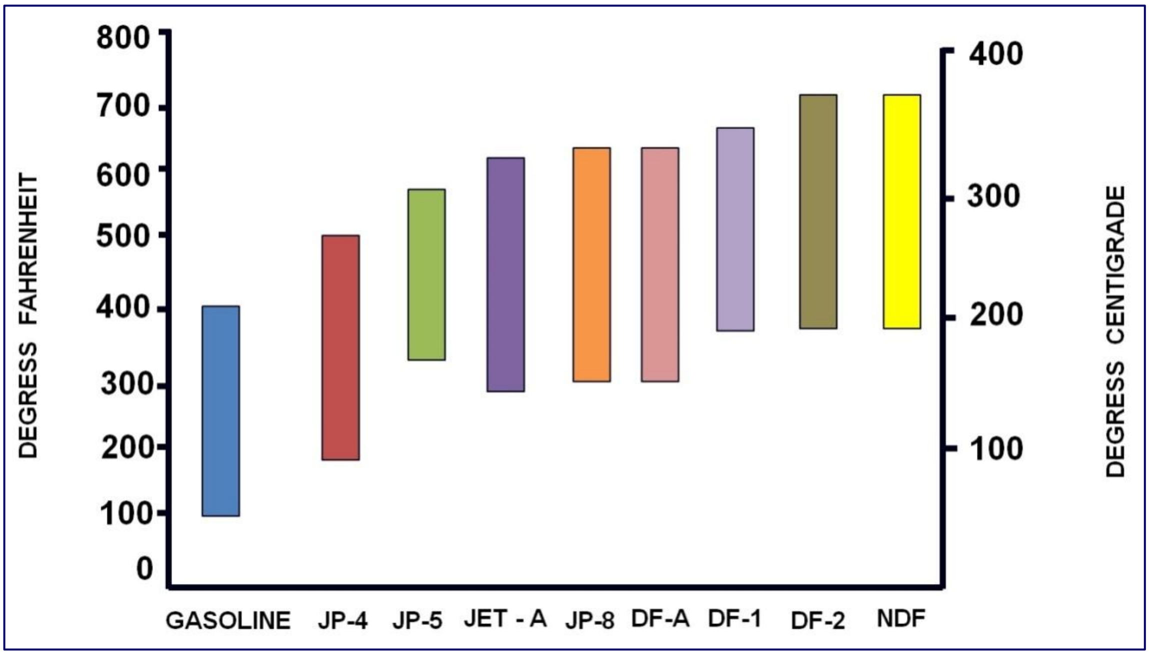


Fig.2 - Boiling ranges of fuel [9]

An aircraft maintenance mechanic is exposed to an inhalation of kerosene : 1 – 15 mg/$m^3$and in the realistic worse case will be : 420 mg.d^{-1}on an surface of 420 cm^2[9]. The most common health problems due to kerosene are chemical pneumonitis and vomiting, due to the inhalation of the vapors in the aircraft fuel tank. In some cases, if the technical staff is more sensitive, inhalation of kerosene vapor can lead to heart attack.

IV. Microbial Environment

The aircraft fuel tank must be inspected to determine the overall status and identify and repair obvious defects to increase the reability of the aircraft. Fuel tanks are inspected for contaminants such as water or microbial growth, sediment etc. A common and serious potential contaminant of the fuel is water. Water can accumulate and contaminate the fuel of the aircraft at any depot or refueling the aircraft fuel tank. An accumulation of water within a fuel tank can provide an atmosphere for microbial growth. Microbial growth produces a variaty of chemicals that are harmful to fuel systems including: hydrogen sulfide, protein coating, organic acids etc. Microbial growth as a brownish silty substance with a gelatinous consistency, called “Apple Jelly” [1], [2], [3]. Microbial growth can cover the components of the fuel systems and can eventually cause clogging of filters of the engines and pipes, causing deficiencies in the fuel system or anomalies and deterioration of the protective layer which can lead to corrosion [1], [2], [3].

To prevent all the negative effects, drain the aircraft fuel tank frequently. Use the specified fuel drain probes and use available test items to detect signs of microbial growth. If large quantities of jelly are present in only one of the tank, a thorough inspection of the fuel must be carried out on the rest of the aircraft fuel tanks.

Good hygiene fuels involves the implementation of a “rigid cleaning regime” assessed for risk. The risk of contamination is increased in hot and humid conditions, especially when the fuel comes from a source that has fewer quality control controls.

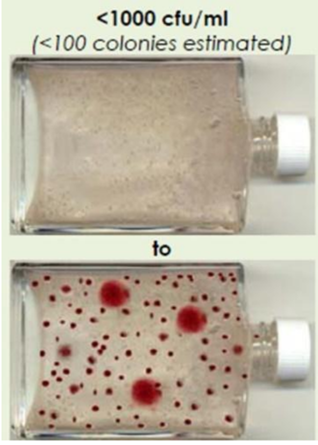
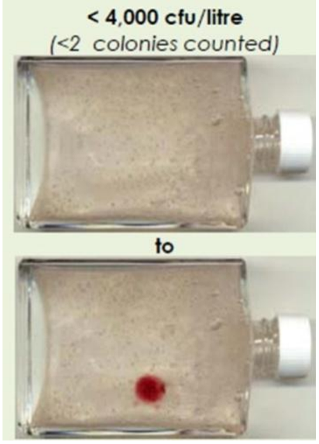
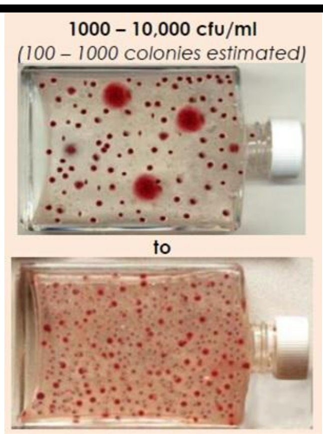
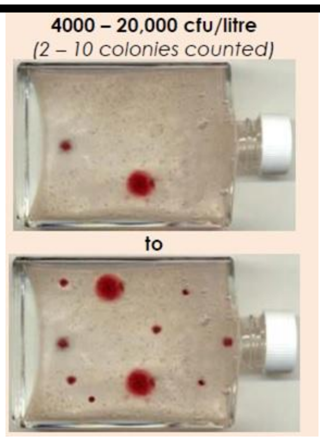
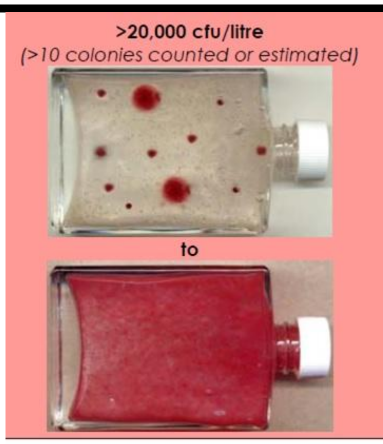
V. Aircraft Fuel Testing Procedure

An aircraft which have no history of microbiological contamination, can be considered – low risk, this being the ideal scenario. Unfortunately, there are other aircrafts that show the possible appearance of bacteria. For increased aicraft safety the test should be performed regardless of the scenario. For performing the aircraft fuel test, I preferred to show the test with MICROBMONITOR2 [10], described below:

Fig.3 - Aircraft fuel test procedure with MICROBMONITOR2 [10]

To interpret the test of the aicraft fuel are presented some IATA [4] compliant verification advice:

TABEL 2.*Interpretation of results [4]*

DATA ANALYSIS	WATER (IF PRESENT)	FUEL
► ACCEPTABLE		
► MODERATE		
► NOT ACCEPTABLE		

For the human factor to use this proceduse is simple. The aircraft mechanic need to use gloves and avoid touching the inside of the bottle. After use the bottle, the aircraft mechanic need to wash the hands, because the bottle contain microbial growth. For the aircraft mechanic health, he must have a proper hygiene every time he use/touches the bottle. The battle with the microbial growth have not yet been shown to have a drastic negative on the human factor.

VI. Conclusions

Following this analysis of work in the aircraft's fuel tank, it appears that this working environment is very harmful to humans exposed for a long period of time. Therefore, the main purpose of this paper is to show this problem and to try as much as possible to reduce the negative effects on the human factor.

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