OIE bulletin

Identifying and testing suitable and safe aircraft disinfectants for use on cargo planes that transport animals

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Summary

Millions of animals are transported around the world by aircraft every year. Although appropriate veterinary checks are in place, the risk of spreading undetected diseases, particularly a new and emerging disease, always remains. Yet there is no global standard procedure to deal with the problem of cleaning and disinfecting cargo planes that transport animals. This challenge is made more difficult by the fact that many chemicals may adversely affect the structural integrity of such planes or the materials used in them; for example, by corroding the metals used in their manufacture (aluminium, titanium, steel), making rubbers and plastics more brittle (seals and sealants, carpets, seat covers), adversely affecting electrical wiring and cabling and affecting the behaviour of all of these materials during a fire. Thus, there is a need for a safe yet effective disinfectant to ensure that aircraft which transport animals are free of any infectious particle capable of spreading disease yet remain completely airworthy. The authors believe that the investigations described in this paper should assist in this demanding task.

Keywords

aircraft disinfection – airworthiness – animal disease – cargo planes – disinfection – infectious disease.

INTRODUCTION

Millions of animals are transported around the world by aircraft every year. Companies specialising in the transport of animals are highly sophisticated in terms of animal welfare and have implemented high standards for their safe transportation. Nonetheless, transporting animals by air may still pose a risk of infectious disease spread, even if appropriate veterinary checks are carried out. This is particularly the case with new and emerging diseases. Perhaps surprisingly, there is no standard global procedure to deal with an animal disease scenario when transporting animals that may later be discovered to have been infected; for example, during outbreaks of foot and mouth disease, African swine fever, classical swine fever (also known as hog cholera), and many other infectious diseases. In such situations, the aircraft are grounded, and measures must be taken to ensure that they are free of infectious particles before they can be used for further transportation. Faecal material, urine, blood and other body fluids must be cleaned up and the whole aircraft disinfected.

Such thorough cleansing is never easy, even in less challenging environments. Before the plane can be cleared for further flight, it must be judged free of infectious particles capable of spreading the disease by the Competent Authority (Veterinary Services). In addition, it must be approved as safe to fly (airworthy) by the chief aircraft systems engineer. If these conditions are not met, the aircraft will remain grounded. The authors believe that the investigations described in this paper should be helpful in such situations, enabling the aircraft to be safely returned to service as soon as possible.

Fig. 1. Material testing by Lufthansa Technik Laboratory Services. *Source: Lufthansa Technik, Laboratory Services*

MATERIALS AND METHODS

Lufthansa Technik AG (LHT) is part of the Lufthansa Group (LH–Group) and is internationally licensed by the European Union Aviation Safety Agency (EASA) as a Part 145 maintenance, production and development organisation and a Part 21 design organisation. This means that LHT has the capability to test and authorise different disinfectants and related procedures for use in aircraft interiors, based on international standardised testing methods **(Fig. 1)**.

A comprehensive evaluation of various potential disinfectants was conducted by LHT Central Laboratory Services in Hamburg. Several substances and agents were tested for aircraft component compatibility. The core task of material testing in this context was to test the effectiveness of the substances in question, as well as their potential to damage aircraft components and affect the safety and airworthiness of the plane. A panel of disinfectants was tested in accordance with the relevant aircraft specifications (Boeing Specification D6-7127). Tests were also based on Aerospace Material Specification (AMS) 1452 to check for harmful effects to the aircraft's interior and structure. The most important aspect of these checks was to ensure that the disinfectants that were finally recommended by LHT would not compromise aviation safety in any way and would ensure that the infectious agent was destroyed.

As a result of their formulation, disinfectants can cause serious damage to the materials used to manufacture aircraft. For example, they may be based on acids in high concentration **(Figs. 2 and 3)**. Therefore, the disinfecting compound and its effect on various materials, such as metals, rubber, elastomers, plastics and other materials (which make up seals and sealants, electrical and avionics cabling, carpets, windows, seat covers, etc.), must be thoroughly tested and approved for use in aircraft cabins and cargo holds by the chief aircraft systems engineer, who is responsible for the plane's airworthiness. In aircraft specifications such as Boeing Specification D6-7127 and AMS 1452, mentioned above, the plane's manufacturers specify exactly how specific substances are to be tested in short-term as well as long-term studies. For example, to check for corrosion, the disinfectant must be tested by saturating a filter paper with the chemical in question. This filter paper is then 'sandwiched' between two sheets of aircraft aluminium and left for a week. This experimental set-up is also exposed to alternating humid conditions and dry warm temperatures.

For a wider range of metals, another corrosion test must be performed: the Total Immersion Corrosion Test for Aircraft Maintenance Chemicals. This involves testing the chemical on materials made from aluminium, titanium, magnesium and steel for possible reactions.

Examples of critical corrosion

Fig. 2. An extremely corroded lavatory floor fitting. *Source: Lufthansa Technik, Laboratory Services*

Fig. 3. A corroded seat track. *Source: Lufthansa Technik, Laboratory Services*

Disinfectants must also be tested on plastics and elastomers, to see whether they make these materials more brittle or affect their tensile strength or volume. Testing is also carried out on the materials making up the plane's electrical and avionics systems, with a focus on cabling insulation.

Materials are also usually tested with disinfectants that have been nebulised by pumping air through the liquid to create a fine spray. The disinfectants must pass this nebuliser test. In special cases, testing may involve complete electronic devices being nebulised with the disinfectant.

To ensure the health and safety of the disinfectant user, only trained personnel with appropriate protective equipment may carry out disinfection in an aircraft. These personnel may face a risk not only from the animal disease, if it can be passed from animals to humans (zoonotic), but also from the disinfectant, which may cause a health hazard. Occupational safety always takes priority.

Materials

Usually, disinfectants are tested in the concentration indicated by the instructions of the disinfectant's manufacturer (ready-to-use solutions are used for disinfection, so concentrates are diluted accordingly). In individual cases, if a concentration range is given, the concentration is adjusted within the range limits and then tested.

Figs. 4 & 5. Materials from the cabin interior used to test disinfectants. *Source: Lufthansa Technik, Laboratory Services*

Methods

The following tests were carried out on the proposed disinfectants:

- the tests relevant to material compatibility and safety in Boeing Specification D6-7127
- the disinfectant, aircraft, general purpose test (AMS 1452)
- the total immersion corrosion test for aircraft maintenance chemicals (American Society for Testing Materials [ASTM] F483)
- the stress crazing of acrylic plastics in contact with liquid or semi-liquid compounds (ASTM F484)
- a rubber test
- the tests relevant to material compatibility and safety in the Federal Aviation Administration (FAA)/EASA Rules (FAR/CS 25, Appendix F).

Standard test method for stress crazing of acrylic plastics in contact with liquid or semi-liquid compounds (ASTM F484)

The substance to be tested is applied to a plastic strip under tension to induce the tendency to crack under stress (stress crazing).

Rubber test

Rubber (silicone) is tested for its characteristics of 'stretch', tensile strength and possible expansion **(Fig. 6)**. The test is based on Boeing Specification D6-7127.

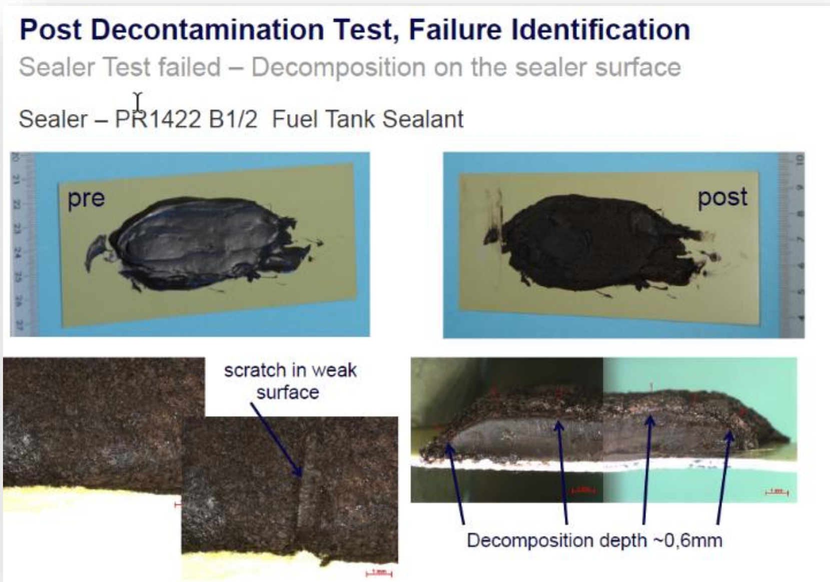

Fig. 6. Rubber test. *Source: Lufthansa Technik, Laboratory Services*

Since disinfectants may adversely affect the behaviour of materials such as seat covers, side wall panels and carpets in a fire, flammability tests must be conducted **(Figs. 7 and 8)**. These tests are based on FAA/EASA rules (FAR/CS 25 Appendix F). Treated and non-treated samples of each material are compared side by side and must meet the standards for flammability.

Figs. 7 & 8. Flammability testing with a Bunsen burner. *Source: Lufthansa Technik, Laboratory Services*

In addition to the tests specified by the aircraft manufacturers, LHT also carries out intensive testing on specific materials that are used in Lufthansa aircraft.

Evaluated test procedures are used to examine the interactions between typical aviation materials such as metal, glass, electrical conduits, synthetics, windows and composite materials.

Lufthansa engineers approve the disinfectants used on Lufthansa aircraft. Only current and constantly updated test procedures are applied.

Standard operation procedures (SOPs) for cleaning and disinfection have been implemented within the Lufthansa fleet by:

- integrating the SOPs into manuals for cockpit crews
- providing information on notification procedures (the chain of reporting) to the operations control centre and to dedicated authorities at the port of destination (POD) or port of entry (POE), and on the products and generics that should be used
- supplying work orders for the staff who disinfect the planes and for aircraft maintenance and ground personnel
- providing a certificate of release to service (RTS) to approve the continuation of regular flight operations.

DISCUSSION

Currently, there are no global SOPs for the disinfection of cargo aircraft that have transported animals infected with pathogens. These pathogens, if zoonotic, can affect the crew, as well as the personnel who are servicing or cleaning the aircraft while it is stationary. Another threat may result from improper or inadequate disinfection. Animals subsequently transported in the same aircraft are at a high risk of becoming infected and thus spreading the disease throughout the world. LHT has therefore tested disinfectants for their suitability in these highly challenging situations.

So as not to impair airworthiness during and after disinfection on board the aircraft, it is imperative to ensure that the use of a disinfectant has no negative effect on any of the materials used in the construction of the aircraft, particularly on highly sensitive materials. If this cannot be guaranteed, the aircraft may not be released for further flights. Moreover, all occupational health and safety standards must be met so as not to endanger the personnel who carry out the disinfection or subsequently service and maintain the aircraft on the ground.

Acid-based disinfectants, especially in high concentrations, may result in serious damage, such as corrosion, to a plane's electrical supply system or wiring. Moreover, the behaviour of materials in a fire, during or shortly after disinfection, can change dramatically and may further increase damage to the aircraft.

Conclusion

So far, the only successfully tested product for the disinfection of aircraft materials is Aldasan 2000®, which belongs to the family of formaldehyde-glutaraldehyde-based agents. However, more than one application results in the ablation of magnesium. Aldasan 2000® should therefore only be used as a single application, e.g. if there is reasonable suspicion or evidence of the causative agent of an animal disease in the aircraft. Multiple use of Aldasan 2000® for cleaning at regular intervals is not possible, due to the high risk of corrosion. It is thus very important to carry out this process in three consecutive steps:

- ***a)*** basic cleaning
- ***b)*** disinfection
- ***c)*** neutralisation.

'The result of the disinfection procedure must in any case meet the requirements of the Competent Authorities (Veterinary Services)'

In consultation with the Competent Authorities, Lufthansa has developed SOPs for aircraft disinfection, which regulate the procedures on board in the event of having transported animals infected with a disease. The results achieved by this work and the procedures themselves are available at Lufthansa and Lufthansa Cargo destinations worldwide, published in the Station Emergency Response Plan (SERP). The SOPs are freely available in a document on board Lufthansa and Lufthansa Cargo aircraft and can be downloaded using the following QR code:

https://doi.org/10.20506/bull.2019.NF.3012

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■ September 2019