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Improved detection of flaws of glider aircraft in terms of technical operation

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Abstract

The development of global civil aviation progress, constantly improving technology and material of manufacture of aircraft. Issues Damaging multilayer structures made of composite materials, are of paramount importance in the operation of aeronautical engineering at the present time. The physical nature of failures and damage to the airframe design is known, but as the volume increased significantly the use of composite materials, their experience has not yet been sufficiently studied. In this article provide an overview of modern and efficient methods of fault detection glider aircraft.

Introduction

In the operation of flying apparatus composite elements of the structure are subjected to various external shocks, leading to mechanical damage: as a result of lightning strikes, the impact of hail and rain, as a result of landing-mechanical effects. Carbon items are subject to galvanic corrosion. When maintenance and repair items are made of polymer composite materials (PTP), you must adhere to a set of principles and requirements. Visual inspections should be conducted with a special care. An impact on the composite panel as a rule leaves only faint traces on the surface, however they may be damaging the supports or causing delaminating. Scratches can be disastrous for the composites, as well as contribute to the ingress of moisture inside, which can lead to a breach of trim and flight control surfaces to flutter. At high altitudes the moisture freezes, causing separation from or damage of the support with PTP bundles of ice. Thus, the most typical and frequent defects of the composite (including honeycomb) structures are:

- “Non” (peeling the shell of a cellular filler);
- “Moisture in honeycomb”.

Detection of these defects in the operation is very difficult and generally is performed in the process of repair. But as for modern aircrafts overhaul is absent, it is necessary to raise the standard of diagnosis of PTP in the operation to more advanced level. Especially difficult is identification of areas of construction with the moisture in sotah which do not lead to the peeling plating. During operation there is no manual nondestructive testing for water ingress in structures of PTP. While the water in honeycomb leads to peeling of plating.

Note the following basic NDT methods used in monitoring of composite materials (CM):

- Acoustic (ultrasound - the echo-pulse, shadow, inpact by a hammer, spectral, Lamb waves, acoustic emission, etc.). Is about 70% of all methods;
- Radiographic, including X-ray tomography;
- Laser (contactless excitation and reception of acoustic oscillations);
- Holographic interferometry;
- Thermal (infrared) method;
- Neutron radiography (control of water content in the cellular structures in the operation of aircraft);
- Optical methods based on exploitation of reflections at the grazing angles of incidence of electromagnetic radiation - «D-sight» and «EOL».

To search for “Non” (detached from the shell of a cellular filler) acoustic impedance method of nondestructive testing or organoleptic using a simple hammer are used. To search for moisture in honeycomb used thermal method, and radiographic technique. Radiation monitoring is not suitable for thin materials, poor absorption of ionizing radiation.

To determine the impact zone of destruction of honeycomb structures from the CM on the helicopter blades acoustic percussion method, first developed and implemented in the aviation industry of the USSR is used.

Thermal (infrared) methods used to control non and detachment of cell panels, as are well as corrosion detection in aircraft structures. This method is also used for the control of water content in the honeycomb structures of aircraft in operation.

Radiation methods are used mainly to control the degree of destruction of honeycomb structures from the CM after the shock of mechanical loads in service. The method of neutron radiography is used to control water in the honeycomb structures.

Nondestructive testing method for determining water content in the cellular structures of aircraft

It was shown that the ultrasonic method was most effective in the control of water content in the honeycomb structures of the aircraft compared with the radiography and infrared methods. This method allows us not only to identify zones of water, but measuring the number of the honeycomb aggregates of water, to control the process of removal of moisture from the unit cell and monitor the quality of its removal. Control of honeycomb aggregates is carried out directly by plane, as well as in a hangar and in field, including testing in winter - when warm airfield honeycomb unit by the heat source.

A rapid method for nondestructive testing of water content in the honeycomb structures of aircraft in the operation, which allows not only to determine its existence, but also to assess the amount of water in the unit was developed. Using the experience of OAO «Vnukovo Airlines», in AIRWORTHINESS CENTER GosNII GA has been developed and introduced into service installation for ultrasonic testing of water in honeycomb structures - UKVS-1. "

Ultrasonic testing equipment includes: ultrasonic flaw detector (using a serial flaw detectors in the high frequency 10 ÷ 15 MHz range), a local immersion bath with a special high frequency ultrasonic transducer 10-15 MHz; the container with a device for emitting the liquid bath in a local (pump) and its discharge; control panel and the battery voltage to 12V (or AC power supply for 12V). All equipment (except for battery) is placed in diplomacy. The set is presented in Fig.1.

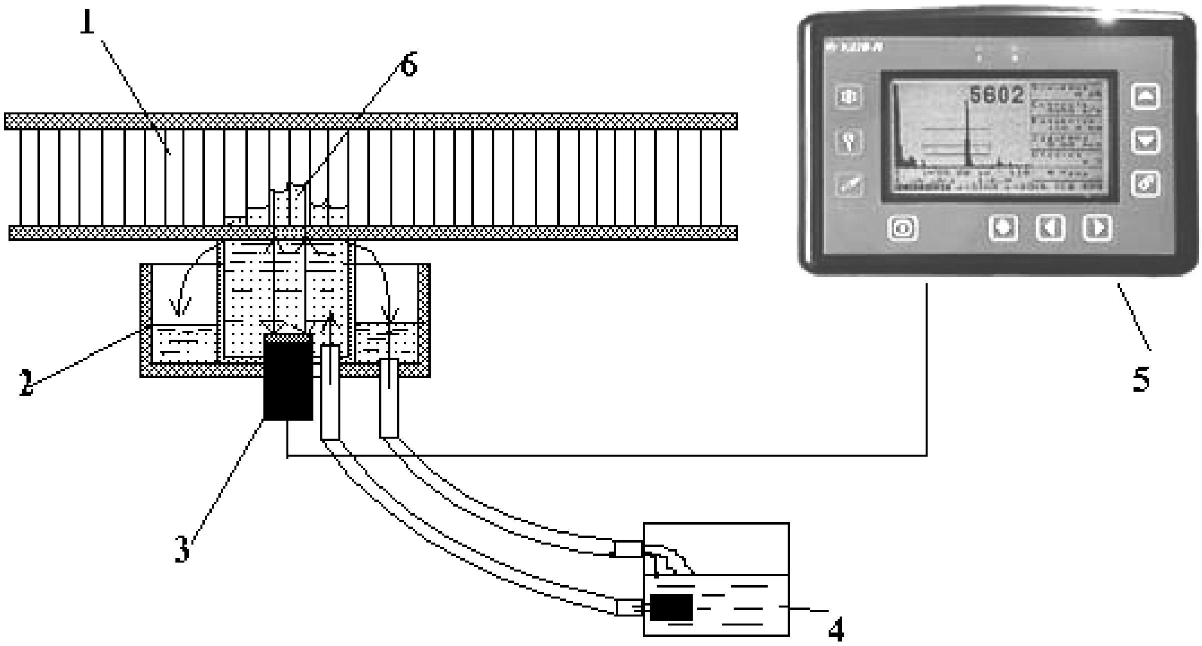

Fig.1. **Installation for ultrasonic testing of water in honeycomb structures: 1 - the honeycomb panel, 2 - a local immersion bath, 3 - the ultrasonic transducer, 4 - the capacity to pump and drain a contact liquid, 5 - ultrasonic flaw detector 6, water in honeycomb**

Output result - the distribution of water on the surface of the unit and its amount is recorded on a computer as an «C-scan» image.

To the lower surface of the honeycomb panel is pressed a local immersion bath, which consists of two sections: the inner, in which are placed the ultrasonic transducer and a pump which supplies the contact liquid (water), and external, through which the liquid is poured into a special tank of about 2 liters. The transducer is connected to the flaw detector.

Testing is performed by ultrasonic echo-pulse method. Ultrasonic oscillations (CPO) excited the transducer, pass through a layer of water in the immersion bath, the lining honeycomb panel, the mobile unit of water (if available), and after reflection from the surface of the water in the honeycomb, are picked up by the same transducer. In the flaw detector, at the beginning and end of the scan, you can see two impulses - the first and second reflection of CPO in the immersion plating bath of honeycomb panel (including the delayed scan).

After clamping the local bath to the surface of the structure, the operator scans the entire surface of a honeycomb unit with a step of ~ 10 mm. In the case on the screen of flaw detector appears echo from the surface of water in honeycomb and alarm sound (light) detectors flaw detector, the operator measures on the flaw detector screen a liquid column height with an accuracy of 0.5 mm and notes the cell with water on the surface of the compartment.

The results of the measurements - the water level in individual cells and their locations on the unit, the controller puts on the sketch. This is the total quantity of water in the aggregate and at the same time the problem of documenting the results of monitoring is solved.

Practice has shown that the quality of the flaw detector - its radial resolution, the type of ultrasonic transducer, the sensitivity control define the minimum level of detectable water in honeycomb.

A special program of computer processing and recording the results of ultrasonic testing of water in the cell aggregates of the data obtained in the form of images of type «C-scan» was developed.

As noted above, the detection method of cell water observed on the surface of the shell of the tested unit cell, which facilitates and accelerates the process of its subsequent removal and repair of the defective zone has been developed.

Conclusion

We believe that the establishment and widespread introduction of user-friendly and adapted to real conditions effective methods, monitoring tools and their tailored to the wishes of engineering and technical staff and operational requirements and technical documentation enables:

- Enhance flight safety;
- Increase the productivity of water detection in honeycomb structures and detection of the epicenter of destruction;
- Enhance the culture of control of composite airframe structures aircraft and make the diagnosis more convenient;
- Reduce finance and labor.

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Orlaivio sklandmens techninėje priežiūroje naudojamos defektoskopijos gerinimo būdai

Reziumė

Pasaulinė civilinės aviacijos pažanga skatina nuolat tobulinti technologijas ir lėktuvų gamybos medžiagas. Ištirtos daugiasluoksnės kompozitų struktūros, kas ypač svarbu aeronautikos inžinerijai šiuo metu. Fiziniai gedimai ir žala sklandytuvų dizainui yra žinoma, tačiau kadangi jis padidina naudojamų sudedamųjų medžiagų tūrį, jų naudojimo patirtis dar nėra pakankamai ištirta. Straipsnyje pateikiama orlaivio sklandmens gedimų aptikimo šiuolaikinių ir veiksmingų metodų apžvalga ir monitoringo priemonės, kurios leidžia padidinti saugos lygį, kontrolės produktyvumą, pagerintų orlaivių sklandmens kontrolės kultūrą, padaryti patogesnę orlaivių diagnostiką, sumažinti medžiagų ir darbo sąnaudas.

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