Development of ultrasonic squirters

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Abstract
This paper is given to development center for new squirter unit, for non-destructive testing of aviation products made of carbon fiber. The first section of this article provides the requirements for general and ultrasonic testing. The following part is a description and selection of carbon composite CFRP used for aviation parts. In the last section, there is design and illustration of practical ultrasonic testing of water squirters and other practical use of it. At final data processing, were compared data from first and second squirter.

Key words: Ultrasonic, Squirter, NDT, composite

1. Introduction

In general, non-destructive testing (NDT) is important final process which can decide, if the final product or device is capable of safe operations. Acceptable part can be put into operation right after testing.

Ultrasonic testing is one of the most used method of NDT for determination of internal defects, both volume and planar defects (crack, delamination…). Surface defects can be detected by ultrasound only partially and with special surface waves, which are not used to detect internal defects.

2. Physical basics of ultrasound

The ultrasonic wave is a mechanical wave of frequency above 20 kHz (normally used from 1 to 20 MHz), which spreads in the environment due to its elastic properties. For transmission, reception and processing of ultrasonic signals, is used ultrasonic device with the appropriate probe. The device produces short duration pulses of high voltage which excites mechanical oscillations in the transducer of the probe at a frequency in the ultrasonic range. These vibrations propagate throught the part as a sound wave that can bounce back and be received again (the reflection method), or go through the material and be received to a second probe (TTU).

With proper setup and calibration of the instrument, can be determine the distance to any defects, by the distance of the defect echo from the initial pulse on the screen. According to the amplitude of the echo from the defect, it is possible to evaluate its relative size.

3. Immerse testing

At the immersion testing the part is immersed into water which then serves as a coupling medium for transmitting ultrasound waves from the probe to the tested material. Sometimes it is necessary to add extra substances to water, which prevents the formation of bubbles, bacteria and algae. Immersion testing can be divided into several testing techniques: full immersion see Fig. 1, partial immersion, through the bath water, space, or spray, which will deal with this contribution.

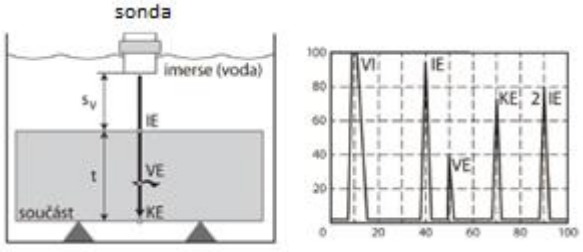

Fig. 1. *Arrangement in immersion testing, VI – a pulse, IE – interface echo, KE – back wall echo*

For immersion testing has to be used special probes, which must be in waterproof case.

3.1. Tested material

Test sample thickness 5 mm was made from the composite CFRP, with artificial defects, which are single-layer, double layer and with the intermediate layer of glass located at depths of 2 and 4 mm, see Fig 2. This material was chosen with respect to the necessity of the use of composites in the aerospace industry.

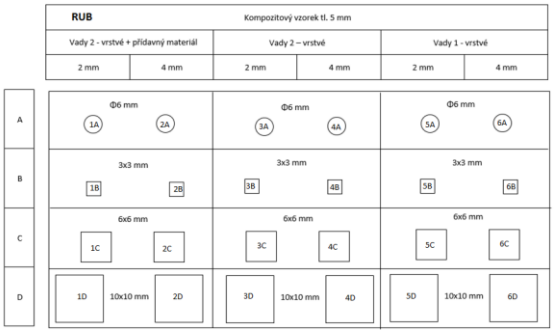

Fig.2. *The specimen of carbon composite (CFRP)*

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4. Design and testing of squirters

Squirters are at ATG s.r.o. designed with the constant need to increase the speed and quality of NDT inspection in aviation industry. Due to very large parts, such as wings and fuselage parts is in these days necessary to inspect by squirter because it is not necessary to build large and expensive tanks. The aim is to reach inspection velocities up to 1 m/s.

At squirter chamber design is important to prevent turbulent flow and ensure laminar flow in chamber and in water column as well because ultrasonic waves in these conditions can spread better and chambers are not stressed too much.

For this experiment was chosen pulse echo technique with defect echo set at 80% FSH, defect was measured with 6 dB drop method, water pressure 0,2 bars. Probe wat Technisonics ISL-0502-HR, non-focused, high damped, 5 MHz, Ø of the transducer 6.3 mm.

4.1. Design of first squirter

Design of the first squirter of POM (polyoxymethylene) was simply made at 3D printer Fig.3. Diameter of nozzle was 6,8 and 10 mm, also simply variable, due to thread.

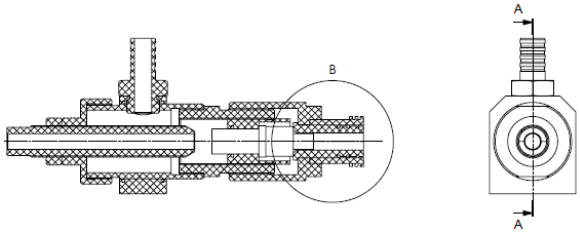
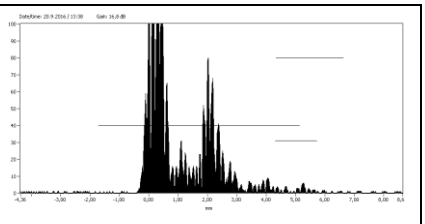


Fig. 3.*The first model of squirter*

After testing and evaluation of the data, squirter was evaluated as unsatisfactory, since it showed a high noise and echoes was wide Fig.1, which could be caused by turbulent flow of external thread of the nozzle. Based on these results was designed squirter number 2. Sec 4.2

Table 1. *Defect evaluation 3A- A scan*

PE 3A
16 % (noise)
16,8 (-15)dB
2 (depth)
6,6 (b)
6,4 (h)
13,98 (SNR)



4.2. Design of new squirter

A new squirter was developed to minimize sharp edges and transitions, therefore we chose the conical shape of the nozzle and the place of threads are all connected by inserting through the small clearance and high precision manufacturing, Fig.4.

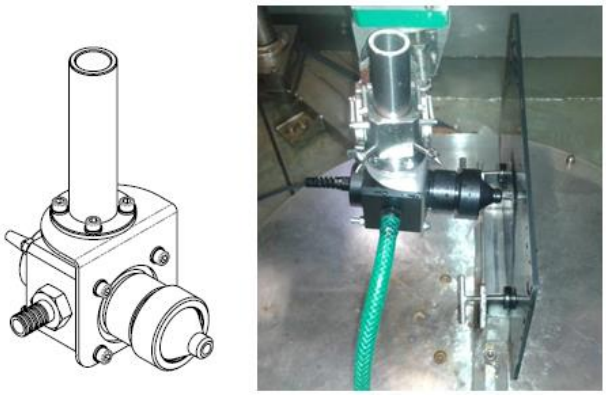
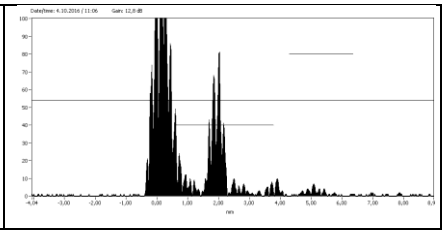


Fig. 4. *The new model of squirter*

This squirter exhibited low signal noise, high signal to noise ratio and higher precision of defects sizing.

Table 2. *Defect evaluation3A- A scan.*

PE 3A
10 % (noise)
12,8 (-15)dB
2 (depth)
6,1 (b)
6,3 (h)
18,06 (SNR)



5. Conclusion

Work on this development takes two years, and now it is checked whether the second squirter chamber meets all the requirements for the aerospace industry.

At verifying at sample of CFRP were found all the defects with the required precision. Noise in all defects was to 12%, and the gain of 5 - 10 dB lower than the previous chamber.

For now, squirter is satisfactory, and the development will continue by dynamic testing.

References

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