COMPARATION BETWEEN NONDESTRUCTIVE TESTING METHODS FOR THE ALUMINIUM BRAZED PIECES

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Abstract: *Presented paper refers to different control methods used in aluminium brazed joining because of possible defects. Low joining complexity permits exact damages position in relation with materials geometry.*

Keywords: aluminium, alloy, NDT, brazing

INTRODUCTION

Nondestructive testing represents an important part of quality testing that identifies material discontinuities without material stereometries modification. Based on acoustic and ultra acoustic emission, ferromagnetism, penetrate radiation or capillarity phenomena's, macrostructurale heterogeneity can be detected on surface or inside the studied material.

These examinations methods are used especially in material quality assurance and less in material structure study. Concerning SR EN 12799 "Nondestructive testing of hard glue joining" [1], for aluminium alloys the following methods are indicated:

- optico-visual examination;
- penetrat liquid examination;
- immersion ultrasonic examination;
- penetrant radiation examination.

INSPECTION METHODS USED IN HARD GLUE JOINING

1. Optico-visual examination

This method represents the most simplest examination method performed only by visualization or with the help of optical instruments.

Visual examination method:

1.1 Free eye examination:

- the eye is more sensitive at yellow-green light;
- adequate light intensity: 800-1000 lux;
- maximal working time: 2 ore;
- detected elements: corrosions, cracks (by shape and orientation), porosity, welding seam defects (results can help in other nondestructive testing)

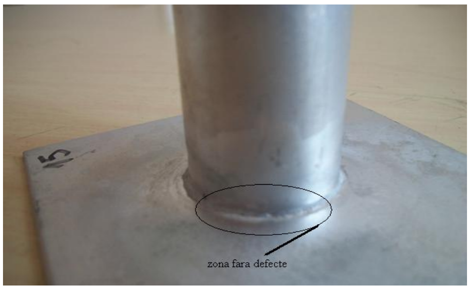

Fig.1 Optico-visual examination

1.2 Optico-visual examination with optical instruments:

- optical instruments permits image zooming of the studied discontinuities or difficult to access zones inspection;
- it is important to know the discontinuities types and the corresponding zones;
- initial surface cleaning of the studied surface must be done;

This inspection method can use the following instruments:

- microscop;
- boroscope - used for low diameter cylinder inspection or inner complex volumes. Examinated surface area is about 25 mm^2 which is placed at about 25 mm from light source. Constructive dimensions of the boroscope has dimensions between 2.5 mm up to 19 mm and up to several meters in length.
- endoscope - represents a superior optical system with a high intensity light source. Examined surface can placed at about 4 mm distance, endoscope length is between 100 mm up to 1500 mm, and the diameter starts from 1.7 mm
- flexiscope - is a boroscope made from flexible optical fiber. Using this instruments, corner zones can be inspected or different pieces with sharp shape modification. Working zone is between 600 up to 3650 mm and the diameter between 3 to 12.5 mm.

Fig.2 Examination using the endoscope

2. Penetrating fluid examination

Method is based on capillary penetration of a liquid with high wetting capacity in pores, cracks, and other surface discontinuities or surface vicinity that communicates with surface.

As principle, penetrating fluid defectoscopy has the following steps:

- mechanical cleaning;
- capping;
- degreasing;
- thin layer coating of the studied surface with a high wetting capacity liquid named penetrant liquid. This liquid penetrates in all surface discontinuity.
- water cleaning of the analyzed surface;
- surface drying in hot atmosphere;
- application of a developant liquid in order to extract the penetrating liquid;
- colored defects are analyzed and studied in order to register the defects;

Method is applied to control:

- any nonmagnetic metallic parts with superficial defects which are not visualized by magnetic defectoscopy;
- metallic pieces exposed to fatigue solicitations;
- nonmetallic material pieces;

Minimal discontinuities dimensions able to be evidenced by this method is 0.01 mm in width and 0.03 - 0.05 mm in depth [2];

Fig.3 Penetrating fluid examination

Advantages*:*

- very simple;
- cracks and blank best method for nonferrous material quality control;
- adequate in automatized testing;

Disadvantages:

- high quantity of penetrant and developant liquid;
- low detection power of discontinuities.

3. Imersion ultrasonic examination

Imersion ultrasonic examination represents a nondestructive control method used for internal defects investigation [3].

Examined piece is introduced into a liquid with a contact medium role. At this method, the detector is not in contact with the examined piece. The control method is working on a multiple control axis and in real time.

The immersion ultrasonic method principle consists in piece and detector liquid plunge. In this moment, an ultrasonic pulse is emitted perpendicular to piece surface from the top zone.

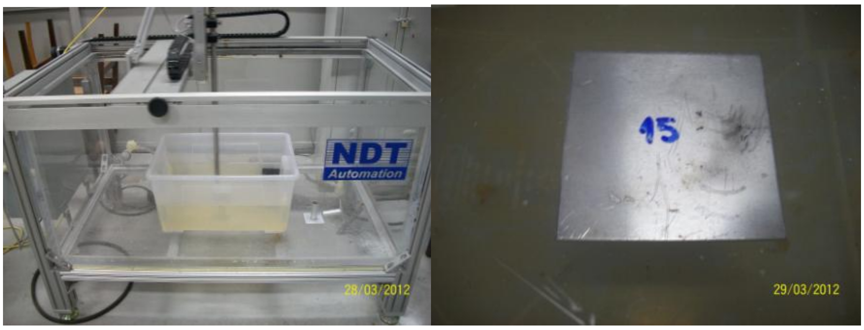

Fig.4 Ultrasonic immersion examination for the brazed pieces

The ultrasonic wave damping is influenced by the material discontinuity, material porosity or surface material deformation. Because of the pores, ultrasonic waves are reflected as a result of acoustic impedance modification between analyzed material and the inside air from material discontinuity. Because of material high roughness, an important ultrasonic wave attenuation is observed. At this control method, the maximum echo amplitude is measured. The scanned probe is presented in different colors, from blue to red, where the colors represents thickness material difference and material defects.

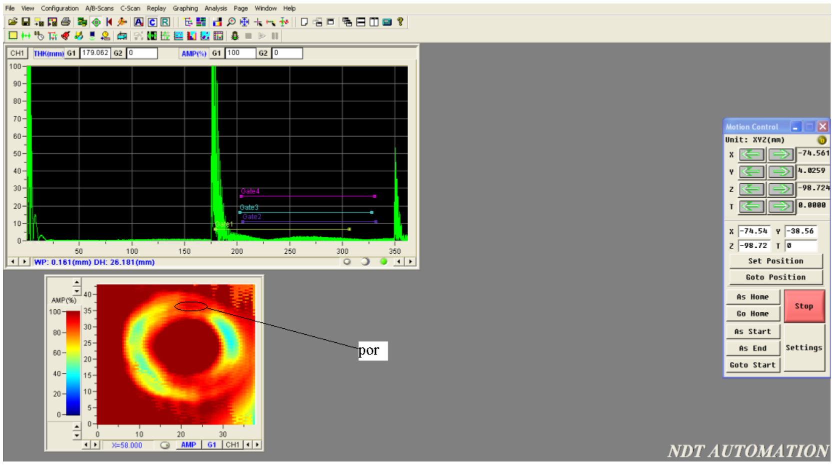

Fig.5 Image interpretation

To detect the material defect, a double crystal detector is used (transmitter - receptor) To control all the piece volume, the detector has to move over the hole surface only once a time, the device being moved by step by step asynchrony electrical motor.

Advantages:
- may be tested pieces with 1144 mm in high and length;
- very precise indications about defect type and size;
- short time examinations;
- automatized control method
- no consuming materials are needed;

Disadvantage:
- high qualified operator is required;
- low thickness material sections are difficult to be detected;
- hight tech devices are used.

4. Penetrate radiation method

Represents one of the most precise discontinuity determination method. The roentghen structural analyze method is based on monochromatic beam properties to be reflected or refracted by atoms from a crystal lattice under a specific angle.

Because X rays has interatomic distance wave lengt, a diffraction phenomenon is produced in the zone of incident beam where multiple beams are produced, with different diffraction angles depending on crystalline lattice and the radiation wave length [4].

Fig. 6 ANDREX PANORAMIC 160kV instrument

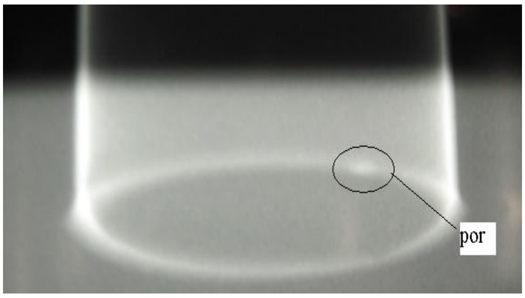

Fig.7 Image interpretation

For the brazed pieces examination, a ANDREX PANORAMIC 160kV instrument was used (fig.6) in the following working conditions:

- power (hard): 150kW;
- intensity - 3mA;
- exposed time - 20secunde;
- focal distance - 800mm.

A C2 type film was used, very sensitive because of piece low thickness. The film sensibility is CEN S 800 according SR EN 584-1 [7] with a extra fine granulation and a very high contrast with high resolution for details. The blackening index after automatic film processing is 2 according SR EN 584-2 [8]. According to SR EN 462-1 [9], a W10AL image quality indicator was used. Using all the mentioned working conditions, a high clarity image was obtain with high defects identification possibility.

Because different attenuation of radiation, the discontinuity will be represented in dark zones [5]. The film quality depends on many factors like: beam density, X ray source power, distance between source and film, disperse radiation or photographic technique.

Advantage:

- visual presentation of the information;
- a permanent film is anytime available;
- efficiency for thin sections;
- can be used for any material.

Disadvantages:

- not properly for high thickness sections;
- dangerous for human health;
- a perfect directioning for bidimensional defects;
- film processing and special facilities are required;
- not for surface defects;
- not able to detect depth of defect.

CONCLUSION

In the case of aluminium alloy nondestructive testing, different techniques has to be used. The correlation between different methods is obviously needed to create a complete image of the entire brazed zone.

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