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COMPARED ANALYSIS OF THE NON-DESTRUCTIVE INSPECTION METHODS AND THE IMPERFECTIONS THAT CAN BE HIGHLIGHTED

Abstract: To ensure the quality of the welded joints on the pipes, instead of one procedure for non-destructive inspection, many times, two or more procedures are used, which complete each other. That is why it is important to have several procedures for the non-destructive inspection. The compared analysis is performed on the following methods: visual, with penetrating liquids, with magnetic powders, with rotational currents, with X-ray radiation. There are other methods as well, without being analyzed in this paper, such as: acoustic inspection of ceramics and axles, with thermal flow, acoustic emission analysis and tightness test with gas.

1. Introduction

The non-destructive inspection methods have as main characteristic the fact that they can be applied to the analyzed components without dismantling or destruction these components. Another advantage of these methods is that they can be applied during production and while the components are in operation.

The fields in which the non-destructive inspection methods can be used are diversified:

- automotive industry,
- naval industry,
- underground pipes or underwater pipes exposed to corrosion,
- sea platforms,
- aeronautical industry,
- energetic industry,
- military and aerospace industry,
- archeology,
- railroad structures,
- petrochemical industry,
- car construction.

2. Non-destructive inspection methods

Visual inspection

The visual inspection is the first step before beginning any of the procedures of non-destructive inspection. In this case the object is simply inspected visually.

More detailed visual inspections are optical inspections, with mirrors, in tight spaces, for example the interior walls of various containers are inspected with interior visualization tubes and curved pipes can be inspected with glass fiber optics.

Penetrating liquids procedure

For the inspection with colored penetrating liquids, the capillary attraction of small openings is used for visual inspection. In this case, the followings steps must be followed:

- preliminary cleaning,
- penetrating process,
- intermediary cleaning,
- drying process,
- development process,
- inspection,
- final cleaning.

To obtain a uniform inspection, the functionality of all auxiliary means used must be verified. This includes: the correct composition of the inspection substances, sufficient storage capacity, the lack of any toxic components, sufficient intensity of the natural light or ultraviolet radiation, the use of adequate inspection indicators.

Magnetic flow dispersion procedure

This procedure is widely known as inspection with magnetic powders. In this case, the capacity of the ferromagnetic materials to contain densely packed magnetic field lines is tested. This attribute is called permeability; it ranges from 100 to 100.000 times more than in the case of air. Where the material is interrupted by defects, the field lines are expelled and rise to the surface as dispersion flow.

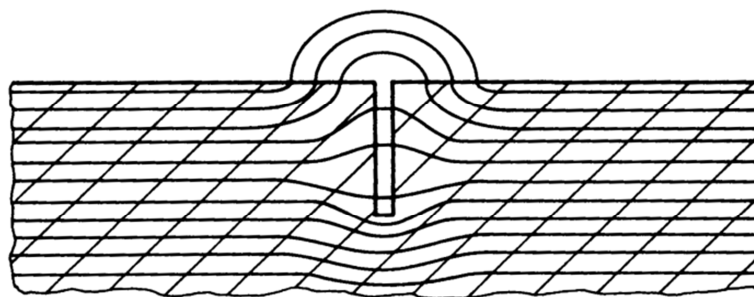


Fig. 1 Surface flute perpendicular on the direction of the field lines

Ferromagnetic particles, components of the magnetic powder, which move on the surface, are attracted and retained by the dispersion flow. They form an agglomeration over the flute thus making it visible. Fluorescent infusions in the magnetic powder increase to an appropriate irradiation the visual effect for the highlighting of the procedure. In case of dark colored objects and non-fluorescent powders, a white base paint coat is recommended to increase contrast.

Inspection with rotational currents

The inspection with rotational currents is adequate only for defects on the surface or close to the surface for all electricity conductive materials.

In this case, high frequency alternating current (AC) passes through a reel, which produces a magnetic field. This magnetic field enters the environment and produces currents inside the conductive object, which have a rotational aspect and which in turn produce a magnetic field, and react with the reel (fig. 2).

If the conductivity reduces due to imperfections in the material, than the reaction also modifies. It is electrically measured and serves to highlight the defects.

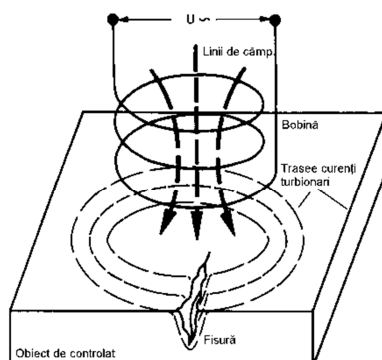


Fig. 2 Arrangement of the prod reels

Inspection with penetrating radiation

Rontgen radiations are electromagnetic waves, produces in the Roentgen tube by slowing down the fast electrons, or appear as gamma radiation upon the disintegration of radioactive materials.

These radiations penetrate all materials in a straight line, but are diminished depending on the material and the thickness of the material. Thus, through an object with cavities, the radiation passes less diminished. The initial equal distribution becomes an intensity profile. This is highlighted with a radiation sensitive film: through the ionizing effect of the radiation, the local intensity distribution transforms into a blacking local distribution.

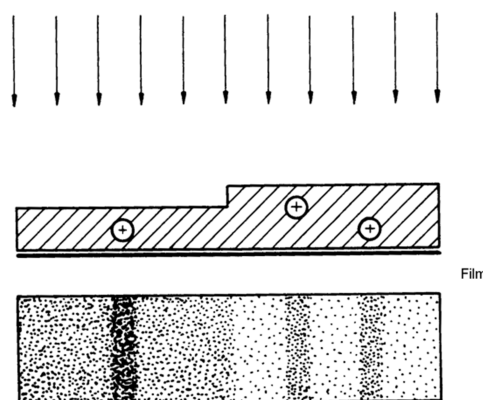


Fig. 3. The principle of the radiographic film cliché

The imperfections in the material appear as dark surfaces on film. In this case volumetric defects such as pits, included slag and air holes become especially visible. Cracks can only be highlighted with very good alignment between the direction of the radiation and the direction of the crack; in case of a reduced length of the crack, high wall thickness and diagonal position, the highlighting possibility decreases.

To ensure a reproducible perceptibility of the imperfections, the following must be used:

- adequate radiation sources, depending on the type, size, energy and dirigibility,
- adequate types of film and enhancement film,
- sufficient distance and blackening,
- adequate image quality indicator,
- adequate screens, filters and tags for the radiogram,
- sufficiently bright negatoscope.

Furthermore, a flawless film development in the dark room and a complete report are also necessary.

Other procedures

The following procedures can also be used for non-destructive inspection:

- acoustic inspection of ceramics and axles,
- thermal flow procedure,
- acoustic emission analysis,
- tightness test with gas.

3. Defects appeared following the non-destructive inspection

In case of visual inspection, the defects highlighted are always surface defects, such as flutes, cracks (fig. 4), pores and corrosion points.

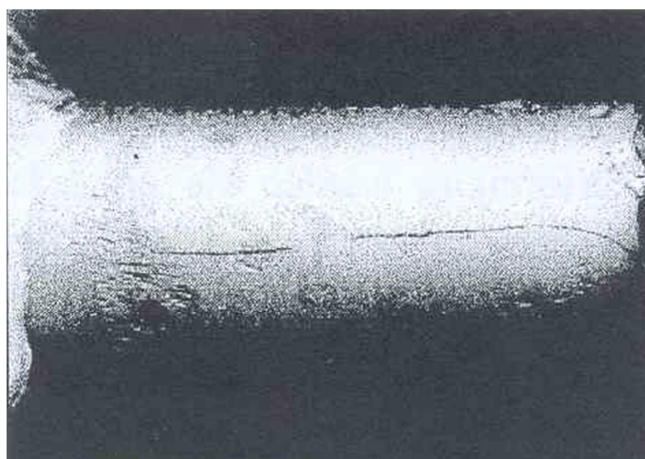


Fig. 4. Forging cracks

The procedure with penetrating liquids is adequate for metallic, ceramic and organic materials, with the help of which we can highlight defects such as the one presented in fig. 5 and fig. 6.

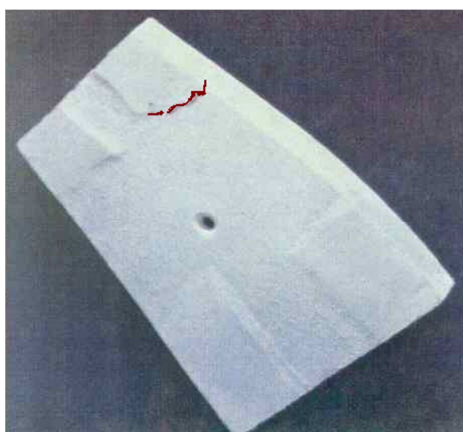


Fig. 5. Curing crack

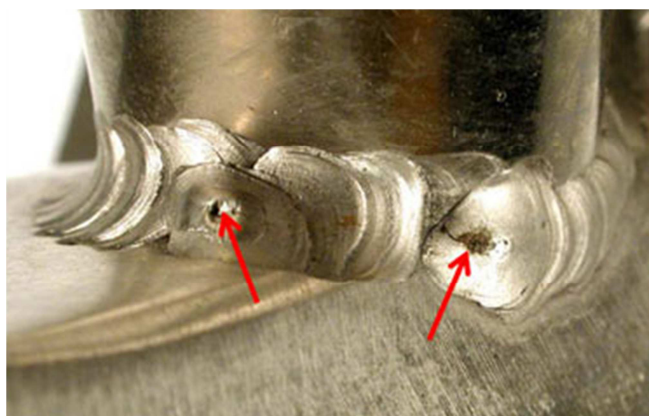


Fig. 6. Crater crack

Decisive for the procedure with dispersion magnetic flow is a magnetic field intensity high enough and the direction of the field, which must be selected perpendicular on the expected extension of the defect.

After the inspection the object must be demagnetized, if the residual magnetism (remanence) is too high and affects the fabrication or the use of the object.

The inspection procedure with rotational currents is used for inspecting the dimensions of the object without contact, because besides conductivity and permeability, the distance between the reel and the inspected object also plays an essential role between geometric reports.

The advantage of the inspection with penetrating radiation consists of a resulting intuitive “shadow” document. Another advantage is applicability for many materials, and the fact that besides the inspection of imperfection, the thickness can also be measured. The disadvantages are that both sides of the object must be accessible, one for the source and the other one for the film, and that radiation protection measures must be implemented according to the law, due to the biological and ionizing radiation hazards.

4. Conclusion

The non-destructive inspection methods, due to their complexity, can be used in any field with remarkable results.

An object (part) that presents visible defect does not have to be submitted to a further costly non-destructive inspection.

The procedure with penetrating liquids only fails in case of spongy and fibrous materials, and in case of defects under the surface.

The inspection with magnetic dispersion flow is adequate for all ferromagnetic materials and allows the highlighting of cracks of up to 1 [mm] wide and coming from 10 [mm] deep, although this is accurate only for defects on the surface or just under the surface and reduced asperity.

The inspection with rotational currents applies for the measuring of the layer thickness, for the inspection of dimensions and inspection of defects. In this case, inspection speeds of up to 100 m/s can be reached and even in the case of mass inspection of pipes and profiles during fabrication, important sorting processes can easily be automated.

The use of the non-destructive inspection procedures presented in this paper leads to a quality increase for the products that go into operation, through the premature identification of visible and hidden defects.

Acknowledgement

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