New Peculiarities of Penetrant Testing with Non-continuous Developer Layer

Nikolai P. Migoun, Nikolai V. Delenkovsky, Alexander B. Gnusin

Laboratory of Capillary Phenomena, Institute of Applied Physics; Minsk, Republic of Belarus
Phone: +375 17 2841794, Fax: +375 17 2841794; e-mail: admcom@iaph.bas-net.by

Abstract
New peculiarities of development stage of penetrant testing process are described. A possibility of surface defects’ revealing in the case of partly covered testing surface by a developer layer is experimentally established for the first time. In this case the defects which mouths haven’t direct contact with developer’s solid particles can be revealed.

It is shown that the increasing of an area of test surface covering by a developer layer until a certain value results in the increasing of defects indications’ area. But after reaching the minimum layer thickness corresponding to a full covering (100%), the further increase of developer’ layer thickness doesn’t increase defects indications’ area for D-IAPh developer and decreases it by 5-10% for D-100 developer that testifies to existence of optimum thickness of developer layer for prescribed penetrant-developer family. Its value may be significantly smaller than traditionally applied one in practice.

Keywords: Penetrant testing, development, developer, layer thickness

1. Introduction

In penetrant testing practice, it is generally accepted that developer layer which cover test surface should be continuous. However, as shown by our researches, a non-continuous coverage of test area by developer (without direct contact of the solid developer particles with defect’s opening) also leads to the extraction of penetrant from the defect cavity.

In our experiments we used a special image processing system [1], which allows to recognize and analyze the defects’ indications by measuring their optical and geometrical characteristics, as well as metallographic microscope with integrated video camera. Also we designed and manufactured a set of test panels made of ferrite stainless steel, each panel has five cracks with different dimensions: width 1-13 μm, depth 140-1000 μm. Our technology allows to produce defect that do not touch the edges of the sample. Additionally we used test panels corresponding to EN ISO 3452-2.

We used fluorescent penetrant BYCOTEST FP400 (Bycotest) and red dye penetrant SONAPEN VP-600 (Sonatest Ltd.), developers – MR 70 (MR Chemie GmbH), D-100 (Sherwin Inc.) and D-IAPh (Institute of Applied Physics, Minsk, Belarus), applied to the test surface by aerosol spraying.

2. Experiment

Some of our research results are presented in Figure 1, illustrating the penetrant extraction from cracks during development stage with incomplete coverage of test sample by developer layer. The figure shows that the local areas of the solid phase of the developer MR 70, which do not contact with defects’ opening are also absorbed a certain amount of dye penetrant. The color intensity of the solid phase area overlying the defect’ opening and another area which lies at a distance of 20-25 mm from the defect is about the same. Similar results were obtained for all other combinations of penetrants and developers. This allows us to conclude that the mechanism of impregnation of developer areas is identical. In such mechanism the most important factors are the liquid phase of developer, as well as thin-film flow of penetrant along test surface.
A method and devices for estimating of test surface developer layer coverage are proposed. In our researches we used fluorescent penetrant testing of samples with cracks at various coverage of surface by aerosol developers. Some results are presented in Figures 2-4.
As can be seen from Figure 2, starting from 16% of test surface developer coverage all of the defects are completely reveals (for developer D-IAPh). With increasing of test sample coverage by developer layer to some value the size of defects indications is increase, and by reaching a 100% of coverage and further increasing of developer layer thickness the indications’ area remains constant (for developer D-IAPh). It is evident, that for each specific pair "penetrant-developer" there is an optimum developer surface coverage (and thickness).
Figure 4 shows that the partial surface coverage (90-95 %) by developer D-100 results in higher cracks indications’ areas than at the lowest possible for this developer continuous layer thickness (10-20 μm). In case of partial surface coverage by D-100 developer defects indications are bigger than in case of full coverage with thickness 15 and 30 μm (by 5-10 %).

3. Conclusion

It is shown for the first time that the process of surface cracks revealing by penetrant testing using suspension developers can be succeeded with non-continuous developer layer. Wherein the cracks without direct contact with the solid particles of the developer are also reveals. It is shown that increasing the test surface coverage by developer to 100% leads to significant increase of defects indication area. Upon reaching the minimum developer layer thickness corresponding to full coverage (100%) , the further increase of thickness do not change the indications area for developer D-IAPh and decrease indications area by 5-10% for developer D-100. This fact indicates that there is an optimal thickness for each pair “penetrant-developer”.

References