Automated dye penetrant systems with process control and documentation in the aerospace industry

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The non-destructive testing method of dye penetrant is becoming more and more important in the aerospace industry as more and more parts are tested by this method. In recent years, Tiede GmbH has developed automated dye penetrant systems that meet the exacting specifications and requirements of aircraft manufacturers. The complete process is controlled and documented in accordance with the customer’s programmed requirements. These functions are carried out by the condition monitoring system QAP-FE.

The dye penetrant method

The principles of the dye penetrant method are illustrated in Figures 1-8.

The first stage of the process is the application of the penetrant on to the surface of the part to be inspected. This can be carried out by spraying or by immersing. During the dwell time, the dye penetrates into any material defect open to the surface of the specimen due to adhesion and capillary attraction. The dwell time is followed by a washing process which, in most specifications, is very well defined in duration, water pressure and temperature to prevent over washing and as a result a loss of indication. In case of the use of oily penetrants, an emulsifier has to be used before washing. The emulsifier combines with the oil and makes the penetrant water-washable.

In the next step the clean surface will be dried by warm air. After the surface is dried, a process starts that is called bleedout. During the bleedout the penetrant liquid, contained inside pores and cracks, starts to crawl back to the surface of the part to be inspected.

To enhance the penetrant bleedout to form indications in most of the cases a developer is applied to the surface of the test-piece. The developer may be a fine powder, a solution that dries to form a dry powder, or a suspension in solvent or water that dries, leaving an absorptive thin coating on the surface of the specimen. After the application of the developer, the penetrant starts to diffuse into it. After a certain period of time which is normally also defined in process specifications, the surface defects can be inspected by using a UV light source.

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The equipment consists of five tanks for penetration, emulsification, washing, drying and developing. Inspection is carried out manually inside a darkening booth. The part is handled by an overhead conveyor.

Figure 10 shows an automated penetrant line for aircraft parts. The system is designed for the processing of different materials.

Automated systems for dye penetrant inspection

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Figure 10 shows an automated penetrant line for aircraft parts. The system is designed for the processing of different materials.
It consists of 15 process stages in three independent lines. The system has the capability to handle up to 15 part carriers at the same time. Figure 11 shows the penetrant tank with one carrier taken out for dripping.

The system is fully controlled by QAP. The process status is displayed on the screen of the QAP-FE system, so that the operator is able to locate every lot at any time during the process. Figure 13 shows the operator desk with PLC touch-screen and QAP display.

The QAP system is connected to the penetrant line via CAN bus. All sensors necessary to control the process parameters, such as temperatures, pressures and process times, are attached to this interface. Furthermore, the QAP communicates to the operator via this interface by displaying some important time measures to count-down and count-up clocks as shown in Figure 14.

Figure 15 shows a UV light intensity sensor mounted to a UV light source. The use of these sensors enables the user to ensure and document that the inspection of the parts is always carried out under the conditions specified in the standards.