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Liquid Penetrant Inspection

2.1 Introduction

Liquid penetrant inspection is a technique which can be used to detect defects in a wide range of components, provided that the defect breaks the surface of the material. The principle of the technique is that a liquid is drawn by capillary attraction into the defect and, after subsequent development, any surface-breaking defects may be rendered visible to the human eye. In order to achieve good defect visibility, the penetrating liquid will either be coloured with a bright and persistent dye or else contain a fluorescent compound. In the former type the dye is generally red and the developed surface can be viewed in natural or artificial light, but in the latter case the component must be viewed under ultra-violet light if indications of defects are to be seen.

The exact origins of this technique are unknown. However, one of the earliest forms of penetrant inspection was the use of carbon black on glazed pottery, to detect glazing cracks. The carbon black was held by the cracks, and hence, their outline was readily visible. Eventually, this was turned to good use as a method of decoration.

Nowadays, liquid penetrant inspection is an important industrial method and it can be used to indicate the presence of defects such as cracks, laminations, laps and zones of surface porosity in a wide variety of components. The method is applicable to almost any component, whether it be large or small, of simple or complex configuration, and it is employed for the inspection of wrought and cast products in both ferrous and non-ferrous metals and alloys, ceramics, glassware and some polymer components.
2.2 Principles of penetrant inspection

There are five essential steps in the penetrant inspection method. These are:

(a) Surface preparation.
(b) Application of penetrant.
(c) Removal of excess penetrant.
(d) Development.
(e) Observation and inspection.

Surface preparation

All surfaces of a component must be thoroughly cleaned and completely dried before it is subjected to inspection. It is important that any surfaces to be examined for defects must be free from oil, water, grease or other contaminants if successful indication of defects is to be achieved.

Application of penetrant

After surface preparation, liquid penetrant is applied in a suitable manner, so as to form a film of penetrant over the component surface. The liquid film should remain on the surface for a period sufficient to allow for full penetration into surface defects.

Removal of excess penetrant

It is now necessary to remove excess penetrant from the surface of the component. Some penetrants can be washed off the surface with water, while others require the use of specific solvents. Uniform removal of excess penetrant is necessary for effective inspection.

Development

The development stage is necessary to reveal clearly the presence of any defect. The developer is usually a very fine chalk powder. This may be applied dry, but more commonly is applied by spraying the surface with chalk dust suspended in a volatile carrier fluid. A thin uniform layer of chalk is deposited on the surface of the component. Penetrant liquid present within defects will be slowly drawn by capillary action into the pores of the chalk. There will be some spread of penetrant within the developer and this will magnify the apparent width of a defect. When a dye penetrant is used the dye colour must be in sharp contrast to the uniform white of the chalk-covered surface. The development stage may sometimes be omitted when a fluorescent penetrant is used.