

Liquid Penetrant Test Methods – SAE J426c

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Purpose—The purpose of this report is to supply the user with sufficient information so that he may decide whether liquid penetrant test methods apply to his particular inspection problem. Detailed technical information can be obtained by referring to the Bibliography at the end of this report.

General—Liquid penetrant testing is a sensitive, nondestructive inspection method suitable for the detection of very small discontinuities that are open to the surface. It is generally used on materials such as metals, plastics, and ceramics. However, the magnetic particle method is generally preferred for ferromagnetic materials. Specific applications include detection of cold shuts, seams, shrinkage, porosity, cracks, and other imperfections which are open to the surface of nonporous objects.

Principle—The liquid penetrant test method is based upon capillary action, using low surface tension liquids. The liquid penetrant is applied to the surface to be inspected by dipping, spraying, or brushing. The excess penetrant is removed and a developer is applied. The bleeding out of penetrant from the discontinuity into the developer yields indications which can be observed and evaluated. This is done under ultraviolet or white light, depending upon the type of liquid penetrant used—fluorescent or nonfluorescent (visible).

Procedure

1. Clean parts by washing, degreasing, or etching.
2. Apply penetrant to the surface to be inspected.
3. Allow adequate time for penetration.
4. Remove excess penetrant from the surface.
5. Dry the surface to be inspected. (Perform after the next step if a wet developer is used.)
6. Apply a developer when applicable. The developer is a material which acts like a blotter and draws penetrant from the defect. Dry or wet (aqueous or nonaqueous) developers are used.
7. Locate imperfections by observing penetrant bleed-out from the discontinuity.
8. Post clean parts. Remove residual penetrant and developer.

Note: Excessive part temperatures can degrade penetrants.

Characteristics—There are a number of different classifications of penetrant test materials. These are discussed in the following paragraphs.

1. Penetrants are classified into two types. One type of penetrant employs fluorescent dyes to make surface imperfections visible under ultraviolet light. The other type of penetrant employs red nonfluorescent dyes which are visible under white light.
2. The penetrants are further classified according to the method of excess penetrant removal:

Method A—The penetrants contain an emulsifier which makes them water washable.

Method B—The penetrants require that an emulsifier be applied over the penetrants to make them water washable. Hence, they are called post-emulsifiable penetrants.

Method C—The penetrants are solvent removable.

Generally, there are several recognized sensitivity levels of penetrant performance relating primarily to the width of discontinuity that must be detected. Selection of the method (that is, A, B, or C) and sensitivity levels will be made based upon the following factors: surface roughness, surface treatment, size of discontinuity to be disclosed, environment, production required, equipment available, type of material to be inspected, subsequent use of the part, disposal restrictions, cost, and others. Where minimal sensitivity with respect to size of discontinuities is needed, the color contrast or visible dye penetrants are usually employed. Either of the three methods above can be used.

Fluorescent penetrants make discontinuities more discernable. Fluorescent penetrants may be selected for use with method A, B, or C. Two principal factors affect performance: the amount of fluorescent dye that is dissolved, and the ability of the penetrant to be retained in the surface apertures after surface excess is removed.

Generally, the least effective method is method C, solvent removable: Because the process is difficult to control accurately, results may vary widely. Either the self-emulsified, water-washable, or the post-emulsified method will yield equivalent results if proper selection of materials is made. For ultra-high performance, a very low activity emulsifier mixture with water is used to clean off the surface excess to a measured depth.

Developers—One of three types of developers is used to draw the penetrant from the discontinuities. The first, called dry developer, consists of a dry, light-colored, powdery material. Dry developer is applied to the surface of the parts after removal of the excess penetrant and drying of the part. Dry developer is applied by immersing the parts in a tank containing powder, by brushing it on with a paintbrush (usually not a desirable technique), or by blowing the powder onto the surface of the part.

The second type is aqueous wet developer and consists of powdered material suspended in water. The use of the wet developers permits rapid coverage of a large number of parts or of parts that have complicated shapes. After application of the wet developer, the part is dried and then inspected for penetrant indications.

The third developer is called nonaqueous wet developer. The powdered developer is suspended in a suitable solvent and sprayed onto the surface of the dry part. The solvent evaporates quickly, leaving a fine coating of developer on the surface of the part. The nonaqueous wet developer produces the greatest sensitivity when inspecting parts with small, tight defects.

Selection of the type of development method or material used for an application is important to the achievement of reliable inspections. The three types of developers vary widely in the degree of enhancement of indications. Nonaqueous wet developer, aqueous wet developer, or dry powder may be preferred depending upon the application. Surface finish may affect the degree of enhancement of developers. An aqueous developer, either soluble or particulate, should not generally be used with water-washable penetrants.

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