3.3 LIQUID PENETRANT TEST

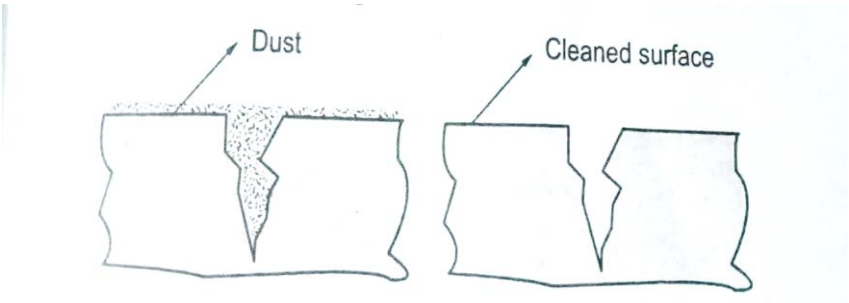
- It also known as liquid penetrant inspection or dye penetrant is based on the properties of surface wetting and capillary action, causes a liquid to rise when confined to a small opening. After the penetrant and wiping away the excess, the penetrant that rises surface can indicate surface-breaking.
- Dye Penetrant Inspection (DPI), also called Liquid Penetrant Inspection (LPI) or Penetrant Testing (PT)
- It is used to detect any surface-connected discontinuities such as from fatigue, quenching, and grinding, as well as fractures, p incomplete fusion, and flaws in joints.

1. PRINCIPLE

- Liquid penetrant testing involves the application of a fluid with viscosity on the material to be tested.
- This fluid seeps into any defects such as cracks or porosity before developer is applied which allows the penetrant liquid to seep upward create a visible indication of the flaw.
- Liquid penetrant tests can be conducted using solvent remove penetrants, water washable penetrants or post-emulsifiable penetrante.

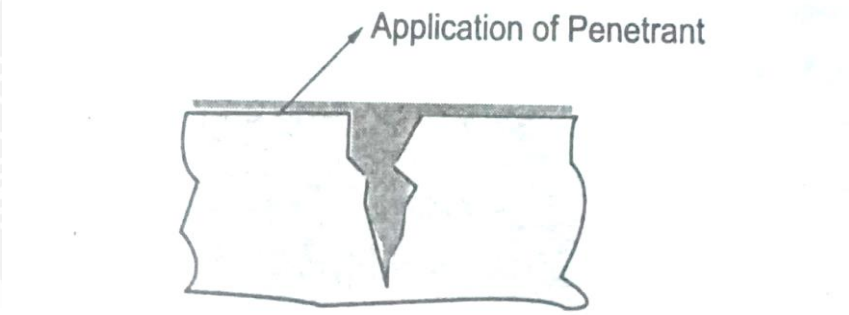
(a) Surface Preparation

- One of the most critical steps of a liquid penetrant inspection is the face preparation
- The surface must be free of it, grease, water, or other content that may prevent penetrant from entering flaws.
- The sample may also require etching if mechanical operations such as machining, sanding, or grit blasting have been performed. These and other mechanical operations can smear metal over the flaw opening and prevent the penetrant from entering.



(b) Penetrant Application

- Once the surface has been thoroughly cleaned and dried, the penetrant material is applied by spraying, brushing, or immersing the part in a penetrant bath.

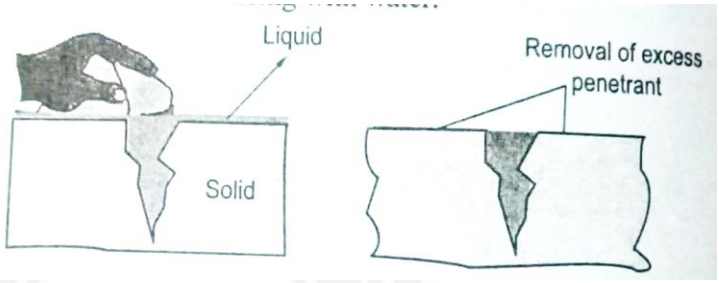


(c) Penetrant Dwell

- The penetrant is left on the surface for a sufficient time to allow as much penetrant as possible to be drawn from or to seep into a defect.
- The times vary depending on the application, penetrant materials used, the material, the form of the material being inspected, and the type of defect being inspected for.
- Minimum dwell times typically range from five to 60 minutes. Generally there is no harm in using a longer penetrant dwell time as long as penetrant is not allowed to dry. This is the most delicate part of the inspection procedure because excess penetrant must be removed from the surface of the sample.

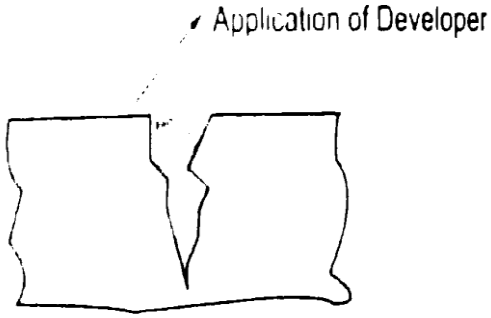
(d) Excess Penetrant Removal

- Depending on the penetrant system used, this step may involve clea with a solvent, direct rinsing with water, or first treating the part with emulsifier and then rinsing with water.



(e) Developer Application

- A thin layer of developer is then applied to the sample to draw penetrant trapped in flaws back to the surface where it will be visible.
- Developers come in a variety of forms that may be applied by dusting (dry powdered), dipping or spraying (wet developers).



(f) Indication Development

- The developer is allowed to stand on the part surface for a period of f sufficient to permit the extraction of the trapped penetrant out of surface flaws.
- This development time is usually a minimum of 10 minutes. Significantly longer times may be necessary for tight cracks.

(g) Inspection

- Inspection is then performed under appropriate lighting to detect indications from any flaws which may be present.

(h) **Clean Surface**

- The final step in the process in to thoroughly clean the part surface to remove the developer from the parts that were found to be acceptable.

3. ADVANTAGES

- High sensitivity to small surface discontinuities.
- Easy inspection of parts with complex shapes.
- Quick and inexpensive inspection of large areas and large volumes of parts/materials.
- Few material limitations (metallic and non metallic, magnetic and nonmagnetic, and conductive and nonconductive can all be inspected).
- A visual representation of the flaw are indicated directly on the part surface.
- It is easy and requires minimal amount of training.
- Suitable for parts with complex shapes. Portable (materials are available in aerosol spray cans).
- Low cost (materials and associated equipment are relatively inexpensive).

4. DISADVANTAGES

- Only surface breaking defects can be detected.

- Only materials with a relatively nonporous surface can be inspected. Pre-cleaning is critical since contaminants can mask defects.

- The surface finish of the specimen after the test is difficult. The compatibility of the materials with the specimen.

- The sensitivity required.

- The size, shape and accessibility of the area to be inspected.

- The inspector must have direct access to the surface being inspected,

- Surface finish and roughness can affect inspection sensitivity.

- Multiple process operations must be performed and controlled. Post cleaning of acceptable parts or materials is required.

- Chemical handling and proper disposal is required.

5. APPLICATION

- **Aerospace:** Typical Components that are checked by this method in Turbine, rotor disc, blades, aircraft wheels, Casting, forged pants welded assemblies
- **Automobiles:** Many automotive parts particularly aluminum castings, forging including pistons and cylinder heads are subjected to this form quality checks before assembly.
- **Railways:** LPI to detect fatigue cracking is also used for the regular service examination of the bogie frames of railway locomotive rolling stock.
- **Tool and dies:** Field drilling rays, drill pipes, castings and drill and equipment's inspected by this methods.
- Inspection on reactors and tank: Tanks, vessels, reactors, piping, do in the chemical, petro-chemical industries.

3.2.3. PENETRANTS

- It is used for detection of surface imperfections in non-porous material and basically consists of applying a flow of liquid to the surface of material to be tested.
- The liquid, by capillary action, will penetrate the discontinuities and excess remaining on the surface will be removed by a suitable clean in system. It will be highly visible or fluoresce brightly to produce easy to indications.

1. Types of Penetrants

- **Fluorescent Penetrants:** They contain a dye or several dyes that fluores when exposed to ultraviolet radiation.

- **Visible Penetrants:** They contain a red dye that provides high contra against the white developer background.

2. Methods used for excess removal of Penetrants

- Water washable
- Post-Emalsifiable
    - Lipophilic
    - Hydrophilic

3.2.4 DEVELOPERS

- The role of the developer is to pull the trapped penetrant material out of defects and spread it out on the surface of the part so it can be seen by an inspector.

1. **The six standard forms of developers are**
    - Dry Powder
    - Water Soluble
    - Water Suspendable
    - Non aqueous
        - Type 1: Fluorescent (Solvent Based)
        - Type 2: Visible Dye (Solvent Based)