Overview of LPT:

Liquid Penetrating Testing detects flaws that are open to the surface and is a type of Visual Inspection.

This method is based upon the Principle of Capillary Action.

Penetrants are of two types, fluorescent or non-fluorescent (Visible).

Several Developers types are available, including:

- Non-aqueous wet developer
- Dry Powder
- Water suspendible
- Water soluble
There are four essential steps required for this test.

- Selection of material with a surface breaking crack that is not visible to the naked eye.
- Penetrant application.
- Excess penetrant removal.
- Developer application.

Non-Destructive Testing:

Liquid penetrant testing is one of the oldest and simplest NDT methods. Its earliest versions (using kerosene and oil mixture) date back to the 19th century. This method is used to reveal surface discontinuity by bleed out of a coloured or fluorescent dye from the flaw.
The characteristic ability of a liquid to be drawn into a clean alternate is demonstrated by capillary action.

After a period of time called the "dwell time," the penetrant is removed and a developer applied.

The advantage that a liquid penetrant inspection offers over an (unaided) visual inspection is that it makes the defect easier to see. For the inspector, it is done in two ways:

A. It produces a flaw indication that is much larger and easier for the eye to detect than the flaw itself.
It improves the detectability of a flaw due to the high level of contrast between the indication and the background which helps to make the indication more easily seen.

Liquid penetrant testing is one of the most widely used NDT methods. Its popularity can be attributed to two main factors: its relative ease and its flexibility.

Steps of Liquid Penetrant Testing:

The exact procedure for liquid penetrant testing can vary from case to case depending on several factors such as the penetrant system being used, the area and material of the component being inspected.
Penetrant Application

Penetrant Dwell

Excess Penetrant Removal

Developer Application

Indication Development

Inspection

Clean Surface
One of the most critical steps of a liquid penetrant testing is surface preparation. The surface must be free from oil, grease, water or other contaminants that may prevent penetrant from entering.

**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.
The penetrant is left on the surface for a sufficient time to allow as much penetrant dwell time as the total time that the penetrant is in contact with the part surface.

Dwell times are usually recommended by the penetrant producer or required by the specification being followed.

Excess Penetrant Removal

This is most delicate part of the inspection procedure because the excess penetrant must be removed from the surface of the lamp, while removing as little penetrant as possible from defects.
A thin layer of developer is then applied to the surface 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 dipping or spraying.

Indication Development:

The developer is allowed to stand on the part of surface for a period of time sufficient to permit the extraction of the trapped penetrant out of any surface flaws. This development time is usually a minimum of 10 minutes.
Inspection is then performed under appropriate lighting to detect indications from any flaws which may be present.

Clean Surface:

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

This are the eight steps of the liquid penetrant testing.
* Portable
* Low Cost
* No Skilled Labour are Needed
* All Metal & Non metals are Tested
* Single Side Access
* Not harmful to the Material being Tested or the Inspector
* Highily Visible (or) Fluoresce brightly.

Disadvantages:

Only Surface defects can be detected.
Only materials with a relatively non porous surface can be inspected.
Pre cleaning is critical since containers can make defects.
Chemical hazard and proper disposal in required.
Penetrant - Urethane + Red Colour Dye

6 High Visibility Index

Penetrants are carefully formulated to produce the level of penetrivity desired by the Inspector.

Spread easily over the surface of the material, be drawn into surface breaks by capillary actions. Defects remain in the defects but remain visible, easily drawn from the surface of the part.

Properties of Penetrant:

* Low Viscosity
* Non-Volatile
* Non-Corrosive
* Non-Poison
Developer - chalk powder + liquid.

Principle -> bleed out or blurry process.

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

Developer used with visible penetrants creates a white background so there is a strong degree of contrast between the indication and surrounding background.

Properties of Developer:

- High flash & fire point
- Chemical inert
- Odourless
- Easily removable
- Low cost
Used to remove the

Material from the part.

Method A: Water washable

Penetrant can be removed with water from the part by rinsing alone. The penetrant contains an emulsifying agent that makes it possible to wash the penetrant from the part or surface with water alone.

Post Emulsifier:

The penetrant is oil soluble and interacts with oil-based emulsifiers to make removal possible.

Solvent Removable:

They require the use of a solvent to remove the penetrant from the part.
This method determines that one, either surface or subsurface.

Thus can be considered as a combination of two non-destructive testing methods:

1. Magnetic Particle Leakage

2. Visual Inspection Method

A magnetic flux is send through the material, at the location of the imperfection a leakage field is formed. This attracts metallic iron dust, which is sprayed onto the surface.
A magnetic flux is lead through the material by excising coils. At the location of the discontinuity, a leakage field is

The leakage is a function of the orientation of the discontinuity to the magnetic field.

The leakage is greatest when the discontinuity is perpendicular to the magnetic field.

When the leakage of the magnetic field is great enough, a pair of magnetic poles are established at the discontinuity.

By applying magnetic particles, the particles are attached to the poles and will gather at the discontinuity, indicating a surface (or sub-surface) flaw.
Magnetic Particle Testing:

This module is intended to present information on the widely used method of Magnetic Particle Inspection.

Magnetic Particle Inspection can detect both production dis discontinuities (cracks, laps, grinding cracks) and in-service quenching cracks) and in-service damage (fatigue and overload cracks).
Magnetized and magnetic lines of force can be found in and around the object.

A magnetic pole is a point where the magnetic line of force begins or enters a material.

Magnetic field lines:
- Form complete loops.
- Do not cross.
- Follow the path of least resistance.
- All have the same strength.
- Have a direction such that they cause poles to attract or repel.

How it Works:

A ferromagnetic test specimen is magnetized with a strong magnetic field created by a magnet or special equipment.
If the specimen has a discontinuity, the discontinuity will interrupt the magnetic field flowing through the specimen and a leakage field will occur.

Milled iron particles coated with a dye pigment are applied to the test specimen. These particles are attracted to leakage fields and will cluster to form an indication directly over the discontinuity.

This indication can be visually detected under proper lightning condition.
Steps Involved in MPT

* Component Pre Cleaning
* Introduction of Magnetic Field
* Application of Magnetic Media
* Interpretation of Magnetic Particle Indication.

Component Pre Cleaning:

When inspecting a test part with the magnetic particles, it is essential for the method to have an unimpeded path for migration to both strong and weak leakage field alike. The part’s surface should be clean and dry before inspection.
Grane or scale may not only prevent particles from being attracted to leakage fields, they may also interfere with interpretation of indications.

Introduction of Magnetic Field:

The required magnetic field can be introduced into a component in a number of different ways.

1. Using a permanent magnet or an electromagnet that contact the test piece.

2. Flowing an electrical current through the domain.

3. Flowing an electrical current through a coil of wire around the part or through a central conductor running near the part.
Two general types of magnetic fields (longitudinal and circular) may be established within the specimen.

The type of magnetic field established is determined by the method used to magnetize the specimen.

* A longitudinal magnetic field has magnetic lines of force that run parallel to the long axis of the part.
* A circular magnetic field has magnetic lines of force circumferentially around the perimeter of a part.
Being able to magnetize the Part in two directions is important because the best detection of defects occurs when the lines of magnetic force are perpendicular to the length of the defect.

This orientation creates the largest disruption of the magnetic field within the part and the greatest flux leakage at the surface of the Part. An orientation at 90 degrees between the magnetic field and the defect is necessary to form an indication.

Since defects may occur in various and unknown directions, the Part is normally magnetized in a direction at right angles to each
MIP can be performed using either dry particles, or particles suspended in liquid.

With the dry method, the particles are lightly dusted on to the surface. With the wet method, the part is flooded with a solution carrying the particles.

The dry method is portable. The wet method is generally more sensitive since the liquid carrier gives the magnetic particles additional mobility.

Dry magnetic particles come in a variety of colours. A color that produces a high level of contrast against the background should be used.
Wet Magnetic Particles are typically supplied as visible or fluorescent.

Visible Particles are viewed under normal white light and:
Fluorescent Particles are viewed under blue light.

Interpretation of Indication:

After applying the magnetic field, indications that form must be interpreted. This process requires that the inspector distinguish between relevant and non-relevant indications. The following device or device depicts relevant indications produced from a variety of components inspected with the magnetic particle method.
Parts influenced by the magnetic particle method may have an objectionable residuum magnetic field that may interfere with subsequent manufacturing operations (or) severe of the component.

Advantages of MPT:

* Can detect both surface as well as sub-surface defects.
* Can inspect parts with irregular shapes easily.
* The clarity of particles are not as much critical.
* Fast method of inspection and indication are visible directly.
* Low cost compared to other methods.
* Portable.
Limitations of NDI:

* Cannot inspect non-ferrous materials.
* May require special use of equipment.
* May require removal of coatings or plating.
* Limited subsurface discontinuity detection capabilities.
* Post cleaning and demagnetization is often necessary.
* Alignment (kick) between magnetic flux and detector is important.