

CATEGORY: ROLL INSPECTION

TYPE: DYE PENETRANT INSPECTION

Dye penetrant inspection (DPI), also called liquid penetrant inspection (LPI), is a widely applied and low-cost inspection method used to locate surface-breaking flaws in both back up and work rolls.

DPI is based upon the principle of capillary action in which a low surface tension fluid penetrates into clean and dry surface-breaking discontinuities. Penetrant may be applied to the test component by dipping, spraying, or brushing. After adequate penetration time has been allowed, the excess penetrant is removed and a developer is applied. The developer helps to draw penetrant out of the flaw where an indication becomes visible to the inspector. Inspection may be performed under ultraviolet or white light depending upon the type of dye used either fluorescent or non-fluorescent (visible).



Figure 1

Firecracking at the barrel surface of a work roll using dye penetrant inspection.

Below are the main steps of the Dye Penetrant Inspection process:

- ❖ **Pre-cleaning:** The roll surface is cleaned to remove any dirt, oil, grease or oxides that could either keep penetrant out of a defect, or cause irrelevant or false indications. Cleaning methods may include solvents, vapor degreasing, or re-grinding. The end goal of this step is a clean surface where any defects present are open to the surface, dry, and free of contamination. Note that if re-grinding is used, it may "work over" small flaws in the roll surface.

- ❖ **Application of Penetrant:** The penetrant is then applied to the surface of the item being tested. The penetrant is allowed time to soak into any flaws (generally 5 to 30 minutes). The dwell time mainly depends upon the penetrant being used, material being testing and the size of flaws sought. As expected, smaller flaws require a longer penetration time.
- ❖ **Excess Penetrant Removal:** The excess penetrant is then removed from the roll surface. Removal method is controlled by the type of penetrant used typically water-washable or solvent-removable. When using solvent remover and lint-free cloth it is important to not spray the solvent on the test surface directly, because this may remove the penetrant from the flaws. All penetrant on the surface must be removed if not this could result in 'background noise' or false flaw indications.
- ❖ **Application of Developer:** After excess penetrant has been removed a white developer is applied to the sample typically a dry powder. The developer should form a semi-transparent, even coating on the surface of the roll. The developer draws penetrant from defects out onto the surface to form a visible indication, a process similar to the action of blotting paper. Any colored stains indicate the positions and types of defects on the surface under inspection.
- ❖ **Inspection:** The inspector will use visible light with adequate intensity for visible dye penetrant or ultraviolet (UV-A) radiation of adequate intensity along with low ambient light levels for fluorescent penetrant examinations. Inspection of the test surface should take place after a 10 minute development time. This time delay allows the blotting action to occur. The inspector may observe the sample for indication formation when using visible dye. Also of concern, if one waits too long after development the indications may "bleed out" such that interpretation is hindered.

Advantages

- ✓ Low cost
- ✓ Minimal operator training typically required although experience is beneficial.
- ✓ The defect indication has a high visual contrast (e.g. red dye against a white developer background, or a bright fluorescent indication against a dark background).

Disadvantages

- ✗ Roll surface condition can greatly affect the quality of the test results
- ✗ The penetrant removing method used may reduce the detection capability for smaller flaws
- ✗ Flaws may be sealed off or impervious to the dye after roll has been ground. Cracks may be wrongly assumed to be cleared after a re-grinding operation.