



Pencil Hardness

Paints need to be hard enough to protect a surface, yet not so soft that they could dent and be tacky. Hardness is a measure of the cure of the film or how the coating has softened when in contact with various liquids. When an organic coating “cures,” it does so in either of two processes. It can allow the solvent used in the formulation to evaporate, thereby leaving a hard film. Lacquer is an example of a coating that cures by this process. The second process by which paints cure is when the coating crosslinks. Crosslinking is a chemical process where the polymer portion of the paint formulation reacts to form a dry, hard and, typically, solvent-resistant film. Test Method D 3363 is an easy and inexpensive technique to determine how hard or soft an organic coating is.

All paint manufacturing companies list the hardness of their products in terms of pencil hardness in their technical literature. This lets the end-user know if the hardness is appropriate for the end-use application.

Pencil hardness is a popular test in the paint industry. It is used to determine scratch (mar) and/or gouge hardness of coatings. Its popularity is due to two of its basic strengths; it is inexpensive and it is quick.

“4.4.26 Pencil hardness: Prepare a film as specified in 4.4.22. Strip the wood from the lead of a standard drawing pencil for a distance of 1/4 inch. With a rotatory motion, square the point of the exposed lead against No. 400 carbide abrasive paper. Hold the pencil at approximately 45° and push forward against the film using a pressure just short of breaking the lead. Clean the mark with a soap or ‘art gum’ eraser. Hold the plate at an oblique angle in strong light and examine for marring. Determine the softest pencil that will mar the film. Express the film hardness as the next softest pencil and check for compliance with table III.”

Hardness, as we understand it here, is the capacity of a given surface to resist scratching, marring or gouging. When expressing the measurement of pencil hardness, we do so with values that range from 6B (softest) to 9H (hardest). Test Method D 3363 goes to 6H. This property is verifiable and can be an indication of results from objects being placed on various painted surfaces that can mar the coating. ASTM D 3363, Test Method for Film Hardness by Pencil Test, is now the appropriate test method for this property.

Today, ASTM D 3363 describes a procedure for a rapid, inexpensive determination of the film hardness of an organic coating on a substrate in terms of using leads or pencil leads of known hardness. A coated panel is placed on a firm horizontal surface. The pencil is held firmly against the film at a 45° angle (point away from the operator) and pushed away from the operator in a 0.256-in. (6.5-mm) stroke. The process is started with the hardest pencil and continued down the scale of hardness to either of two end points; one, the pencil that will not cut into or gouge the film (pencil hardness), or two, the pencil that will not scratch the film (scratch hardness).

This test method is especially useful in developmental work and in production control testing in a single laboratory. It should be recognized that the results obtained may vary between different operators and laboratories. Every effort should be made to standardize the hardness of the lead used and a technique followed. If used as a basis for purchase agreements, this test method will achieve maximum precision if a given set of referee pencils are agreed upon between the purchaser and the seller. Obviously, the results may be inconsistent from one operator to another because we all know different people will push a pencil at different pressures each time.