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Theory of Operation

Dart Drop Impact Testing is a product development test or quality control test used to determine the energy that causes plastic film or other materials to fail under specified conditions of an impact caused by a free-falling dart. It is a measure of the impact resistance of plastic film, flexible packaging, paper, and other materials. This energy is expressed in terms of the weight (or mass) of a dart falling from a specified height which would result in 50% failure of the specimens tested.

By releasing weighted darts onto the sample, the material is either fractured (or not) by the dart, and the weight of each dart dropped is recorded. A reporting technique is used called the "staircase method" where a standard dart weight increment is added or subtracted after each successive specimen test depending on the result (fail or not fail) observed for the specimen.

An alternate technique tests specimens in successive groups of ten. One dart weight is employed for each group of ten specimens, and dart weight is varied in uniform increments from group to group.

Recorded weights to accomplish successive failures and non-failures are used to calculate the impact resistance of the sample material.

ASTM and International Standards

The Oakland Instrument Series DX-8000 Dart Drop Impact Testers are designed to meet the testing requirements of ASTM D-1709 "Impact Resistance of Plastic Film by the Free-Falling Dart Method". D-1709 tests for failure initiated energy. Other test methods and instruments test for initiation plus completion energy, or "total" energy.

Oakland Instrument manufactures models to meet the two drop heights specified by ASTM standards: Method A (with a 38 mm or 1.5 inch diameter dart dropped from a height of 0.66 m or 26 inch) and standard Method B (with a 51 mm or 2 inch diameter dart dropped from a height of 1.52 m or 60 inch). Test Method A is suggested for materials whose impact resistance is between approximately 50 grams and about 2 kg for fracture. Test Method B is suggested for impact resistances between 0.3 kg to in excess of 2 kg for fracture.

Preparing Film or Material Samples

Test specimens need to be large enough to extend outside of the specimen clamp gaskets at all points around the clamp ring. They should be free of pinholes, wrinkles, folds, and imperfections, unless, however, those imperfections constitute a variable under study.

An efficient method of preparing film samples is to trim samples into strips approximately 18 cm (or 7 inches) across, which is slightly less than the distance between the two pneumatic cylinder posts which support the clamp ring on the Model DX-8285 Dart Drop Testers. This way, a sample can be pulled through the tester for consecutive tests on different test points on the same strip of material.

Loading Film or Material Samples

First, lift the upper clamp ring, either manually by releasing the hold down clamps and lifting with the lift-knob (for manual tester models) or by lifting the toggle switch labeled "Clamp Ring" to the "Raise" position to raise the upper clamp ring with the automatic lift mechanism (for pneumatic tester models).

Place the first test specimen over the bottom part of the sample clamp, and position it so it is uniformly flat, free of folds, and that it covers the gasket at all points. Clamp in place with the upper clamp ring.

Running the Dart Drop Impact Test

Measure and record the average thickness of the test specimens in the area of impact. Load the specimen, and prepare a dart with an appropriate starting weight.

If running the Staircase method, a uniform dart weight increment is employed during test and the dart weight is changed after test of each specimen. For a starting point, a dart weight near the expected impact failure weight is chosen. Load the dart into the dart holder and actuate the dart clamp mechanism to hold the dart in place. Release the dart. Examine the specimen to determine whether is has, or has not, failed. Record the result on a standard data form using a "0" to denote non-failure or an "X" to denote failure. If the first specimen failed, decrease dart weight by the appropriate weight increment. If the first specimen did not fail, increase dart weight by the appropriate weight increment. The sequence is repeated until 10 non-failures are recorded.

Following the alternative testing technique, successive groups of 10 specimens are tested. For each group, one dart weight is employed; and from group to group the dart weight is varied in uniform increments. Testing is carried out until there are at least five results for percentage failure.

For routine quality control inspection, it is typical to accept material lots on the basis of testing a minimum of 10 specimens at a specified weight as stated in the material specification. Using this procedure, a result of no more than 5 failures is considered acceptable.

Pass vs. Fail of Individual Specimen Tests

A failure is defined by this test method as any break through the specimen that can be readily observed by feeling or by viewing under backlighted conditions. The dart does not need to completely penetrate the specimen to be considered a failure.

Recording Your Data

During the test, record your data on a standard data form as shown. If following ASTM or other standards, you are typically required to record: product (specimen) description, sample conditioning procedure followed, instrument configuration and setup, testing technique used, specimen thickness, impact weights used, failure vs. non-failure occurrences, date and operator name.

Reporting Your Data

After recording the test data, determine and report the calculated Impact Failure Weight, typically reported in grams. From the standard data form, the dart weights used in the test, the uniform weight increment used, and percentages of reported failures at each dart weight are used in the calculation of Impact Failure Weight.

Oakland Instrument provides standard Data Forms with its testers, which can either be filled out manually, or used in a computer-assisted manner with 3rd party Statistical Software packages such as Microsoft ExcelTM.