FALLONG DART IMPACT TESTER

Item 43-26

TESTING MACHINES INC.
The Finest Test Equipment for all Industries

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43-26 Falling Dart Impact Tester.doc 1 Rev. C (1/24/12)
Dear Valued Customer:

You are now the proud new owner of quality physical testing equipment manufactured by Testing Machines Inc., the industry’s leader for over 80 years. TMI has a long-standing commitment to quality products and customer satisfaction.

To aid in setup, calibration, and operation of all Testing Machines Inc. equipment, we offer telephone assistance by our Technical Support Department, available Monday through Friday from 8:30 AM to 5:00 PM EST. TMI also offers on-site Preventative Maintenance and Calibration service.

Please take the time to fill out the postage paid Warranty Card completely and return it to us. Your comments make it possible for us to evaluate how well we are servicing your needs.

In the unlikely event that your equipment requires warranty repair service, or if you need to arrange for non-warranty repair service, please follow the instructions on the repair policy page located in this manual. Supplying the requested information on the repair policy page enables our Technical Support Staff to service your needs faster.

Please contact us at (302) 613-5600 if additional information is required.

Sincerely,

Richard Young
Vice President of Sales
Unpacking

The following components should be delivered together with the instrument:

 Penal base plate with specimen clamp and vertical column with release mechanism for the dart

 Serial no: ...........................................

 A dart consisting of a hemispherical aluminium part with a polished surface and a 38.1 mm (1.5") diameter that has a vertical shaft in the entry of the flat top surface. The weight of the dart without the additional weights is 50 gr. approx. 0.1 gr.

 Additional weights:  

 \[ \begin{align*} 
 &\rightarrow 10 \text{ pcs of } 5 \text{ gr. approx. 0.1 gr.} \\
 &\rightarrow 8 \text{ pcs of } 15 \text{ gr. approx. 0.1 gr.} \\
 &\rightarrow 8 \text{ pcs of } 30 \text{ gr. approx. 0.2 gr.} \\
 &\rightarrow 8 \text{ pcs of } 60 \text{ gr. approx. 0.2 gr.} 
\end{align*} \]

 Nylon clamp to hold the additional weight in its place during the falling and the rebounce of the dart (weight 5 gr.)

 Date:______________       Signature:______________

 Note: Carefully check all small wrappings, boxes and envelopes in the large box to be sure all parts and supplies, as listed on the packing list, are accounted for.
The Instrument

A circular clamping device has been fitted on the base-plate in the vertical centre line of the inserted dart. You can push the dart in the release mechanism at the top of the vertical column. The clamping device consists out of both a firm and a moveable cylinder that have an inner diameter of 127mm (5”).

When the dart is inserted, the falling height of the material in the clamping device is 660mm (26”).

Scope

This method covers the determination of the energy that causes polyethylene film to fail under specified conditions of impact of a free-falling dart. This energy is expressed in terms of weight (mass) of the missile falling from a specified height that would result in 50% failure of the tested specimens. The method employs a dart with a 38mm (1.5”) diameter hemispherical head dropped from a 0.66m (26”) height. This method can be used by companies that want to test impact resistances that require masses of approximately 50 gr. or less to 2kg to fracture them.

Two testing techniques are described:

- Staircase method

  The staircase method is the standard technique. With this technique, a uniform weight increases or decreases by the uniform increment after testing each specimen. Whether it increases or decreases depends on the result – fail or not fail – observed for the specimen.

- Alternative technique

  The alternative technique provides in testing specimens in successive groups of ten. One missile weight is employed for each group and the missile weight varies in uniform increments from group to group.

The staircase and the alternative technique give equivalent results for the obtained impact failure weight values and for the precisions used to determine these values.

Significance

The method is used to establish the weight of the dart when 50% or more of the specimens fail under the specified conditions. The results gained are greatly influenced by the films you use in the test. The data limits with which you are content and that are obtained by this procedure can therefore vary significantly, depending on the sample quality, uniformity of film gauge, marks, contaminants, etc. These methods have been found useful for specification purposes. Correlation between test results and field performance can usually be established.

The impact resistance of polyethylene film, which partly depends on thickness, has no simple correlation with sample thickness. Hence, impact values cannot be normalized over a range of thickness without producing misleading data as to the actual impact resistance of the material. Data obtained with this method are only comparable to specimens that do not vary more than approx. 25% from the nominal or average thickness of the tested specimens.
Definitions

Missile Weight: The weight (mass) of the dart plus the total value of incremental weights attached plus the locking collar

Impact Failure Weight: The missile weight, estimated statistically, which would cause 50% or more of the specimens to fail the specified test

Conditioning

Test conditions: Conduct tests in the standard Laboratory Atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5% relative humidity unless otherwise specified in the test methods. In case of disagreement, the tolerances shall be ± 1°C (± 1.8°F) and ±2% relative humidity.

Instrument Preparation

Clamp a trial film specimen between the specimen clamps and do not add weights to the dart. Release the dart and observe the point where the dart hits the specimen, catching the dart after it bounces off the film surface.

If the specimen shifts during testing, reject the results. The chance of the specimen shifting increases with a higher dart weight and depends on the material that is being tested. Check shifting of the specimen throughout a test sequence of a standard sample at a missile weight in which both failures and non-failures are being observed.

Either one of the following procedures is effective. Draw a circle on the film with a ball point pen in contact with the inside wall of the upper clamp before dropping the missile on a clamped specimen. Only apply the pressure of the pen itself to the film.

CAUTION: For safety reasons, the dart should not be inserted in the release mechanism when you perform this procedure.

After the dart has been dropped and before removing the plastic, draw another circle with a ball point pen of another color. Once the lines are drawn, distinct double lines at any point on the circumference show that it shifted.
Staircase Testing Technique

Procedure:

At this technique, a uniform missile weight increment is employed during tests and the missile weight is changed after the testing of each specimen. Measure and record the average test specimen thickness in the impact area to the nearest 0.0025mm (000.1”). Select a missile weight near the expected impact failure weight to get the starting point. Add the necessary number of incremental weights onto the dart shaft and put the locking collar into position, so that the weights are held securely in place. Select a missile weight increment $\Delta W$ appropriate to the impact strength of the sample. The chosen value for $\Delta W$ should be a value in which three (minimum) to six missile weights will be employed in the determination. Usually, a $\Delta W$ value equal to some $5 – 15\% W_F$, the impact failure weight, is appropriate.

Place the first test specimen over the bottom part of the clamp, making sure that it is uniformly flat, that it has no folds and that it covers the entire gasket. Clamp it in place at the top part of the annular clamp. Put the dart into position. Release the dart. If the dart bounces off the specimen surface, catch the dart in order to prevent both multiple impact with the specimen surface and damage to the hemispherical contact surface of the dart, which is caused by impact with metal parts of the instrument. Check to see that the specimen has not shifted. If it did, you have to reject the results.

Check to see if the specimen failed or not. Failure is defined as a break through the film that can be observed readily by touching or looking at the specimen under a black light. Record the result on a form similar to the one in picture 1. Use a 0 for a non-failure and an X for a failure. If the first specimen fails, decrease the missile weight by $\Delta W$. If the first specimen does not fail, increase the missile weight by $\Delta W$.

Test the second specimen. Continue testing successive specimens, decreasing or increasing the missile weight by $\Delta W$ between drops, depending on whether the preceding specimen did or did not fail.

After having tested 20 specimens, count the total amount (N) of failures (Xs). If N=10 at this point, testing is complete. If it is not, complete the testing as follows:

1) If N<10, continue testing additional specimens until N=10
2) If N>10, continue testing additional specimens until the total number of failures (0’s) reaches 10.
Calculations

On the data record calculation form, put in the total number of X’s at each missile weight under the ni column, but take only the last 10 X’s during the test into consideration.

Note: If during the testing, N<10 or N>10 after 20 drops, there will only be 10 X’s after the testing is completed. Only when N>10 after 20 drops, it will be necessary to omit some of the earlier X-results.

Under i, enter integers 0, 1, 2, etc. for each ni entry. Put in 0 for the lowest missile weight for which a ni-value was entered, put in 1 for the second lowest ni-value, and so on. Enter the product of i times ni under ni. Add the ni’s and enter as N at the described procedure. N will always be equal to 10. Add the ini’s and enter as A. Enter Wo, the missile weight with an i-value of zero and also put in ΔW, the uniform missile weight increment employed. Calculate the impact failure weight Wf, g, as follows: Wf = Wo + (ΔW (A/N - ½)).

Alternative Testing Technique

Procedure:

This technique tests successive groups of ten specimens each. One missile weight is employed for each group and the missile weight varies in uniform increments from group to group. Testing is continued until there are at least five results for percentage failure: one 0% result, one 100% result and at least three results between 0% – 100%.

Note 2 – When you are into quality control, you may find it useful to estimate Wf from fewer than five failure results at missile weights not necessarily uniformly spaced. None of these results should have a 0% or 100% failure, at least one result should be less than 50% and at least one other result should be greater than 50%. Either the individual result or the changing averages of two results are plotted on probability paper: a straight line is fitted and Wf is read from the plot. Values of Wf estimated in this manner will be rather accurate, but not as precise as values derived from at least five failure results employing uniform missile weight increments as described above.

Set up the instrument for testing.

If you wish, you can conduct a slippage check as described at some point during the course of testing.

Measure and record the average thickness of the test specimens in the area of impact to the nearest 0.0025mm (0.0001”).

In order to get a starting point, select a missile weight near the expected impact failure weight. Add the necessary number of incremental weights onto the dart shaft and put the locking collar into place so that the weights are held securely in place.

Place the first test specimen over the bottom part of the clamp and ensure that it is uniformly flat, free of folds and that it covers the gasket at every point. Clamp in place with the top part of the annular clamp. Put the dart into position. Release the dart. If the dart bounces off the specimen surface, catch the dart to prevent both multiple impacts with the specimen surface.
and damage to the hemispherical contact surface of the dart resulting from impact with metal parts of the instrument.

Test a total of ten specimens at the selected starting missile weight. Record the missile weight and the percentage of failures. If the failure result for the first group of ten specimens is 0 or 100%, increase or decrease the missile weight by 15 gr or more. Continue doing this until a failure result between 0 and 100% is obtained.

Continue testing specimen groups at decreasing missile weights employing the new uniform increment until the 0% failure result is obtained.

NOTE: One or more of the percentage points found in 11.8 may be useable in this series employing a smaller weight increment.

If the minimum of five results has been obtained, you can stop the testing. If not, select a smaller weight increment and repeat the process described above. Continue to do this until you have the minimum of five results at uniform weight increments.

Calculations

Determine impact failure weight, Wf, by calculation or graphing. Both approaches basically give the same results. Calculate Wf as follows:

\[ A_f = W_l \left( \frac{S}{100} - \frac{1}{2} \right) \]

In which:

- Wf = impact failure weight, gr.
- W = uniform weight increment used, gr.
- Wl = lowest missile weight, gr. according to the particular W used, at which 100% failure occurred
- S = sum of percentages of breaks at each missile weight (from a weight corresponding to no failures up to and including Wl).

Example:

<table>
<thead>
<tr>
<th>Missile weight, gr.</th>
<th>% Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>0</td>
</tr>
<tr>
<td>106</td>
<td>10</td>
</tr>
<tr>
<td>121</td>
<td>20</td>
</tr>
<tr>
<td>136</td>
<td>60</td>
</tr>
<tr>
<td>151</td>
<td>100</td>
</tr>
</tbody>
</table>

\[ S = 190 \]

\[-W = 15 \text{ gr} \quad Wl = 151 \text{ gr} \]

\[ Wf = Wl - \left( W(S/100 - \frac{1}{2}) \right) \]

\[ = 151 - (15 (190/100 - \frac{1}{2})) \]

\[ = 151 - (15 (1.4)) \]

\[ = 130 \text{ gr} \]
Average successive pairs of missile weight percentage failure results, incl. 0% and 100% failure points, in order to obtain points for plotting.

Construct a plot on probability paper with percentage failure on the probability scale and weight of the linear scale after having dimensioned the linear scale in such a way that the result is on a straight line and the points slope between approx. 0.3 and 1.0. Draw the best line as straight as possible through the points and read Wf from the graph where the missile weight corresponds to the intersection of the straight line with the 50% probability line.

Routine Inspection and Acceptance

13.1 For routine inspection of thin plastic film of a specified gauge supplied by a certified supplier, it is sufficient to accept a lot based on the testing of a minimum of ten specimens at a specified weight as stated in the relevant material specification. This procedure accepts no more than five failures.

Report

The report will include the following information:

- Complete identification and description of the tested material, including type, source, manufacturer’s code, principal dimensions and previous history;
- Impact failure weight to the nearest 1;
- Thickness of tested film and thickness range for tested specimens;
- Conditioning procedure followed;
- Testing technique applied and date of test.

Only the following will be reported for routine inspections and acceptance testing:
- Weight used and number of failures.
Specifications

- Falling Height: Method A (43-26) 660 mm (26 in.)
- Weight of falling dart without additional weights: 50 g ± 0.5%
- Additional weights: 10 pcs of 5 gr. approx. 0.1 gr.
  8 pcs of 15 gr. approx. 0.1 gr.
  8 pcs of 30 gr. approx. 0.2 gr.
  8 pcs of 60 gr. approx. 0.2 gr.

- Falling speed on sample: Approx. 3.5 m/sec.

Instrument size

- Depth: 280 mm (11 in.)
- Height: 900 mm (35.5 in.)
- Width: 280 mm (11 in.)
- Weight: 19 kg (42 lb)

- Falling Height: Method B (43-26/27) 1500 mm (59 in.)
- Weight of falling dart without additional weights: 300 g ± 0.5%
- Additional weights: 8 pcs of 15 gr. approx. 0.1 gr.
  8 pcs of 45 gr. approx. 0.2 gr.
  8 pcs of 90 gr. approx. 0.2 gr.

- Falling speed on sample: Approx. 3.5 m/sec.