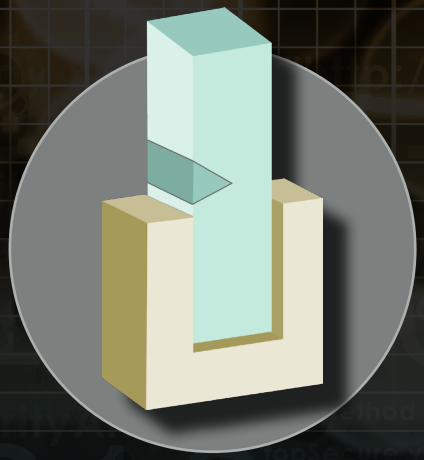
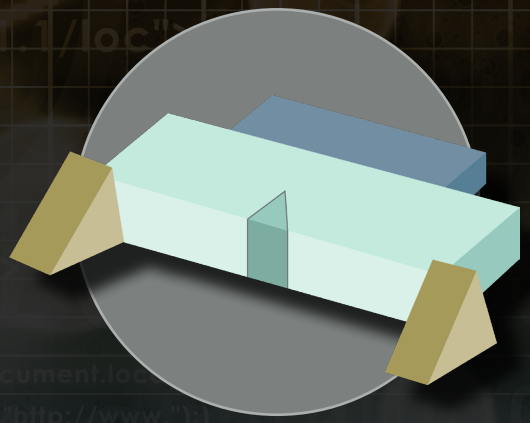
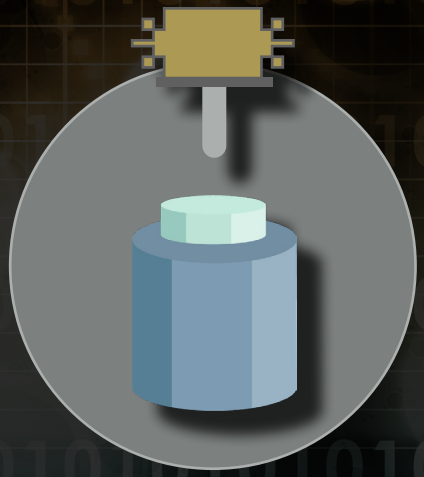
UNDERSTANDING DIFFERENT IMPACT TESTS USING ASTM & ISO STANDARDS

CHARPY | IZOD | MULTI-AXIAL







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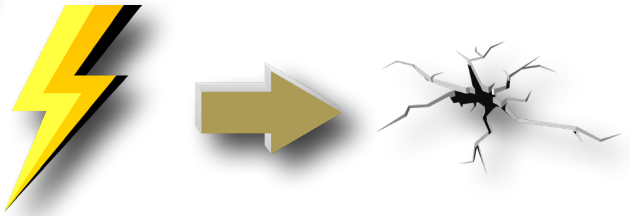
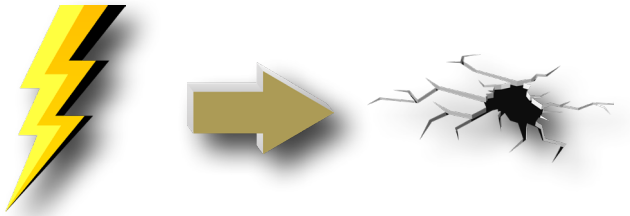
What is an impact test? It is when a load is applied to a specimen, generally at a high velocity, then measuring the response of the specimen. There is a two-step process when breaking the sample.

STEP 1 Energy is provided to initiate a crack.



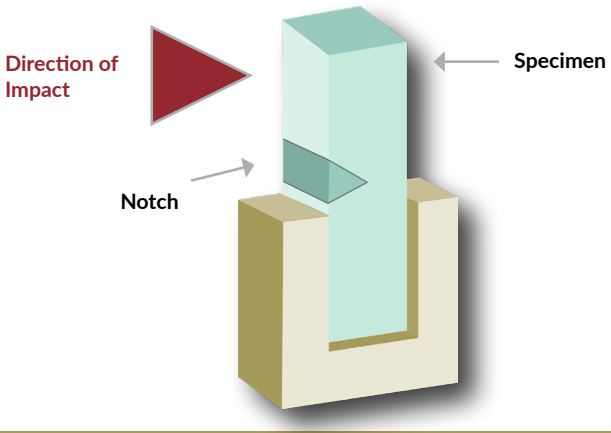
STEP 2 It is followed by more energy to enlarge the crack to failure.



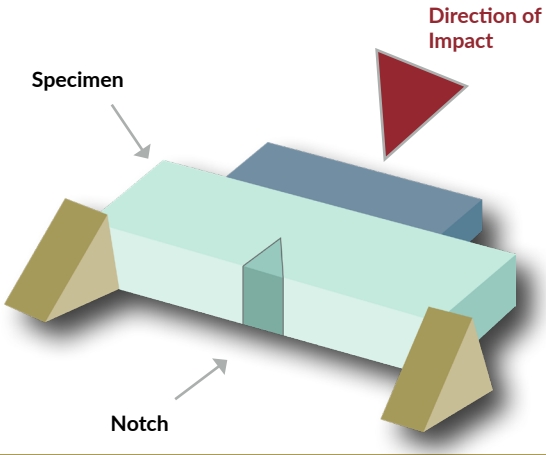
TYPES OF PLASTICS IMPACT TESTERS

- The two most basic and well known impact pendulum testers for plastic materials are the Izod and Charpy. These plastic impact test methods measure the energy absorbed by the specimen caused by the impact to create failure. These test are typically pass/fail tests: They give the average impact energy required to break the samples.
- The Multiaxial impact test produces a load-deflection curve. Numerous data values related to toughness and total energy are calculated including maximum force, energy at maximum force and total energy to break.

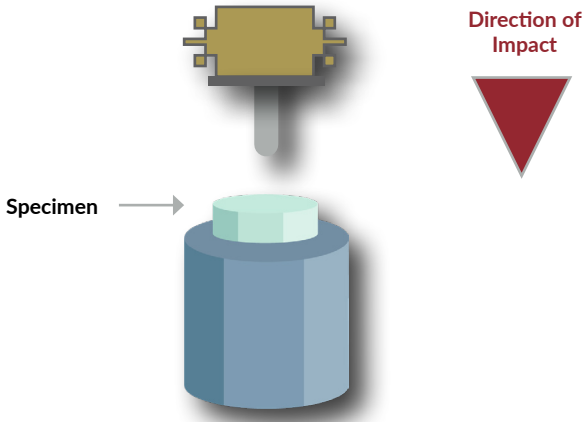
IZOD



CHARPY



MULTI-AXIAL



IMPACT RESULTS ARE AFFECTED BY MANY FACTORS:

- Temperature.
- Humidity or moisture content.
- Impact velocity or strain rate.
- Total kinetic energy of the pendulum.
- Impact geometry—shape and dimensions of the sample and the impact device, as well as the angle and direction of impact.
- How the sample is prepared / fabricated (molded, extruded, or machined).
- Sample-notching procedure.
- Sample mounting in the tester.

CHARPY IMPACT TEST ISO 179

Charpy Impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Charpy impact is defined as the kinetic energy needed to initiate fracture and continue the fracture until the specimen is broken. The values recorded can be used for quality control or to simply differentiate toughness.

Test Procedure:

The specimen is mounted horizontally and supported unclamped at both ends. The hammer is released and allowed to strike through the specimen. If breakage does not occur, a heavier hammer is then used until there is a failure.

Specimen Size:

Specimens are 80 x 10mm by thickness. The specimens can be either notched or unnotched.

Data:

Impact energy is expressed in kilojoules. Impact strength is calculated by dividing impact energy in kilojoules by the area under the notch, with the units of kJ/m2. A higher number indicates a tougher material.

√ Charpy Impact ISO 179 √ ISO 180 √ kJ/m^2

IZOD PENDULUM IMPACT RESISTANCE ASTM D256

ASTM D256 covers the determination of the resistance of plastics to "standardized" pendulum-type hammers, mounted in "standardized" machines, in breaking standard specimens with one pendulum swing. The standard test for ASTM D256 requires specimens to be made with a milled notch. This is technically an equivalent standard to ISO 180 – Determination of Izod Impact Strength of Rigid Materials.

The excess energy pendulum impact test indicates the energy to break standard test specimens of specified size under stipulated parameters of specimen mounting, notching and pendulum velocity-at-impact.

TESTING STANDARDS FOR ASTM AND ISO

- ASTM D256 – Standard Test Method for Determining the IZOD Pendulum Impact Resistance of Plastics.
- ISO 180: Plastics – Determination of Izod Impact Strength of Rigid Materials.

	CHARPY IMPACT TESTING	IZOD IMPACT TESTING
Tested Materials	Plastics	Plastics
Types of Notches (0.25mm) Preferred	V-notch	V-notch
Specimen Position	Horizontally, Notch facing away from the pendulum	Vertically, Notch facing towards the pendulum
Point of Impact	Middle (center) of the sample	Upper Tip of the sample
Common Specimen Dimensions	80 x 10 x 4 mm (ISO)	64 x 12.7 x 3.2 mm (ASTM)
Specifications	ISO 179	ASTM 256, ISO 180

IZOD IMPACT: ASTM VS ISO

There are two primary differences between the ASTM method and ISO method.

1. The ASTM uses a specimen that is ½ inch wide and can be either 1/8 or 1/4 inches thick. The ISO method uses a specimen that is 10 mm wide by 4 mm thick.

2. The ASTM method requires you to take the torque and divide it by the specimen thickness only. The ISO method requires you to divide the torque by the thickness times the width of the specimen, in other words, the cross-sectional area.

The ASTM method provides a torque/thickness value. The ISO method provides a torque/cross-sectional area value which makes it very difficult to convert from one to the other. Typically, the ASTM Izod method reported in units of ft-lb/in or J/m and the ISO method is usually reported in kJ/m^2 or less commonly $ft\text{-}lb/in^2$.

COMPARISON OF IZOD IMPACTS FOR ASTM METHOD VS ISO METHOD FOR SOME COMMON MATERIALS

MATERIAL	ISO 180 (NOTCHED)	ASTM D 256 (NOTCHED)
Tested Materials	Plastics	Plastics
Types of Notches (0.25mm) Preferred	V-notch	V-notch
Specimen Position	Horizontally, Notch facing away from the pendulum	Vertically, Notch facing towards the pendulum
Point of Impact	Middle (center) of the sample	Upper Tip of the sample

This correlation can be useful for making rough estimations of impact strength results but the most ideal way to compare impact strength results is to mold, condition and test the specimens using the size, dimensions and test method. The difference between ASTM and ISO will exist as they are of two different specimen sizes and the value never match.

*Key Reminder: ISO test method uses a square at the end of the unit. ASTM test method does not use a square at the end of the unit.

DATA SHEET CONVERSION FACTOR				
Impact	ISO Unit	ASTM Unit	ISO to ASTM	ASTM to ISO
Charpy	kJ/m^2	ft-lb/in	* by 0.476	* by 2.1
Izod	kJ/m^2	J/m	* by 10.16	* by 0.098
Izod	$ft\text{-}lb/in^2$	ft-lb/in	* by 0.4	* by 2.5
Izod	J/m	ft-lb/in	* by 0.019	* by 53.35
Izod	kJ/m^2	ft-lb/in	* by 0.019	* by 5.25

Note: There is not an exact conversion from ISO to ASTM, this is only an approximation.

MULTIAXIAL IMPACT ASTM D3763 AND ISO 7765-2

The Multiaxial impact test provides full force and energy curves during the millisecond of the impact, using a “Tup” which incorporates an impact head and a load cell. Data is often used to specify appropriate materials for applications involving impact. This test is also used to evaluate the effects of secondary finishing operations or other environmental factors on plastic impact properties.

Test Procedure:

The specimen is clamped onto the testing platform. The crosshead, with the attached Tup, is raised to the appropriate height and is released so that it impacts the sample at a specified speed. A load-deflection curve is produced.

Specimen Size:

Generally 4” x 4” plaques or 4” diameter disks. Any size or shape that will fit an impact tester.

Data:

Specimens are conditioned in a freezer until an equilibrium is met at a specified temperature, normally a 6 hour minimum. Prior to testing, the thermal chamber is brought to temperature and moved from the freezer to the chamber and one specimen is clamped onto the testing platform. Once the chamber returns to equilibrium the crosshead is released to impact the specimen.

The energy required to puncture a material by impact with a falling dart under specified test conditions. This test measures the multiaxial impact behavior of a material and can be used as a measure of the rate sensitivity of a material.

Impactor Head:

A 12.7 mm (0.5 in) diameter hemispherical head dart is dropped from a height sufficient to produce a specified impact velocity. The dart is equipped with load and displacement transducers so that a load/displacement plot of the test can be produced. Energy is the area beneath the load/displacement plot. Energy reported is either energy to peak load or total energy.

INSTRUMENTED DART IMPACT - ISO 7765-2

The energy required to puncture a material by impact with a falling dart under specified test conditions. This test measures the multiaxial impact behavior of a material and can be used as a measure of the rate sensitivity of a material. This test method is for thicknesses less than 1 mm. For thicknesses greater than 1 mm, ISO 6603-2 should be used.

Impactor Head:

A 20 mm diameter (10 mm may also be used) hemispherical head dart is dropped from a height sufficient to produce a specified impact velocity. The dart is equipped with load and displacement transducers so that a load/displacement plot of the test can be produced. Energy is the area beneath the load/displacement plot. Energy reported is either energy to peak load or total energy.

When analyzing multiaxial test results, whether ASTM or ISO standards are utilized, if the load/displacement plot shows a clear point of first failure, the failure energy is the area beneath the curve up to the failure point. The difference in the diameter of the impactor heads and the thickness of the specimen will determine which standard is necessary.

Note: Since many thermoplastics exhibit lower impact strength at reduced temperatures, it is sometimes appropriate to test materials at temperatures that simulate the intended end use environment.

Please note that this test description is intentionally generic and we are not able to provide copies of standards due to copyright restrictions. Standards can be obtained from appropriate standards authorities.