Instrumental Setup (Charpy Mode)

Information:

At the start of the experiment, the instrument should have already been setup for Charpy mode impact test. A specific anvil should be used for Charpy Impact Test. The setup complies with the ASTM standard.

Equipment Setup

The digital setup should be done on the small digital controller that is installed on the machine (*Figure 5.3*).

1. Turn the main power "On". This switch is located at the back of the digital controller.
2. Select **button #4** (Configuration), then hit **Enter**.
3. The hammer weight reading on the digital controller screen should read **18.48 N** (corresponds to weights 2018 on the pendulum)
4. Go to the next screen, Units, by selecting **button #3**, followed by **Enter**.
5. In the next screen, select the appropriate units as follows:
    (a) For Energy, select option **Joules** and hit **Enter**.
    (b) For Strength, select option **J m^{-1}** and hit **Enter**.
    (c) For Strength 2, select option **J m^{-1}** and hit **Enter**.
6. Select **button #5** (Procedure), then hit **Enter**.
7. In the next screen, select **None**, then hit **Enter**.
8. When prompted for the specimen ID, select **Auto Increments**.
9. The next screen will ask for the specimen dimensions, in this case, select **Once**.
10. For break type, select **None**.
11. For limits, select **None** also.
12. For results, select **Auto Accept**.
13. For print mode, select **Table**.

Calibration

1. Start the calibration by ensuring that the pendulum/weights are not latched in the test position.
2. At the digital controller, select **button #2** (Calibration), and hit **Enter**.

3. Follow the instructions on the screen that follows.
4. Go to the Friction Loss screen by selecting **button #7,** and hit **Enter**.
5. The next screen would show: "number of half cycle: 11". Keep the number the same *i.e* simply proceed by selecting **Enter**.
6. Follow the instructions as displayed on the screen.
7. Upon the completion of the calibration, if everything is fine, the display should show the following, while the pendulum is latched:

    PE = 11.259 J

    EL = 0.0000 J

    HT = 609 mm (±0.2 mm)

    ANG = -145 DEG

    [Note: In order for the experiment that follows to comply with the *ASTM D256* standard, the HT value, in particular, should display a value of 609 mm (±0.2 mm). This indicates that the anvil velocity is about 11.3 feet per second. If the value is not within 0.2 mm, adjust the latch arm and start the calibration all over again].

Impact Test Experiment

1. Take note of the position of the transparent plastic shield, such that the pendulum does not hit while swinging. The amount of energy loss due to hitting the shield will result in experimental errors. Then, remove the shield.
   (Note: If you are running the second sample, stop the pendulum carefully with your hand by grabbing it at the central edge of the arc-shaped the pendulum. Grabbing it at the lower end may cause injury due to the presence of a sharp metal).
2. Latch the pendulum.
3. Place the specimen on the sample holder. Make sure that it is placed horizontally and well aligned to ensure an accurate result. For the notched sample, place the sample such that the notch is positioned opposite to the direction at which the pendulum strikes, and be quick when placing the nitrogen cooled sample.
4. Go to the digital controller, and select **Test** button.

5. When prompted for the Sample ID, select **None**.
6. When prompted for the width of the sample, select the appropriate buttons to enter the width value that was measured earlier in mm.
7. The digital controller display will then prompt you to select **Enter** when ready. In that case, place the transparent plastic shield back to the position that was noted earlier.
8. Start the experiment by releasing the pendulum from its latch position by unlocking the latch with one hand and be sure that you do not stand too close to the instrument.
9. Once the pendulum hit the sample, the digital controller screen will display the results of the experiment only for one minute. Past one minute, the display will disappear. To prevent the display from disappearing, or to return the results back on the display screen, select the **Stats** button.
10. Take note of the values displayed on the screen and record your observation as to whether the sample was broken or not. If the sample is broken, examine the cross section of the sample to look for any cause of failure propagation.
    (Note: Keep the sample for later examination. Also, be sure that each sample is clearly labeled to alleviate your later study).
11. Start over from number 1 of this section to run the next sample.

Cleanup

1. Use a small broom and dustbin to clean any fragments from the broken samples.
2. Turn the main power of the digital controller "off" using the switch located on its back.
3. Return the transparent plastic shield back to its place.

Lab 5: Impact Testing

Introduction

Plastics are often more prone to fail under impact rather than under slowly-applied or constant load. The ability of a material to resist a high-rate loading is most commonly determined by a method known as impact test. This property is known as impact resistance or toughness. Impact resistance is one of the most important properties for a part designer in industry to consider because it involves the perplexing problem of product safety and reliability. In the design process, when considering the impact property of a material, one must determine the following factors:

1. The amount of impact energies in a part that can be expected in its lifetime.
2. The type of impact that will deliver that energy.
3. The choice of materials that will resist such assaults over a projected lifespan.

Molded-in stresses, polymer orientation, weak spots (e.g. weld lines or gate areas), and part geometry will also affect the impact performance of a material. Impact properties can be changed when additives, e.g. coloring agents, are added to plastics.

During an impact experiment, a certain amount of energy is induced (impact energy) onto a material under study, which is later absorbed. The absorbed energy, in an engineering term, is a measure of a material's strength and ductility.

Ductile vs. Brittle Behavior

Most real world impacts are biaxial rather than unidirectional. Further complication is offered by the types of failure modes: ductile or brittle. Brittle materials take little energy to start a crack, and a little more to propagate the crack to a shattering climax, which leads to failure. Other materials possess ductility to varying degrees. Highly ductile materials require a high-energy load to initiate and propagate the crack.

Many materials are capable of either ductile or brittle failure, depending upon the type of test and rate and temperature conditions. Others possess a ductile/brittle transition that actually shifts according to these variables. Figure 5.1 shows a plot of force versus time to show these differences.

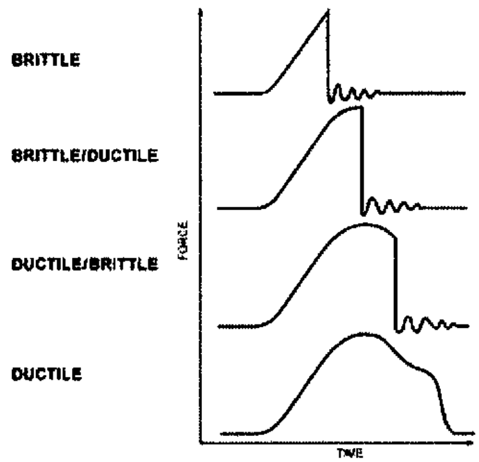

Figure 5.1. Typical force curve in ductile and brittle failure.

Pendulum Test

There are basically two types of impact tests: pendulum and drop weight[1]. Izod, Charpy, and tensile impact are the most common of the pendulum type tests. In this lab, we will deal only with the Charpy impact test. The difference between Charpy and Izod impact tests is the way in which the specimen is placed while being struck by a pendulum. In a Charpy impact test, a sample is laid horizontally on two supports against a pendulum. Figure 5.2 illustrates this. In an impact experiment, the sample could be notched, which acts as a crack propagator, or unnotched. Figure 5.3 shows the impact test instrument used in this lab.[2] This instrument could be setup for both Charpy and Izod impact test experiment. The experiment that was done in this lab complies with the ASTM standard (*ASTMD 256*).

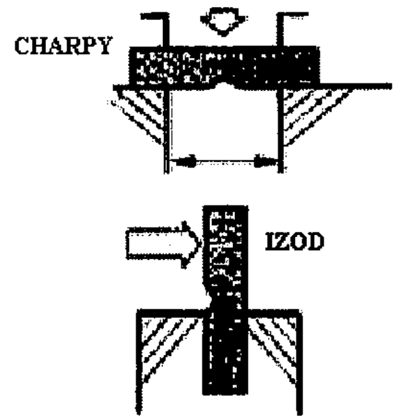

Figure 5.2. Schematic diagram of a Charpy and Izod mode for impact testing.[1]

The first attempts at obtaining the energy in a pendulum test were done by hoisting a pendulum having a specific weight to a known height on the opposite side of a

[1] A website of "Impact Strength", University of Manchester: http://www2.umist.ac.uk/material/research/intmic/features/charpy/notes.htm
[2] A website of tiniusolsen company: www.tiniusolsen.com/products/ p-model92t.html

pivot point. When released, the weight falling from the set height will contain a certain amount of impact energy at the bottom of the swing. By clamping or supporting a specimen on the bottom, the pendulum can be released to strike and break the specimen. The pendulum will continue to swing up after the break event to a height somewhat lower than that of a free swing. The energy that was lost in breaking the specimen can be calculated using this lower final height point. Many pendulum machines will incorporate a pointer and energy reading device so that calculation is unnecessary.

Figure 5.3. Tinius Olsen Model 927 Impact Tester.

Procedure

Important!!

1. Wear the safety goggles throughout the impact testing experiment to prevent any of the broken pieces from the sample from getting into your eyes.
2. A teaching assistance will handle the liquid nitrogen to place the polymer specimen in and out of the liquid nitrogen container.

   (**Warning**: Do not handle the liquid nitrogen without any instruction of the teaching assistance).

Sample Information (ASTM Standard)

1. Use a pair of vernier-calipers to measure the width and thickness of each specimen. When measuring the width of the notched sample, be careful not to agitate the notching as it could weaken the sample unnecessarily.

   [Note: Each of the polymer samples should have approximately the same width and thickness dimension. The samples were injection molded. Its dimensions were determined according to *ASTM D 256 (Test Method B)*: Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens for Plastics (Charpy method)].
2. One of the samples, Glass-Filled Nylon66 is notched using a standard milling machine. The manner and the dimensions at which the notching is made are also described in the ASTM standard manual.
3. Three specimens of the same material are provided, so that an average value could be obtained in the experiment. Number each specimen of the same material from 1 to 3.
4. For the low temperature impact tests specimens, the teaching assistance will place them in the liquid Nitrogen container.

   [Note: Allow enough time for the specimens to cool. It takes a while (5-10 minutes) for the polymer specimen to reach an equilibrium temperature with the liquid Nitrogen].