Experiment 4

Izod Impact Test of Metals and Alloys

Aim: To determine the Izod number of specimens of alloys/metals.

Apparatus Required: Izod impact testing machine.

Theory: Apart from *strength* and *hardness*, the most important mechanical property is *toughness*. It is nothing but *resistance to fracture*. Fracture in a specimen can take place in different ways. One of the ways is *impact or suddenly applied loading*. *Izod impact test* is one type of *dynamic impact test*. Another type of impact test is known as *Charpy impact test*. Before we proceed further, we must know the differences between these two types of tests. In case of Charpy test, the specimen is supported as a beam and an impact is made by a *swinging pendulum* of large weight. The side of the specimen where the pendulum hits suffers compression while the other side is in tension. On this tensile surface, a V-shaped or U-shaped *notch* is made. In fact the *V-notch* is the most common one. Before placing the specimen, the heavy pendulum is allowed to swing freely and with the specimen held in position, the reduced swing of the pendulum is noted. The difference in swing when converted into energy gives the *Charpy V notch energy*. This represents the *energy absorbed by the specimen before breakage*.

In *Izod impact tester*, the *specimen is supported as a cantilever beam*. Its bottom part is held rigidly in a clamp and the upper free end is hit by the swinging pendulum. The difference between the free swing of pendulum and the swing with the specimen in position gives the energy required for breaking the specimen. The energy difference (associated with the difference in swing) is shown in foot-pound in a scale fitted with the frame of the machine (Figure 1).

The specimen has a typically made notch with an internal angle of 45° (Figure 2). These notches are responsible for raising the localised stress concentration and trigger the fracture. *Izod number* is nothing but the *energy expressed in foot-pound which a specimen absorbs prior to fracture*. If the notch angle is changed or notch depth is changed, Izod number also changes. For those metals and alloys where ductility is high, Izod number is also high, that is, more is the energy absorbed. Metals like Aluminium are *ductile at room temperature* and absorb *higher amount of impact energy* than specimens made of Brass or Cast Iron. So Izod number is higher for Aluminium than Brass. The typical geometry of the specimen is given in Figure 2.

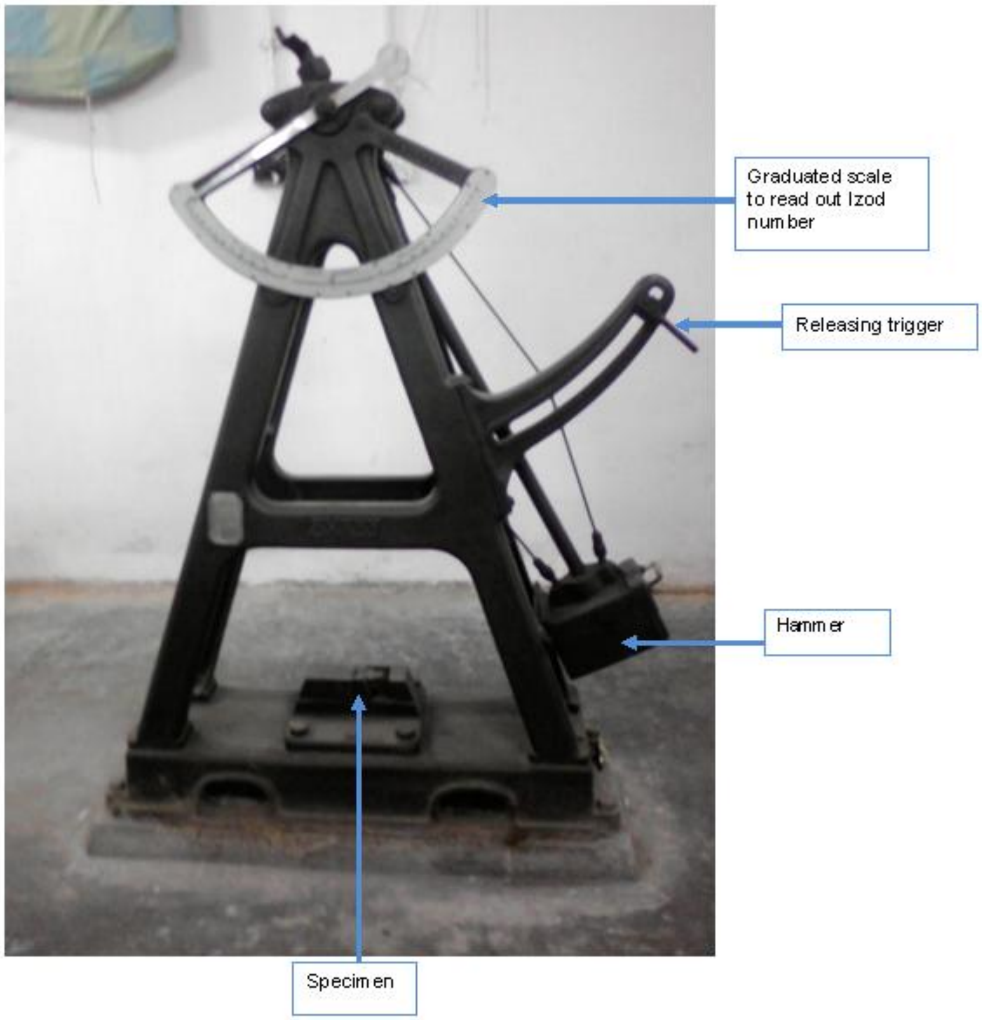

Figure 1 Izod testing machine.

(*Photo Courtesy*: Applied Mechanics Laboratory, Mechanical Engineering Department, Jadavpur University, Kolkata)

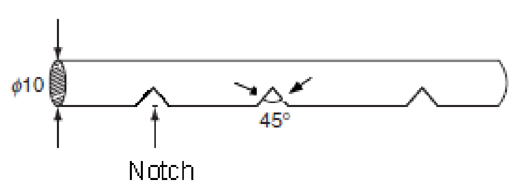

Figure 2 Izod specimen.

Precautions:

1. During free swing of the heavy pendulum, it should be carefully noted whether there is any loss or not. If there is frictional loss in the supporting bearing evident from the free swing range, that loss of energy is to be subtracted from the energy absorbed during hitting.

2. The sample should be held rigidly so that it does not move during impact.

3. The sample should be placed in such a manner that maximum bending stress (tensile) develops at the notch level.

4. Speed of impact affects the Izod number. So care should be taken so that every time the weight swings freely.

Special Observations:

1. *Notch sensitivity* is high for Izod test and hence all the notches should be same in dimension to avoid scattering in the experimental results.

2. With ductile materials like Al, the Izod number is higher and the fractured surface is predominantly rough. Here the fracture takes place along a tortuous path. In case of brittle materials like cast iron, the surface of fracture is comparatively smooth. This is termed as *cleavage fracture*.

3. Although classically Izod number is not synonymous with toughness, it provides some idea about the fracture toughness of materials on a comparative basis.

4. The speed of the swinging pendulum can have some effect on energy absorption. It is because with increased speed of impact, the specimen breaks easily which causes a reduction in Izod number.

5. With increase in temperature, Izod number increases. Hence, while quoting the Izod number of any material, the temperature of testing should be maintained. For different metals and alloys, this variation of Izod number or so-called *impact toughness* can be plotted against temperature and a specific temperature (or more correctly a temperature zone) can be identified where ductile to brittle transition (if the temperature goes down) takes place. Above that temperature, the concerned material is ductile while below that it is brittle. This range is commonly known as the *Ductile-to-Brittle Transition Temperature* or *DBT*.

6. It has already been mentioned that notch geometry influences stress concentration in Izod test. This is also true for Charpy test and different types of Notch geometry can give different values of Izod number or Charpy 'V' notch energy or CVN.

So, the tests are always to be conducted as per specific standards. Finally, it may be noted that Izod or Charpy data cannot be used directly for design purpose. For high yield point materials, this is possible but only after considering these values to suitable value of stress intensity factor, they can be used in design.