Abstract:-

In this lab we performed impact and tensile testing on various types of Polymers. Impact testing was performed to determine the brittleness of the materials. Tensile testing was performed on polymers to determine their brittleness and plastic behavior during tension forces. The High Impact Polystyrene (HIPS) samples were found to be more brittle as they were exposed to cooler temperature conditions. While for tensile testing, HIPS was again, observed to have the lowed resistance to tensile forces.

Introduction:-

Impact energy is the energy that can cause fracture on a specific material. This type of testing or impact testing is known as destructive testing because usually in order to get the physical measurements, one has to destroy the material. The more brittle a material is the less energy it is required to cause fracture. A material can be hard but at the same time also brittle. That is, it won’t resist much force before it breaks at a point. In our experiment, we used the pendulum tester. As the name implies, it uses the swinging motion of a pendulum, to fracture the material, and any resistance to its motion is measured as the energy required to cause that fracture.

Tensile testing is a bit different. Here, tensile forces are applied on the polymers and they are forced to stretch. The more brittle material will resist this at first and then finally break at a certain point. This point would be where the atomic lattice is stretched so thin over each other that keeping the material intact would no longer be possible by inter-atomic and inter-molecular forces. The tension forces here exceed the combined inter-molecular and inter-atomic forces. We used Tinius Olsen tensile tester for this purpose.

Materials and Methods:-

We performed the impact testing first. The material used for this part of the experiment was High Impact Polystyrene (HIPS), with a ‘v’ notch cut on the side. This allowed the easy, calibrated fitting on the testing equipment. A pendulum based testing machine was used to calculate impact energy. The machine works on the principle of gravitational potential energy. The pendulum has a certain amount of gravitational potential energy and hence when it impacts the test material, a resistance to the motion occurs. The decrease in the potential energy is the impact energy for the material. We used only High Impact Polystyrene for this part. High Impact Polystyrene was treated at five different temperatures. We had three samples for each of the temperatures. They were treated at room temperature, cooled by immersion in ice, immersion in liquid Nitrogen, place in oven at 70°C and oven temperature at 90°C. The impact results were then displayed on the Screen of the machine in Joules of energy.

For the second part of the experiment we performed tensile testing. Tensile testing was performed using the Tinius Olsen tensile tester. We place the sample between two grips of the machine. One grip remains stationary while the other one moves in the upward vertical direction. The concept here is to impart tension on the sample until it breaks. Different materials exhibit different mechanical properties. Materials that tend to extend a lot, exhibit ‘elastomeric’ stress-strain behavior. Materials that have a moderate extension show ‘plastic’ stress strain behavior, while materials that resist any form of extension, exhibit brittle behavior, that is, they are hard and stiff but crack when subjected to tensile forces. We used six different samples. They were Nylon 6, Polypropylene (PP), Polymethyl methacrylate (PMMA), Polycarbonate (PC), Polyvinyl chloride (PVC) and High Impact Polystyrene (HIPS). The physical dimensions of the six samples were taken by a dial caliper and results represented in millimeters (mm) of length. We then repeated the measurements after the samples had been subjected to tensile testing.

Discussion:-

From the result of the first experiment, BE and increases as the temperature increase. Thus, the impact energy increases faster as the temperature increases. From these trends, our best result of the result is that impact energy (breaking energy) is exponentially related to the temperature. Also, during the experiment, we can notice that the sample gets softer as the temperature increases.

In the second experiment, the data graph shows that most material went up to their maximum stress and then had a dramatic drop on the stress, except Nylon which had its maximum stress just before it broke. This linear elastic period at the beginning is relatively short for all materials. All materials’ stress increases before they broke. In all, Nylon has the best elastic property and has the lowest slope of linear elastic region, which indicates it is easy to be stretched and has good elastic extension; Polypropylene has the longest extension under stress and relatively low slope of linear elastic region, which shows it has good inelastic extension; both PMMA and PVC have very large slope of linear elastic region and break very fast, which presents they are hard be extended and very brittle; Polycarbonate and HIPS all shows a drop of stress after maximum stress achieved, but the stress keeps increases until they break.

Conclusion:-

* Impact energy of polymers increases exponentially as temperature increases
* Most polymers achieve their maximum stress after the linear elastic region
* All polymers show an increase in their stress before they break
* Due to different structure and order of their molecules, polymers have different characteristics.

Appendix: