PLASTIC TECHOLOGY

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INTRODUCTION

- A plastic material is any of a wide range of synthetic or semi-synthetic organic solids that are mouldable.
- Plastics are typically organic polymers of high molecular mass, but they often contain other substances.
- They are usually synthetic, most commonly derived from petrochemicals, but many are partially natural.
- Synthetic resigns may be phenol, formaldehyde, cellulose vinyl, alkyl, etc. The moulding compounds are catalysts, fillers, hardeners, lubricants, pigments, plasticizers, solvents, etc.

- **POLYMERIZATION:** The simplest substances consisting of one primary chemical are known as the monomers or monoliths. They are to be combined or synthesized to form polymers by the process known as the **polymerization**.

- **POLYMER** : The word polymer literally means " many parts ". A polymeric solid material may be considered as to be one that contains many chemically bonded parts or units which themselves are bonded together to form a solid.

- Two industrially important polymeric materials are:
  1. Plastics
  2. Elastomers

- Plastics are a large and varied group of synthetic materials which are processed by forming or molding into shape. Just as we have many types of metals such as aluminium and copper, we have many types of plastics such as polyethylene and nylon.

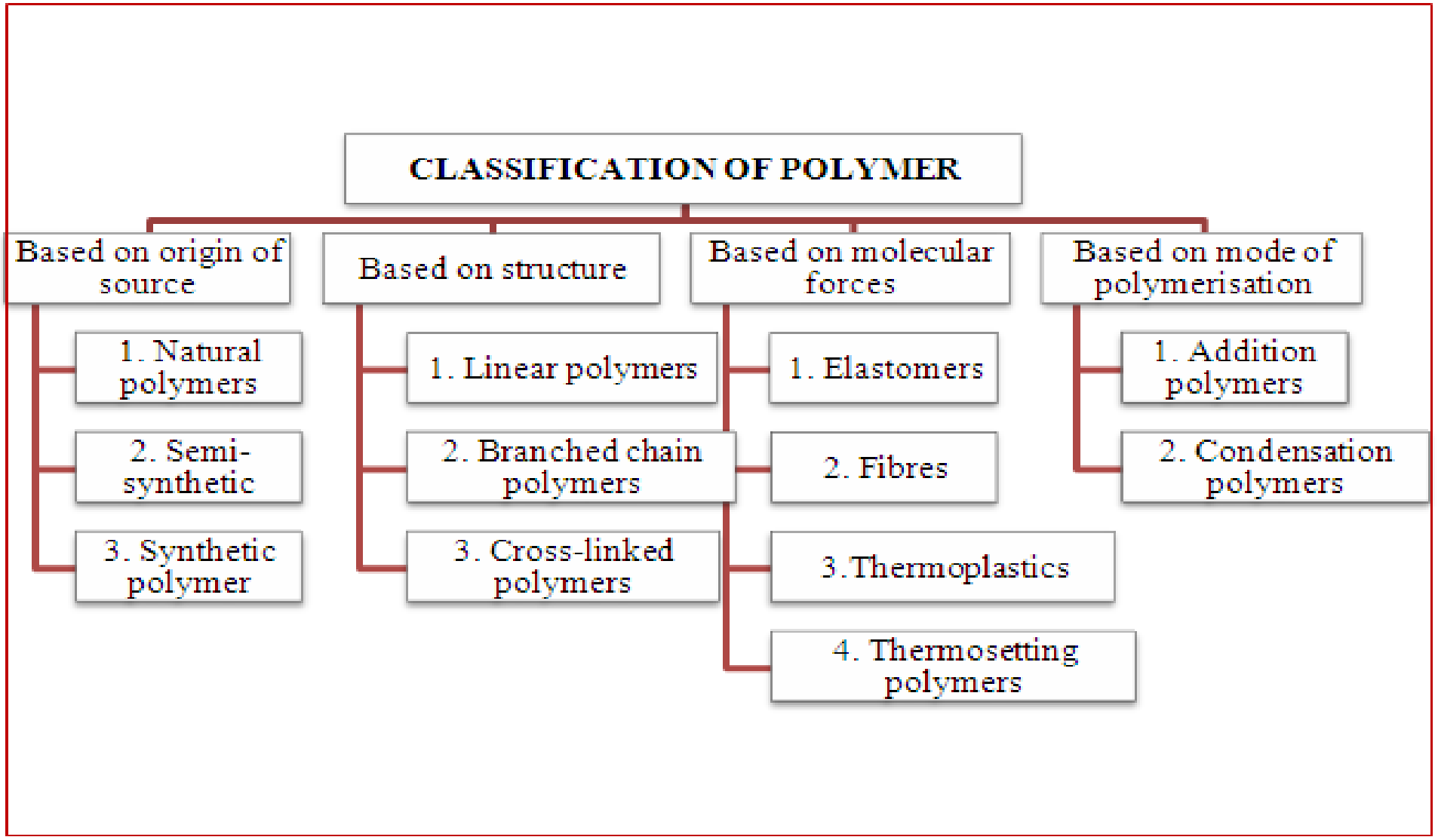
- Plastics can be divided into two classes.

  1. Thermo plastics

  2. Thermo setting plastics,

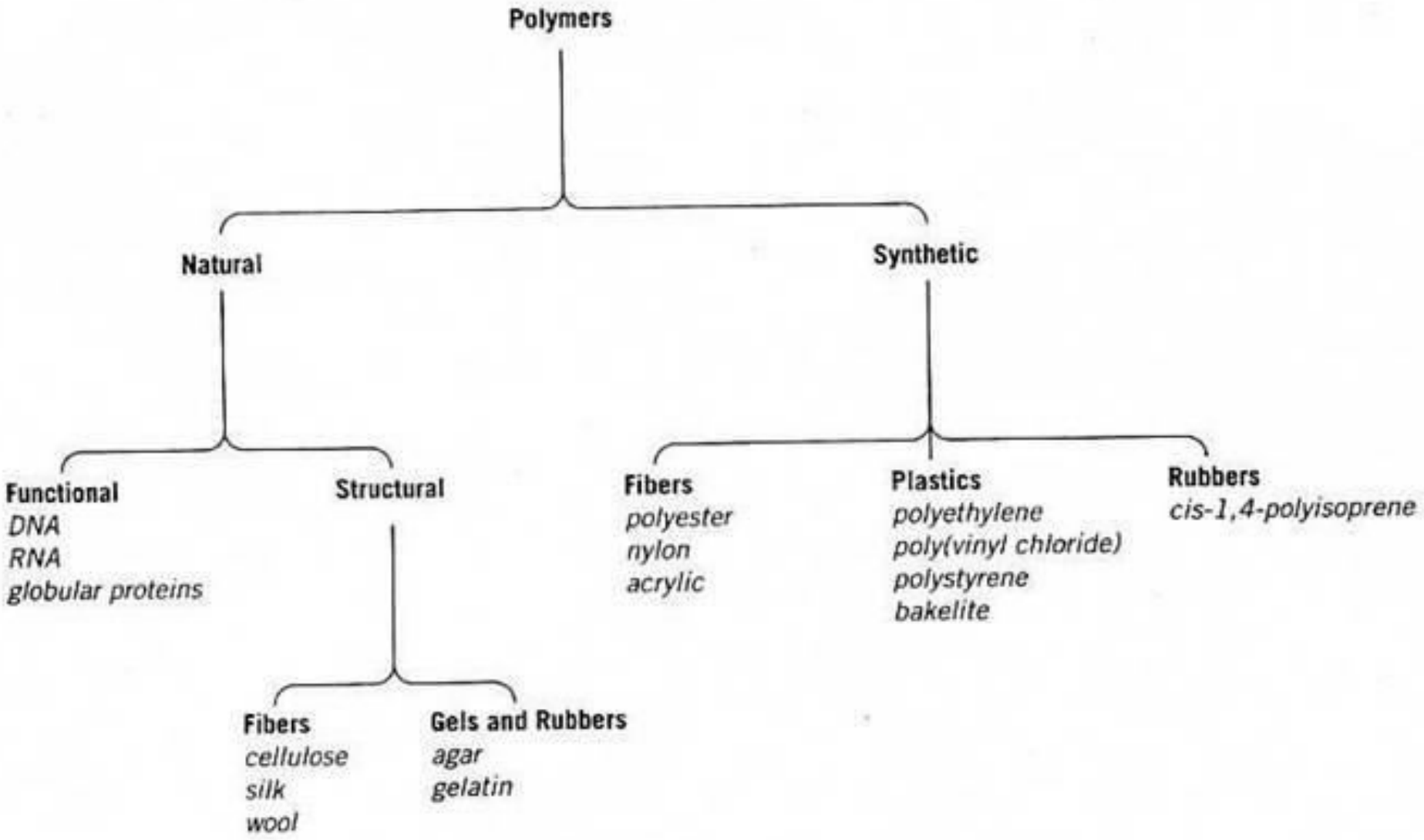
  depending on how they are structurally and chemically bonded.

CLASSIFICATION OF POLYMERS



A- Classification Based on Source Under : this type of classification, there are three sub categories:-

1. Natural polymers: These polymers are found in nature , example plants and animals. Examples are proteins, cellulose, starch, resins and rubber.
2. Semi-synthetic polymers: The polymers obtained by simple chemical treatment of natural polymers to change their physical properties like Starch, silicones
3. Synthetic polymers: The fibres obtained by polymerisation of simple chemical molecules in laboratory are synthetic polymers, ex.. Nylon, polyethene, polystyrene, synthetic rubber, PVC, Teflon…. etc..


Polymers
Natural
Synthetic
Functional
DNA
RNA
globular proteins
Structural
Fibers
cellulose
silk
wool
Gels and Rubbers
agar
gelatin
Fibers
polyester
nylon
acrylic
Plastics
polyethylene
poly(vinyl chloride)
polystyrene
bakelite
Rubbers
cis-1,4-polyisoprene

B- Classification Based on the structure of polymers :

There are three different types based on the structure of the polymers.

1. Linear polymers on Structure

• In these polymers monomers are linked with each other and form a long straight chain.

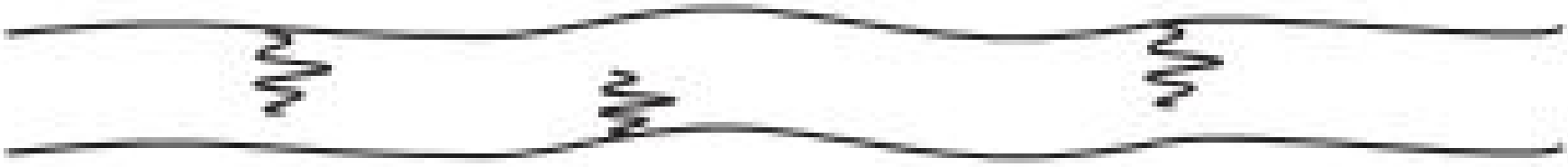
• These chains has no any side chains, ex. Polyethene, PVC, Nylons, polyesters etc.

• Their molecules are closely packed and have high density, tensile strength. These are represented as:

2. Branched chain polymers

• They have a straight long chain with different side chains.

•Their molecules are irregularly packed hence they have low density, tensile strength and melting point, ex… polypropylene, amylopectin and glycogen.:



3. Crosslinked or Network polymers:-

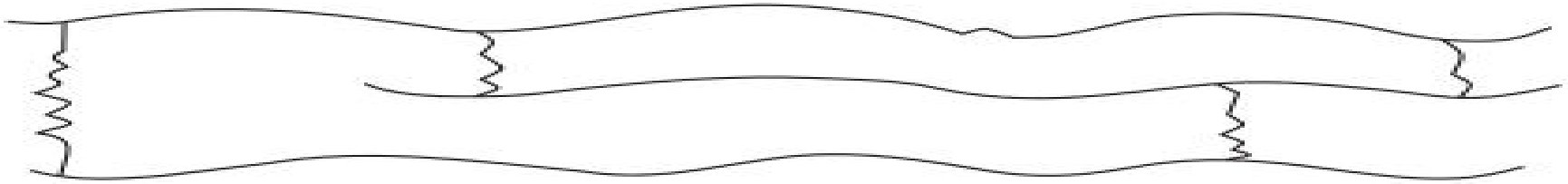
❑Those polymers in which two linear chains are joined together by covalent bonds and it have three dimensional.

❑ Degree of crosslinking is a number of junction point per unit volume.

❑ Polymers crosslinking are hard, rigid .and brittle due to their network structure.

❑ Polymers Crosslinked do not dissolve in solvents because all the polymer chains are covalently tied together, but they can absorb solvents.

Ex. Bakelite, melamine, formaldehyde resins, vulcanised rubber etc. These polymers are depicted as follows:



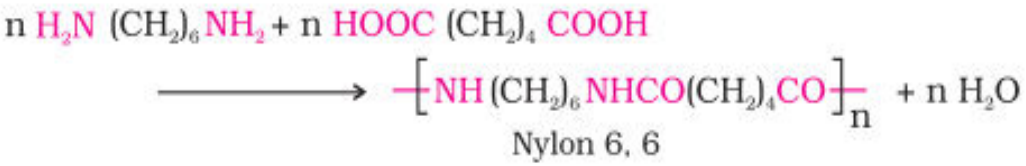
C- Classification Based on Mode of Polymerisation:-

Polymers can also be classified on the basis of mode of polymerisation into two sub groups:

1. Addition polymers: The addition polymers are formed by the repeated addition of monomer molecules possessing double or triple bonds, The polymers formed by the addition of monomers repeatedly without removal of by products are called addition polymers. e.g., the formation of polythene from ethene and polypropene from propene. However, the addition polymers formed by the polymerisation of a single monomeric species are known as homopolymers.

2. Condensation polymers :

They are formed by the combination of two monomers by removal of small molecules like water, alcohol or NH3.ex.. Nylon 6, 6, Nylon 6, etc. For example, nylon 6, 6 is formed by the condensation of hexamethylene diamine with adipic acid.



D- Classification Based on Molecular Forces

Mechanical properties of polymers like tensile strength, toughness, elasticity depends upon intermolecular forces like van-der waals forces and hydrogen bonding. On the basis of these forces they are classified as

1**. Elastomers These are rubber** – like solids with elastic properties. In these elastomeric polymers, the polymer chains are held together by the weakest intermolecular forces. These weak binding forces permit the polymer to be stretched.

A few ‘crosslinks’ are introduced in between the chains, which help the polymer to retract to its original position after the force is released as in vulcanised rubber. The examples are buna-S, buna-N, neoprene, etc.

Neoprene

2. Fibres Fibres are the thread forming solids which possess high tensile strength and high modulus. These characteristics can be attributed to the strong intermolecular forces like hydrogen bonding. These strong forces also lead to close packing of chains and thus impart crystalline nature. used in textile industries The examples are polyamides (nylon 6, 6), polyesters (terylene), etc.

Nylon 6,6

3. Thermoplastic polymers :-

• These are the polymers having intermolecular forces between elastomers and fibres.

• They are those polymers which can be softened on heating and hardened on cooling room temperature.

• They may be linear or branched chain polymers.

• these polymer can be recycled many times. Ex , Polythene, polyesterne, PVC.

4-Thermosetting polymers :-

• This polymer is hard and infusible on heating.

• These are not soft on heating under pressure and they are not remoluded.

• These polymers are cross linked or heavily branched molecules

 These polymers we cannot reused or recycle .

Ex. Some common examples are bakelite, urea-formaldelyde resins, etc.

E-Classification Based On the basis of types of Monomers:

1-Homopolyme: A polymer containing a single type of repeat unit is called a homopolymers e.g., polystyrene

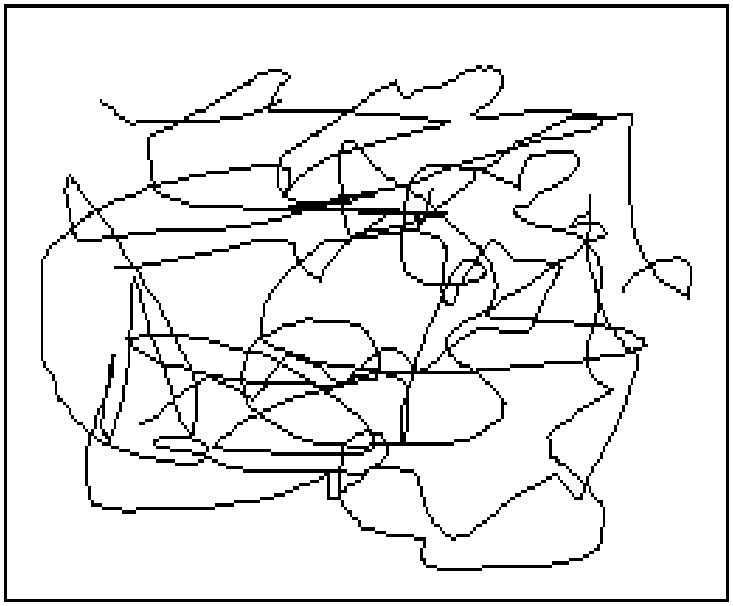
2-Hetropolymer (Copolymer): if a polymer is made up two different monomers then it is called copolymer, e.g., butadiene –styrene rubber

F-Classification Based on the Basis of Morphology:

Polymers can be classified into two classes on the basis of morphology:

1-Crystalline polymers: invariably don't form perfect crystalline materials but instead are semi crystalline with both crystalline and amorphous regions. The crystalline phase of such polymers are characterized by their melting temperature (Tm)

2-Amorphous Polymers: Characterized by their glass transition temperature (Tg), the temperature at which they transform abruptly from the glass state (hard) to the rubbery state (soft). This transition corresponds to the onset of chain motion**.**



Amorphous	Crystalline
Random Structure	Ordered Structure
Broad Melting Point	Narrow Melting Point
Low Shrinkage	Higher Shrinkage
Lower Mechanical Properties	Higher Mechanical Properties
Example: ABS, PC, PS	Example: Nylon, Acetal, PET

G-Classification Based On the basis of End Use:-

polymers can divided into three classes:

1-**Rubbers**: They are dimensionally unstable. These polymers are characterized by long-range elasticity. The rubbery polymers are characterized by low molecular cohesion. Their mechanical properties are poor. Their tensile strength ranges between 300-1000 psi.

2-Plastics: these are much stronger than rubbers. They exhibit tensile strength ranges between 4000-13000 psi. some plastics are hard, stiff and dimensionally stable and some are soft and flexible.

3-Fibres: they are the strongest of the three different types of polymers. They exhibit tensile strength which ranges between 20000-150000 psi.

PROPERTIES OF PLASTICS

The following properties are common with most of the plastics.

1. They are light in weight.
2. They have good resistance to most of the chemical.
3. They have high electrical strength.
4. They have good corrossive resistance.
5. Plastics can be moulded to any desired shape and size.
6. They can be made transperent or color.
7. They are cheap compared to metals.
8. All operations like drilling ,sawing, punching can be done on plastics.
9. Painting and polishing is not necessary.
10. The plastics posses excellent electric insulating properties.
11. The plastics, have low specific gravity, the average being 1.3 to 1.40.

1. STRENGTH

The plastics are sufficiently strong and can be used for load bearing structural members. The strength of plastics can further be increased by reinforcing them with various fibrous materials.

Plastic as structural material has not gained much popularity because of the following resins.

- High cost of construction
- High temperature susceptibility
- Poor stiffness
- Being subjected to creep under constant load

2. WEATHER RESISTANCE

The plastics, prepared from phenolic resins, are only good in resisting weather effects. Certain plastics are seriously affected by ultraviolet light.

3. FIRE RESISTANCE

Plastics, being organic in nature, are combustible. But the resistance to fire temperatue depends upon the plastic structure.

Cellulose acetale plastics burn slowly.

Polyvinyl chloride (PVC) plastics are non-inflammable.

Phenol formaldehyde and urea formaldehyde plastics are used as fire proofing materials.

4. DURABILITY

Plastics generally possess sufficient durability, provided they offer sufficient surface hardness. Thermoplastic varieties are found to be attacked by termites and rodents.

5. DIMENSIONAL STABILITY

Plastics easily maintain its shape and do not go under plastic deformations.

6. CHEMICAL RESISTANCE

Plastics offer great resistance to moisture, chemicals and solvents. Many plastics are found to possess excellent corrosion resistance. Plastics are used to convey chemicals.

8. WORKING CONDITIONS

All operations like drilling, sawing, punching, clamping etc are carried out easily on plastics, just like wood.

9. MOISTURE RESISTANCE

This property depends upon variety of plastics used, for example, cellulose plastics are considerably affected by the presence of moisture, whereas polyvinyl chloride plastics offer high resistance to moisture.

10. DUCTILITY

Plastics, generally, have low ductility and hence plastic structural members may fail without prior warning.

INGREDIANTS IN MOULDING COMPONENTS

The properties of polymers can be further modified by the addition of agents which are basically of two types :-

1. PLASTICIZERS:- Plasticizers are liquids of high boiling point and low molecular weight, which are added to improve the plastic behavior of the polymer. The broad role of the plasticizer is to separate the macro-molecules, thus decreasing the inter-molecular forces and facilitating relative movement between the molecules of the polymer, that is making deformation easier.
2. Fillers :- A filler is used to economize on the quantity of polymer required and /or to vary the properties to some extent, for example, mechanical strength, electrical resistance etc. A filler, whose function is to increase mechanical strength, is termed a “reinforcing filler”. A filler is commonly fibrous in nature and is chemically inert with respect ti the polymer with which it is to be used.

commonly used fillers are :- wood flour, cellulose, cotton flock etc.

Wood flour is general prpose filler. It improves mouldability, lowers the cost with fairly improved strength of the plastics.

3. CATALYSTS:- These are usually added to promote faster and more complete polymerization and as such they are also called “accelerators” and “hardeners” example :- urea formaldehyde

4. INITIATORS :- As the same indicates, the initators are used to initiates the reaction, that is, to allow polymerization to begin. H202 is the common initiators.

5. DYES AND PIGMENTS:- These are added, in many cases, to impart a desired colour to the material.

For example :- titanium dioxide is the excellent white pigment.

6. LUBRICANTS :- Lubricants are added to the polymers for the following purpose: to reduce friction during processing, to prevent parts from sticking to mould walls, to prevent polymer films from sticking to each other.

7. FLAME RETARDANTS :- Most plastics will ignite at sufficiently high temperature. The non-inflmmability of the plastics can be enhanced either by producing them from less inflammable raw material.

8. SOLVENTS :- Solvents are useful for dissolving certain fillers or plasticizers and help in manufacturing by allowing processing in the fluid state.