CH0204 Organic Chemical Technology

Lecture 10

Chapter 3 Plastics

Balasubramanian S
Assistant Professor (OG)
Department of Chemical Engineering

Overview of topics

Chapter 3 Plastics

1. Polymers, Plastics, and Resins
2. Production of Polyethylene
3. Production Polypropylene

Overview of topics

Chapter 3 Plastics

1. Polymers, Plastics, and Resins
2. Production of Polyethylene
3. Production Polypropylene

Polymers, Plastics and Resins

A **monomer** (from Greek *mono* "one" and *meros* "part") is an atom or a small molecule that may bind chemically to other monomers to form a polymer.[1]

A **polymer** is a large molecule (compound) of repeated structural units. These units or sub units are typically connected by covalent (sharing pair of electrons between atoms) chemical bonds.

Although the term polymer is sometimes taken to refer plastics it actually encompasses a large class of natural and synthetic materials with a wide variety of properties.

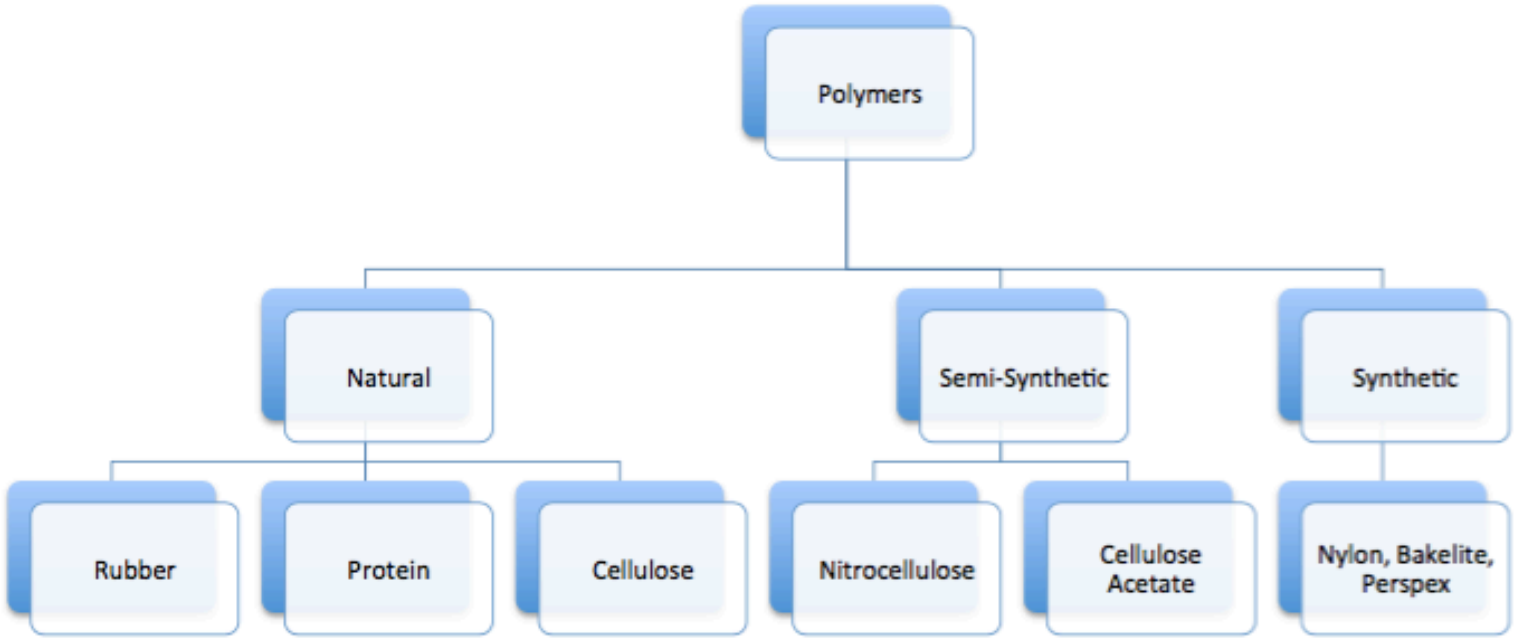
Polymers, Plastics and Resins

Polymers usually posses a certain amount of crystallinity, and their tensile strength increases with molecular weight.

Also greater the crystallinity, the greater is tensile strength, lower is the solubility and higher is the melting point.

Finar IL, Organic Chemistry Vol. 1 6th Edition Pearson Education 2009 pp.116-117

Polymers, Plastics and Resins



Finar IL, Organic Chemistry Vol. 1 6th Edition Pearson Education 2009 pp.116-117

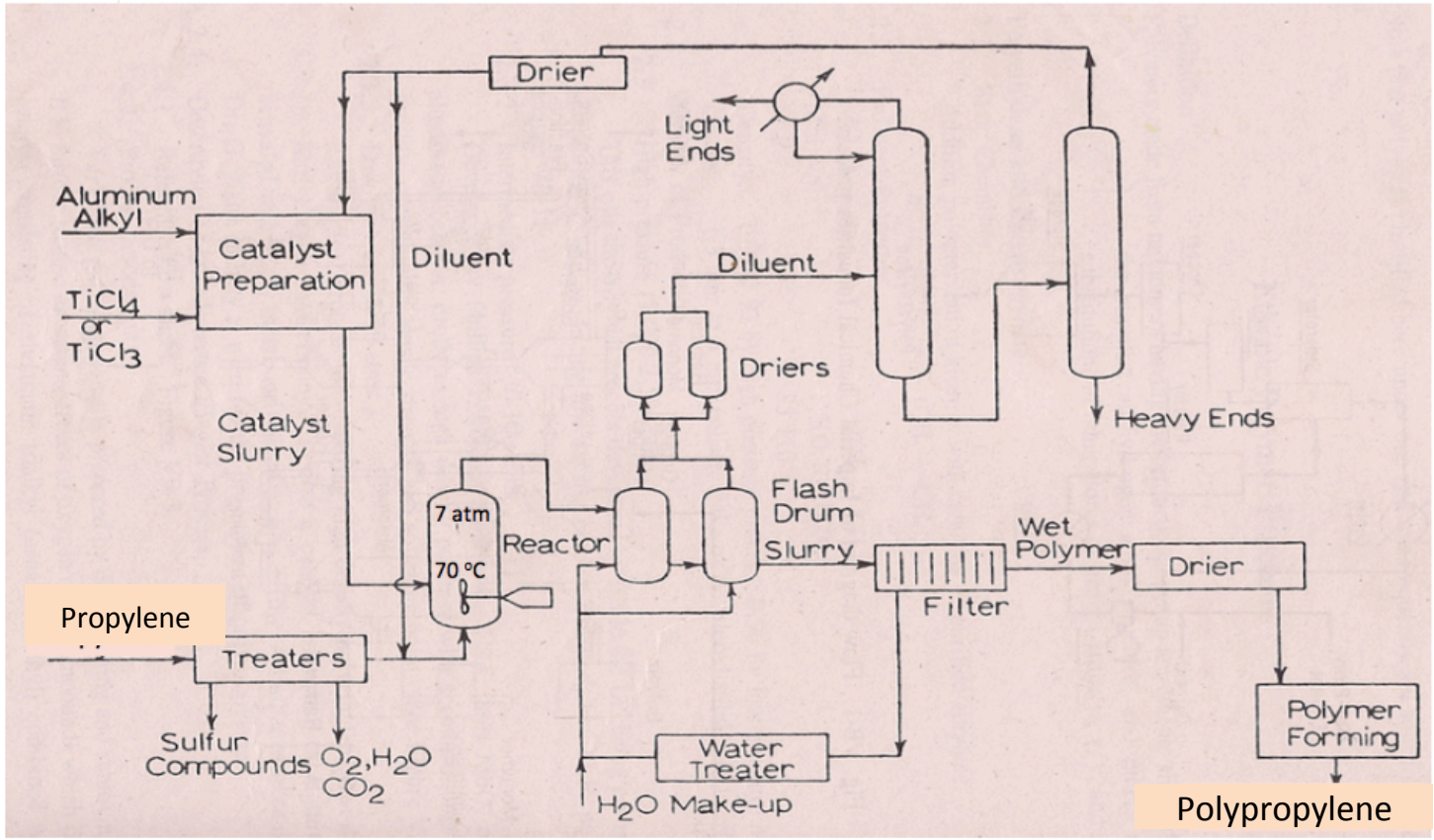
Polymers, Plastics and Resins

Plastic

A **plastic** may be defined as material that contains a polymerized organic substance of large molecular weight as an essential ingredient, is solid in its finished state, and at some stage in its manufacture or its processing into finished articles can be shaped by flow.

Finar IL, Organic Chemistry Vol. 1 6th Edition Pearson Education 2009 pp.116-117

Polypropylene Production



Overview of topics

Chapter 3 Plastics

1. Resins
2. Production of Phenolic and Epoxy resins
3. Polymers and their Engineering Properties

Resins

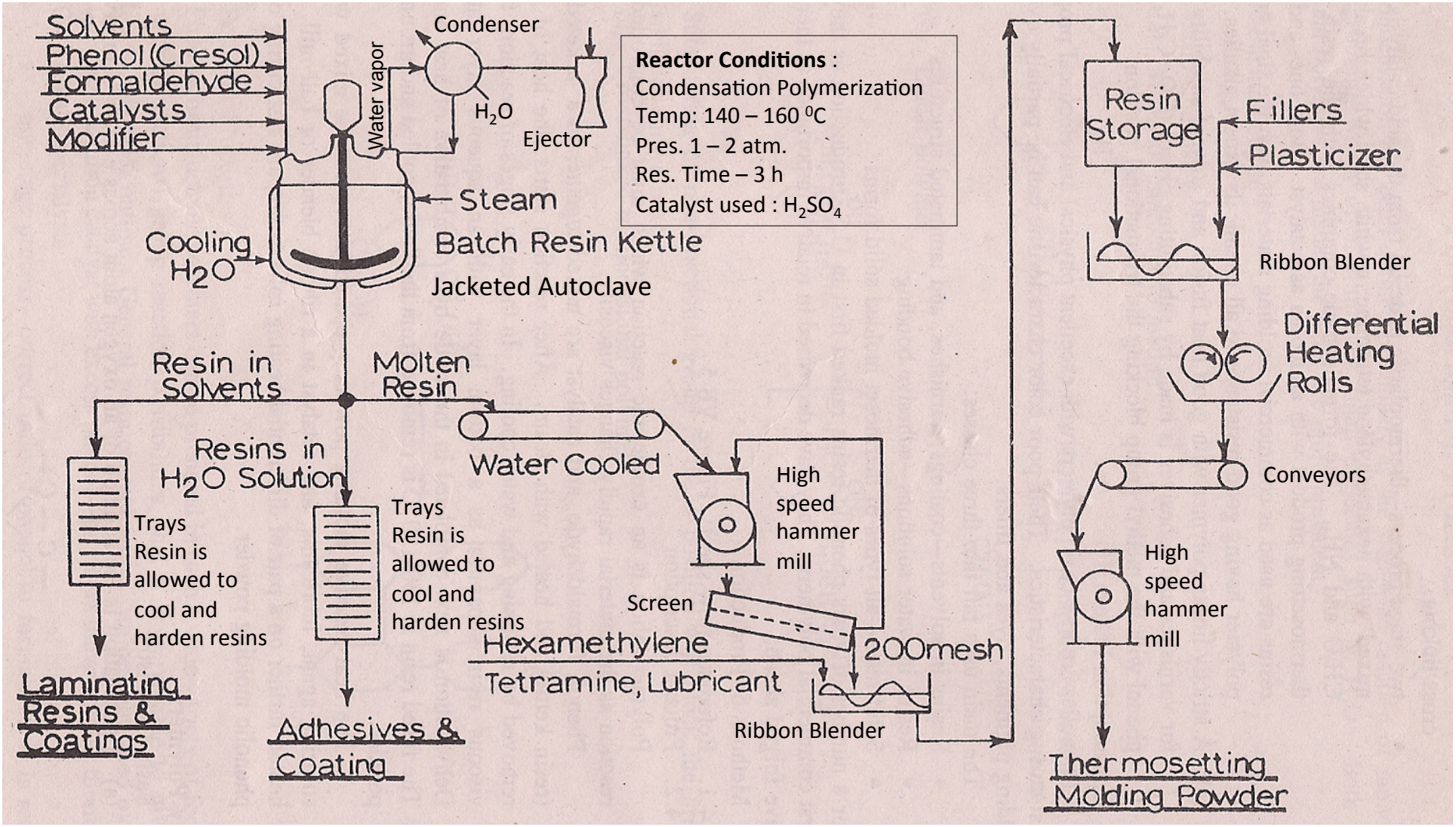
Resin is also hydrocarbon secretion of many plants, particularly coniferous trees. It is valued for its chemical properties and associated uses, such as the production of varnishes, adhesives, and food glazing agents; as an important source of raw materials for organic synthesis.

Resins

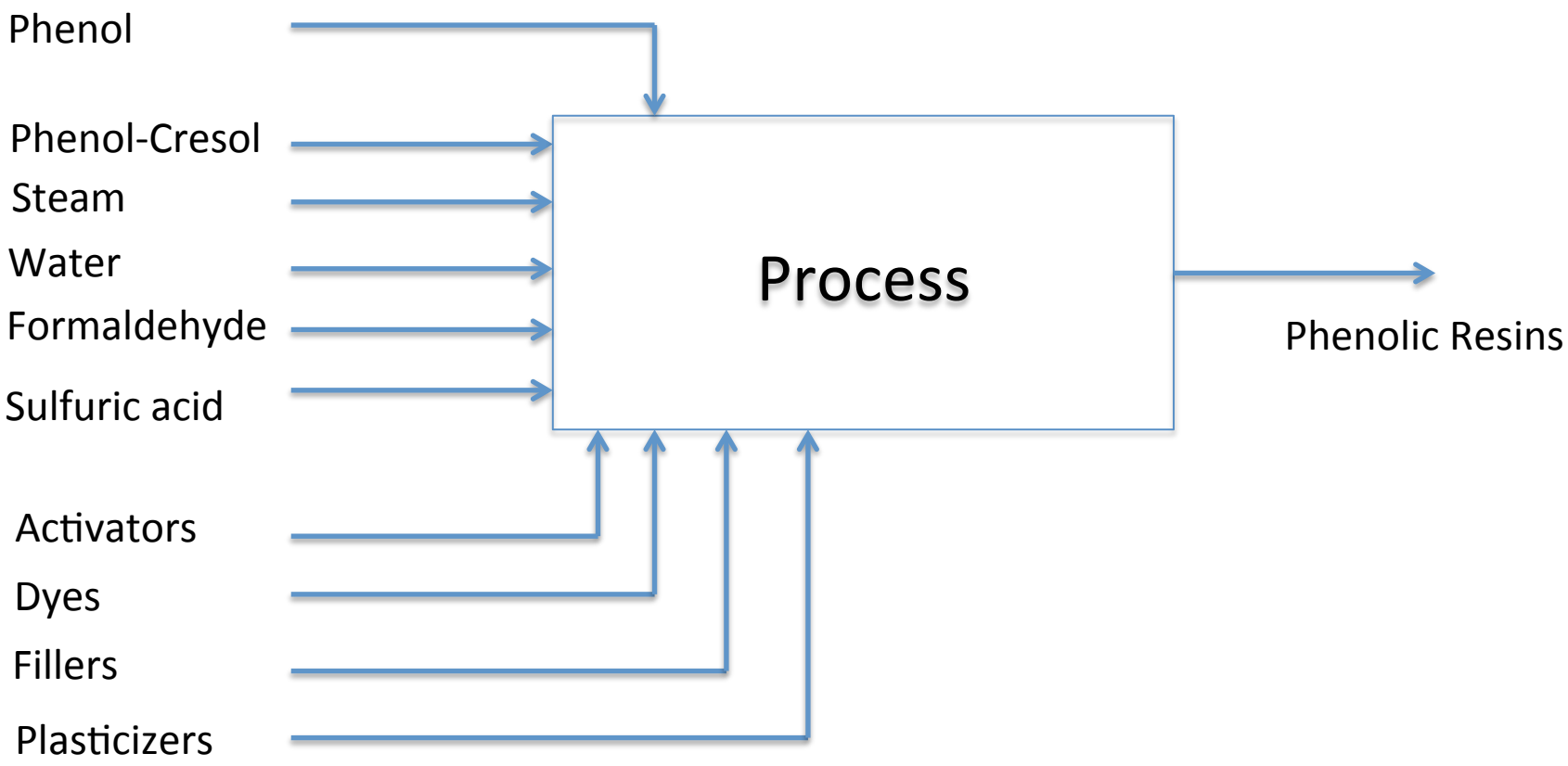
On the basis of derivation, plastics can also be grouped as

1. Natural resins
2. Synthetic resins
3. Cellulose derivatives
4. Protein products

Phenolic Resin



Phenolic Resin

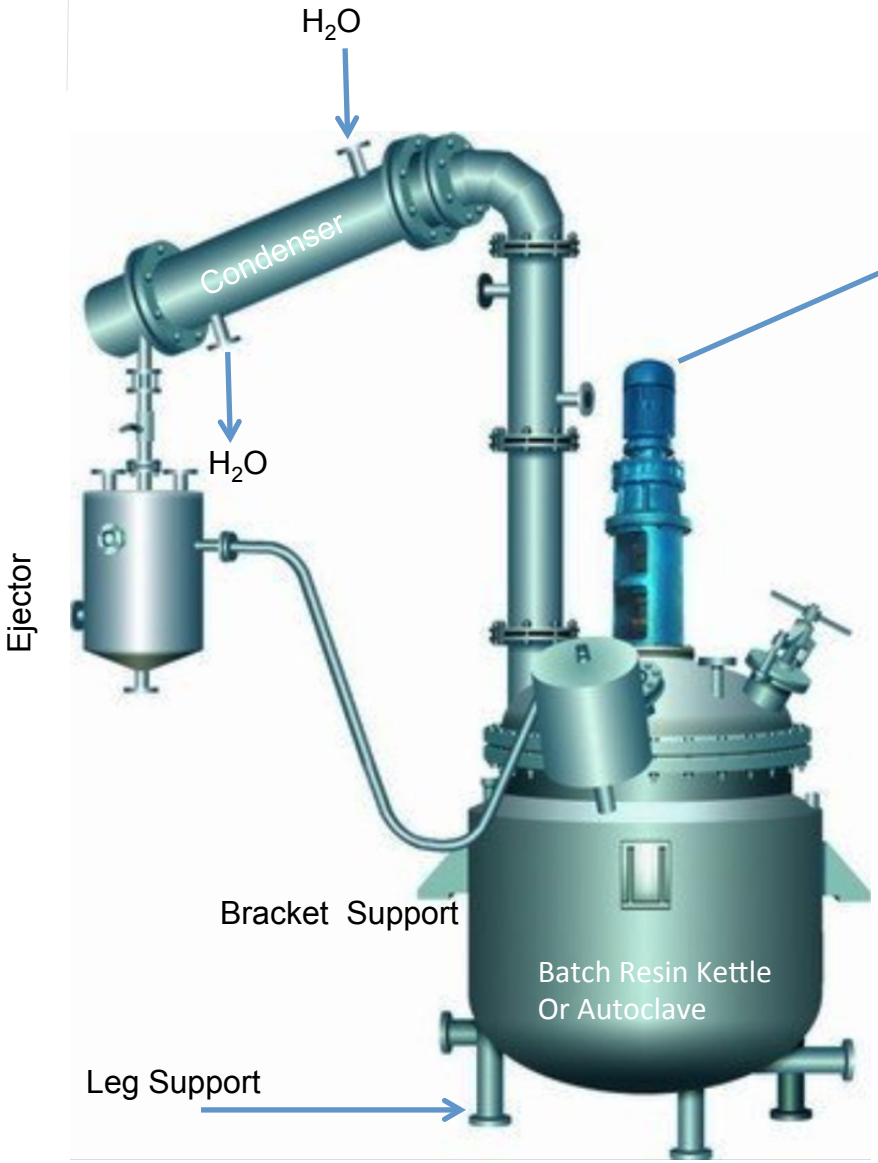


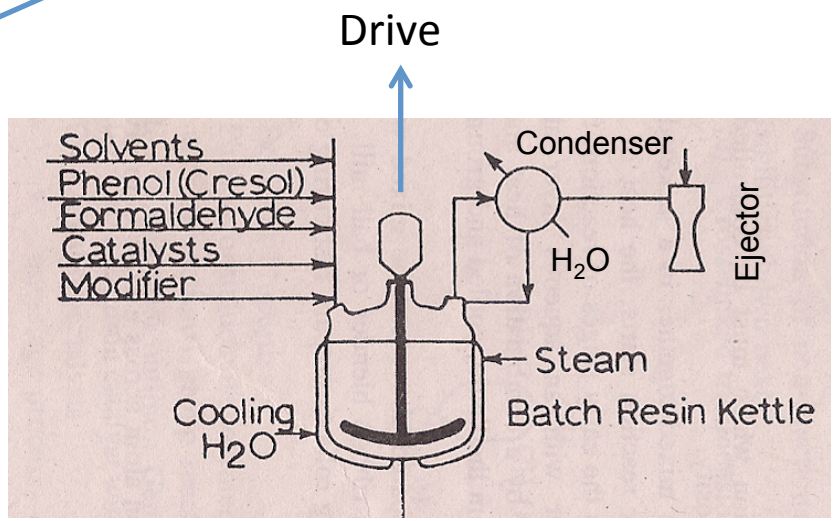
Uses of phenolic resins

Phenolic resins

1. Packing films and sheets
2. Car bumpers dash boards
3. Containers
4. Wire cable insulation
5. Pipes
6. Coatings, molds, and toys etc.,

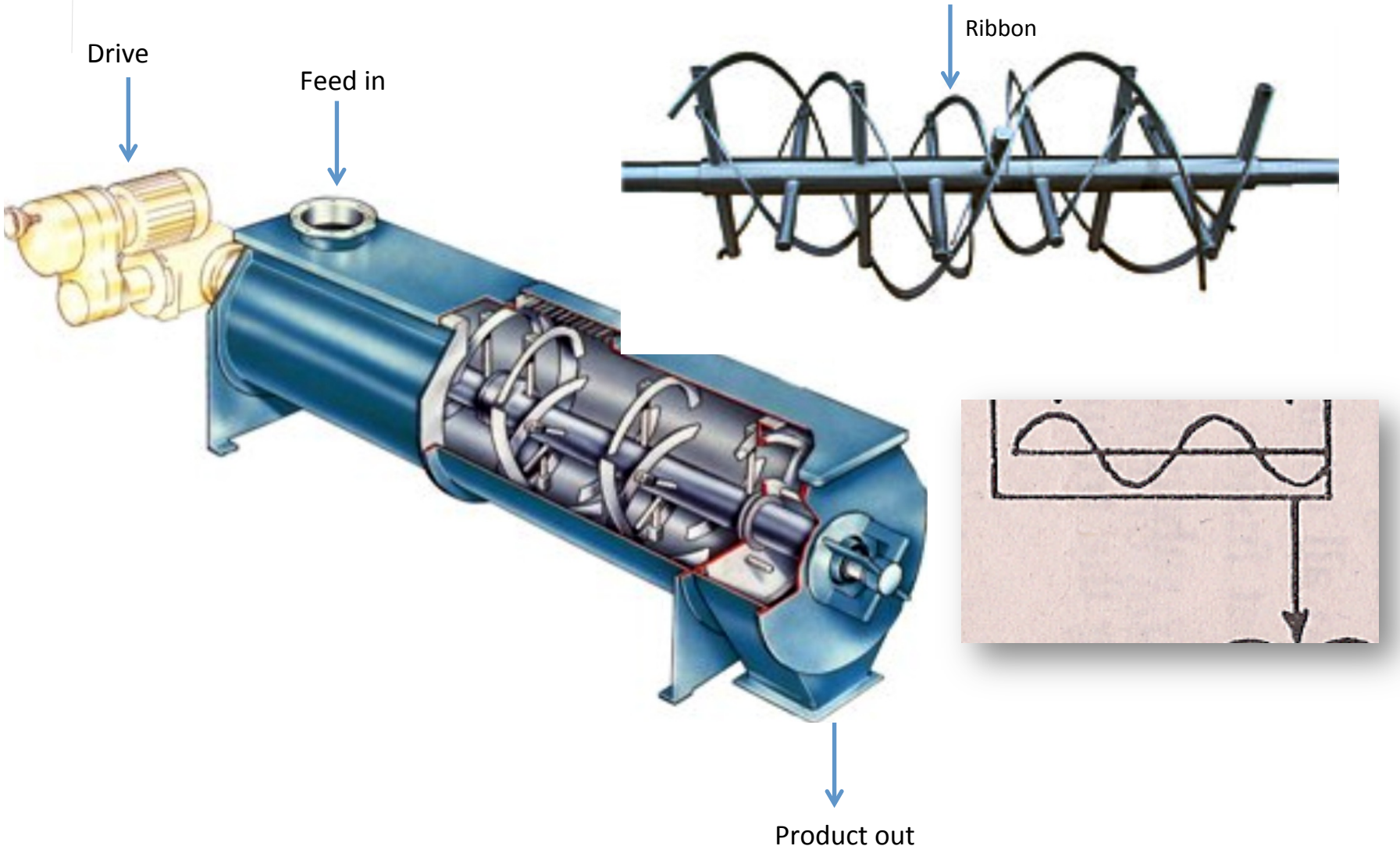
Kettle or Auto Clave Reactor





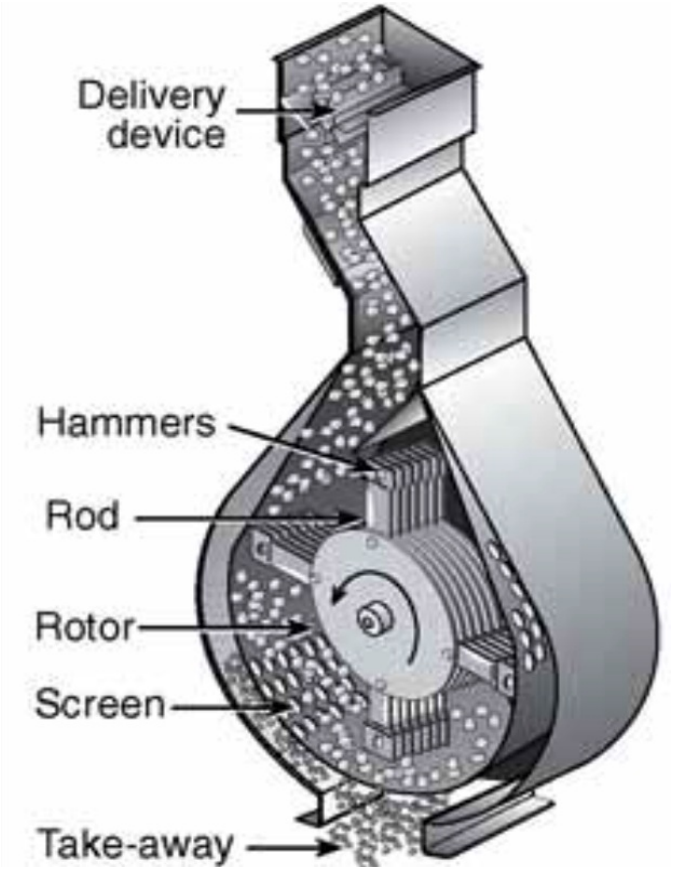
Schematic Representation

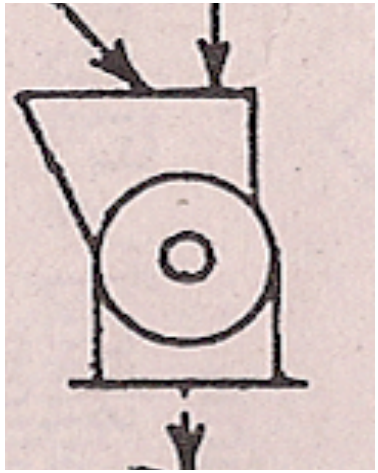
Ribbon Blender



Hammer Mill

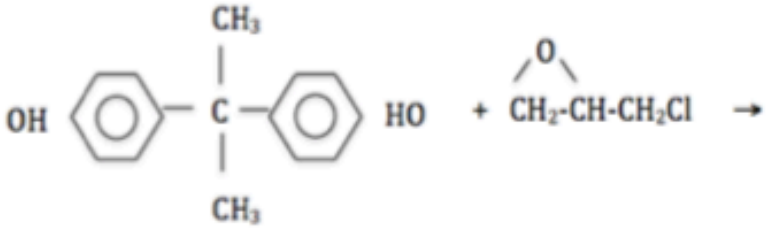

Hopper
Hammer mill

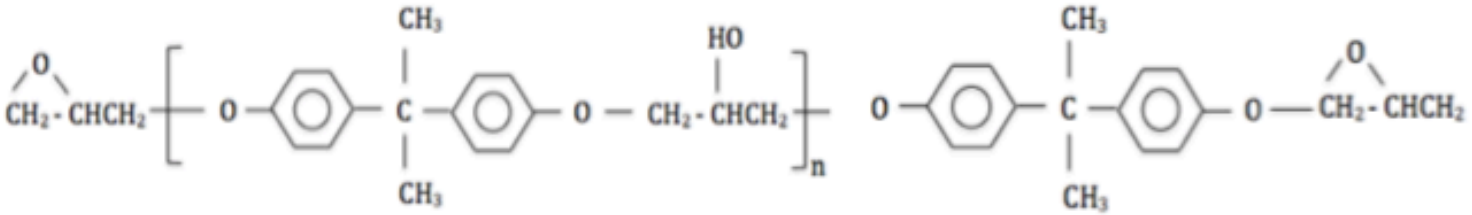

Delivery device
Hammers
Rod
Rotor
Screen
Take-away



Epoxy resins

Bisphenol A + Epichlorohydrin ⟶ Epoxide groups or polymer





Resin Properties and its Applications

Resin Types	Properties	Applications
Phenolics	Good strength, heat stability, and impact resistance, high resistance to moisture penetration and chemical corrosion	Electrical components, structural boards, Laminates, glues, and adhesives
Epoxies	Excellent chemical Resistance, good electrical and thermal properties adhesion properties, strong and tough with low shrinkage	Laminates, Adhesives, Floorings and linings

Polymers in engineering applications

Binder: This is usually a resin or cellulose derivative added to increase strength.

Fillers: Cellulose, Cotton fibers, Glass fibers or fabrics may be added to increase strength.

Plasticizers: Plasticizers are organic chemicals added to synthetic plastics in order to

(I) Improve the workability during fabrication

(II) Reduces the viscosity of the resin and also impart flexibility to finished product

Lubricants: Lubricants such as stearates and other metallic soaps are used particularly in cold-molding compounds to facilitate the molding operation

Polymers in engineering applications

Engineering plastics are high-strength; high performance materials that can be substituted for many metal uses.

There are wide variety of engineering plastics available. Each one has its own special properties, and thus care must be taken in choosing a resin of particular use.

These materials are often the usual plastics but have been carefully manufactured to posses extra quality properties. These materials shows better resistance towards wear impact and corrosive chemicals and have excellent electrical properties.

Some of the uses of engineering plastics are automobile bumpers and dash boards, pumps, valves and gears, drive shafts and transmission in heavy duty equipment.

Synthetic Fibers

1. Acrylics
2. Polyamides
3. Polyesters

Synthetic (or man-made fibers)

What are Synthetic Fibers?

The clothes that we wear are made up of fabrics

Fabrics are made up of fibers 

Depending on the sources the fibers are classified in two types
1. Natural and 2. Synthetic

Natural fibers are the fibers which are obtained from plants and animals e.g. silk and wool

Synthetic fibers are made by human beings or also called as man-made fibers Nylon, Polyester, Rayon etc.

Synthetic (or man-made fibers)

Natural Fiber, Silk wool

Synthetic (or man-made fibers)

Synthetic Fibers

Nylon

Polyester

Synthetic (or man-made fibers)

The first synthetic or man-made fiber is cellulose nitrate and the next synthetic fiber is regenerated cellulose or viscose.

Some of the man-made fibers emerged after 1940's were acrylics, polyamides, polyesters and polyolefin.

The uses of man-made fibers depend upon the nature of the individual fiber. Clothing, Carpets, and Upholstery are all made largely, or wholly, of synthetic fibers.

Acrylics

Acrylic fibers are **synthetic fibers** made from a polymer (**polyacrylonitrile**) with an average molecular weight of ~100, 000 about 1900 monomer units

The Dupont Corporation created the first Acrylic fibers in 1941 and trademarked them under the name **"Orlon"**

Polyamides

A polyamide is a polymer containing **monomers of amides**.

They occurs both **naturally and artificially**.

Polyamides are commonly used in **textiles, automotives, carpet and sports wear.**

Polyamides – Method of production

Adipic acid

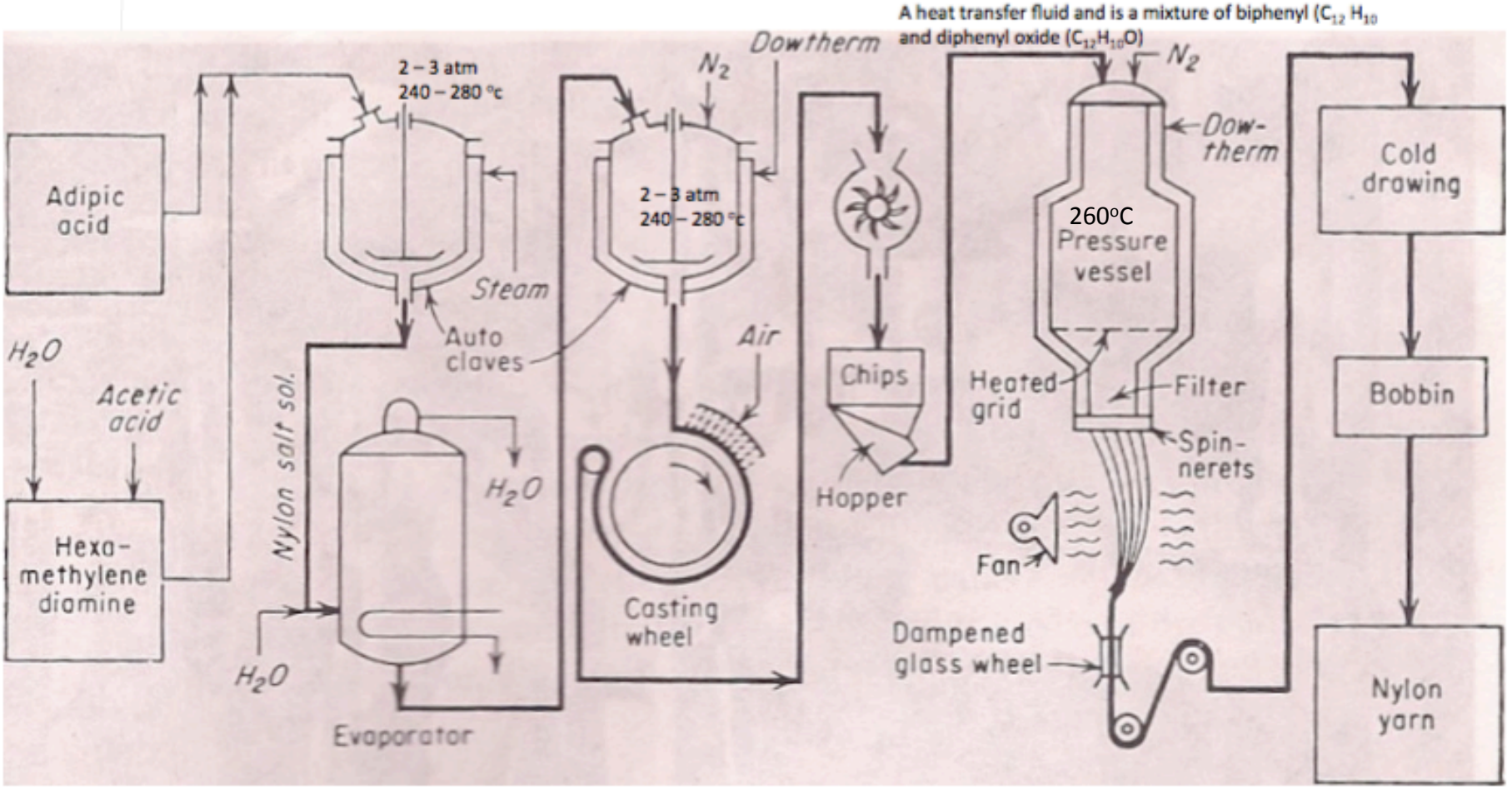
+

Hexamethylene diamine ⟶

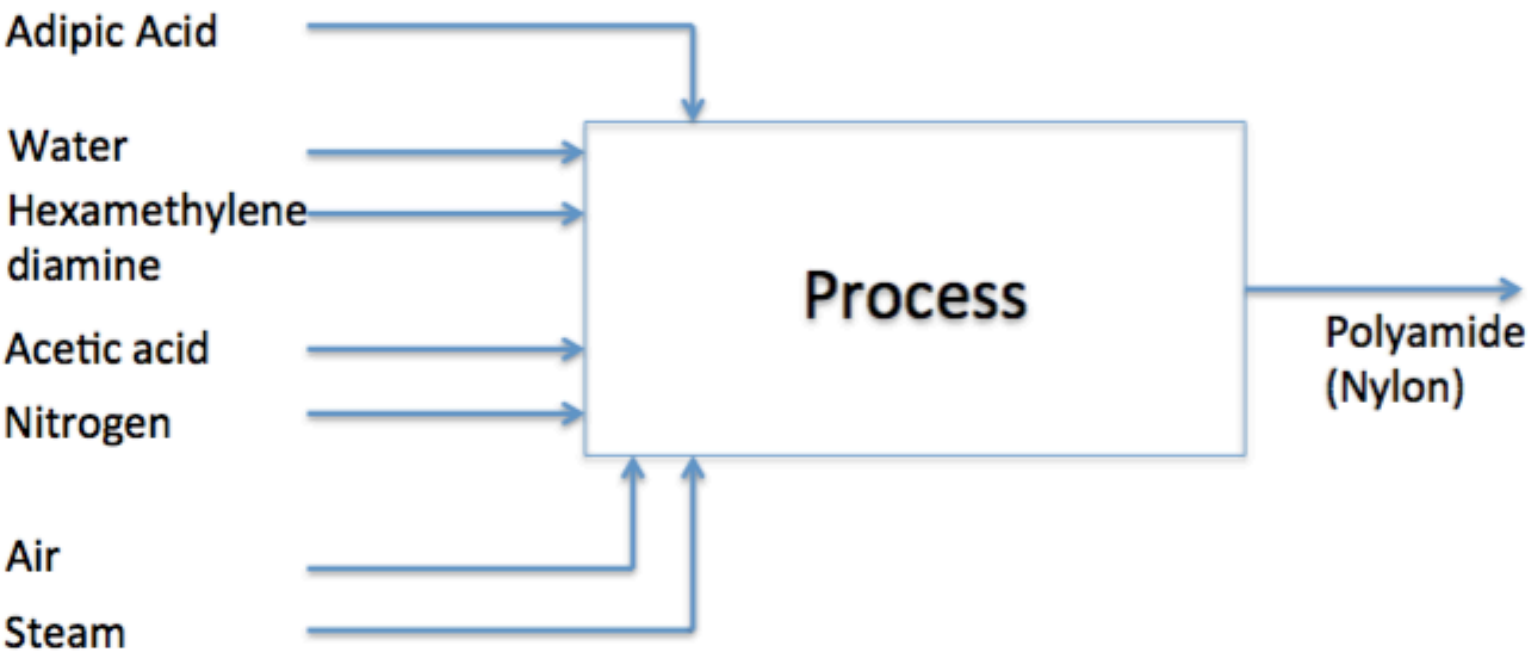
Hexamethylene diammonium adipate (or) nylon salt ⟶

Poly(hexa methylene adipamide) or Nylon

Polyamides (Nylon)



Polyamide (Nylon fiber) Production



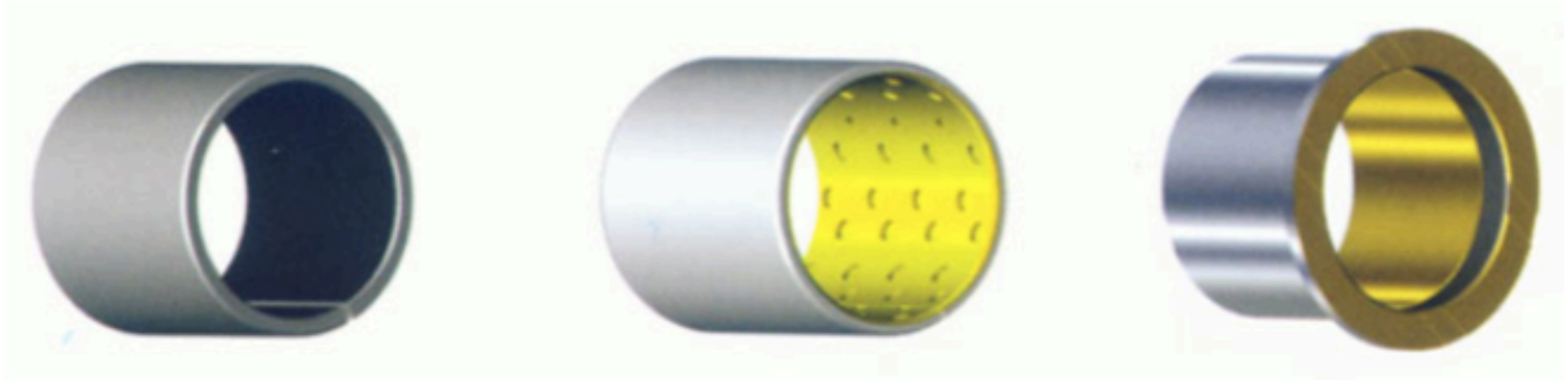
Uses of Polyamides (Nylon)

Used in the manufacture of

1. Unlubricated or non lubricated bearings
2. Bags
3. Fabrics
4. Ropes
5. Fishing line or net

Uses of Polyamides (Nylon)

Used in the manufacture of unlubricated or non lubricated bearings



Uses of Polyamides (Nylon)

Used in the manufacture of ropes

Used in the manufacture of
Fish lines or fish nets

Uses of Polyamides (Nylon)

Used in the manufacture of bags

Used in the manufacture of fabrics

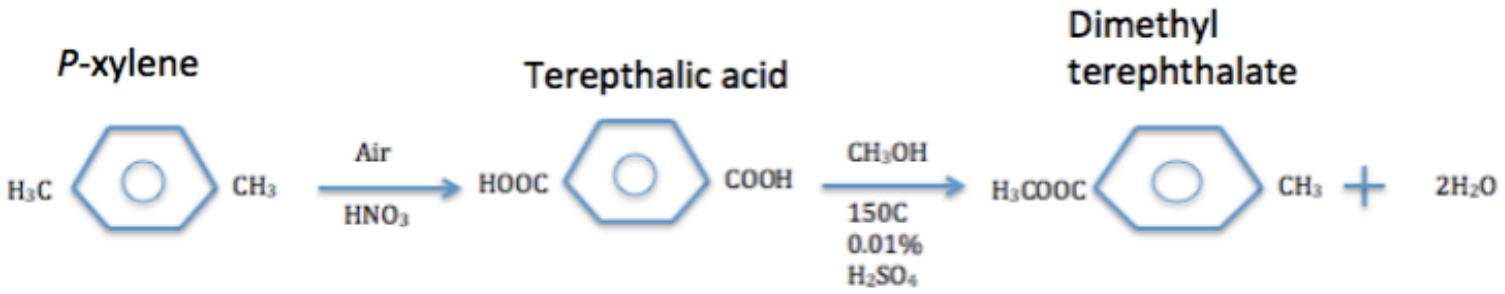
Polyesters (PET)

The common polyester fibers are polymers of **the ester**

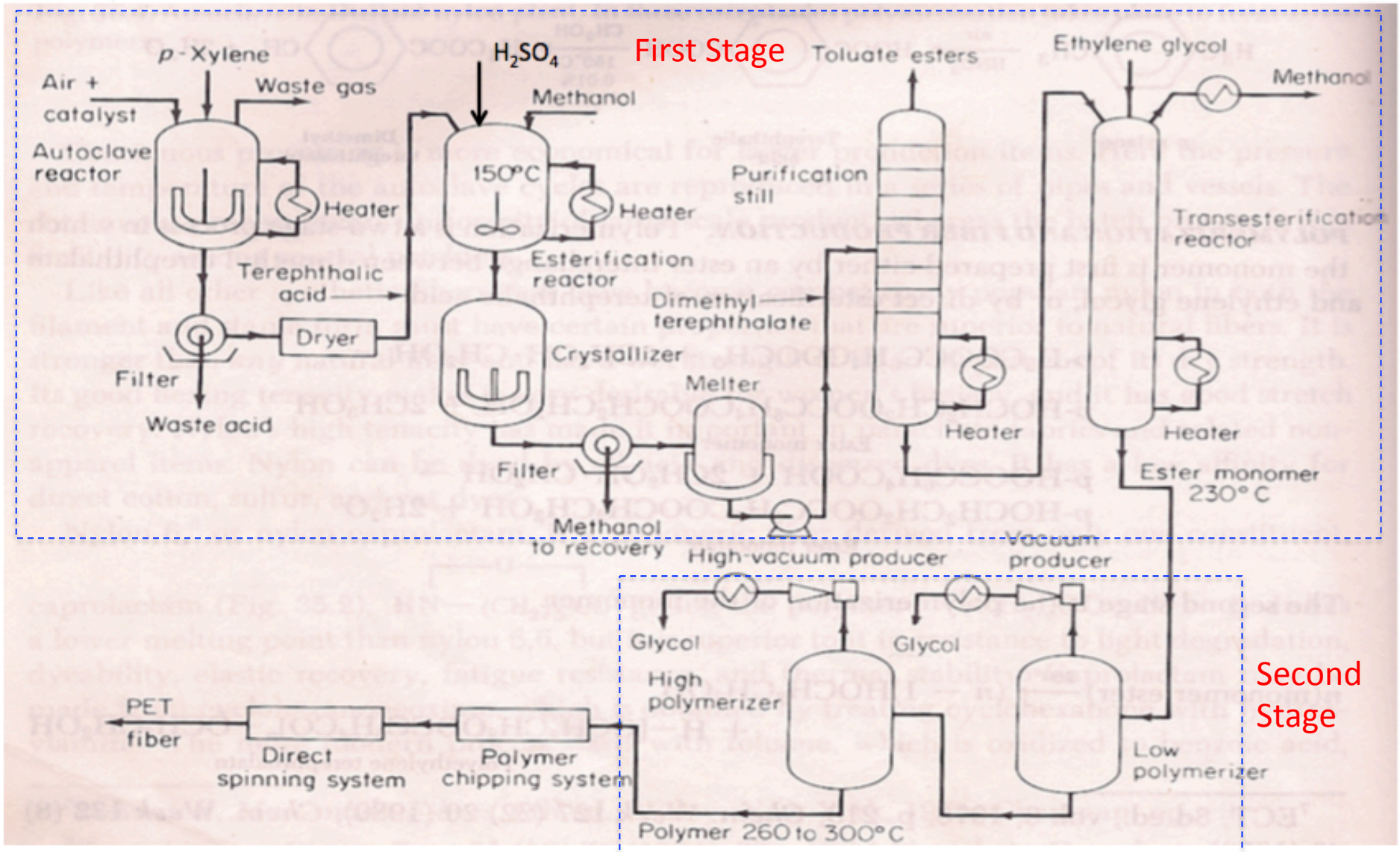
formed from dimethyl terepthalate and ethylene glycol

Production steps

1. Preparation of intermediates
2. Polymerization of ester monomers



Polyesters-PET



Uses of Polyesters (PET)

Used in the manufacture of

1. Fabrics
2. Wrinkle free fabrics
3. Hoses
4. V belts
5. Pillows
6. Carpets

Uses of Polyesters

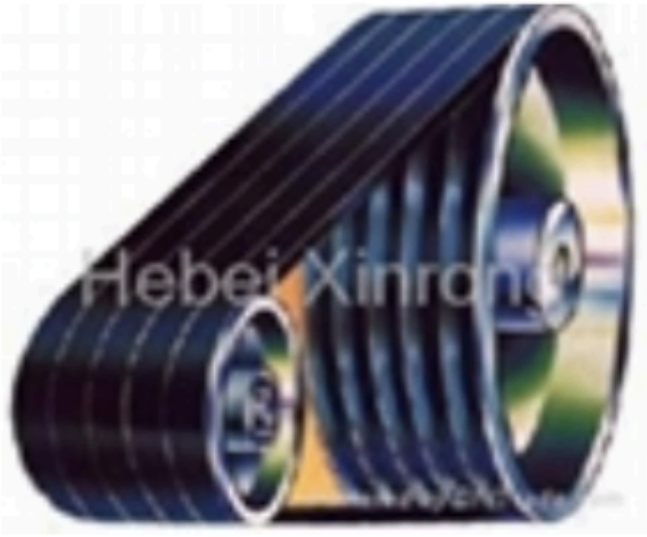
Fabric

Wrinkle free fabric

Uses of Polyesters

Hose

V - Belts



Uses of Polyesters

Pillows

Carpets

Viscose Rayon

Major Steps

1. Alkali Conversion

   Cellulose + NaoH = Alkali Cellulose + Water

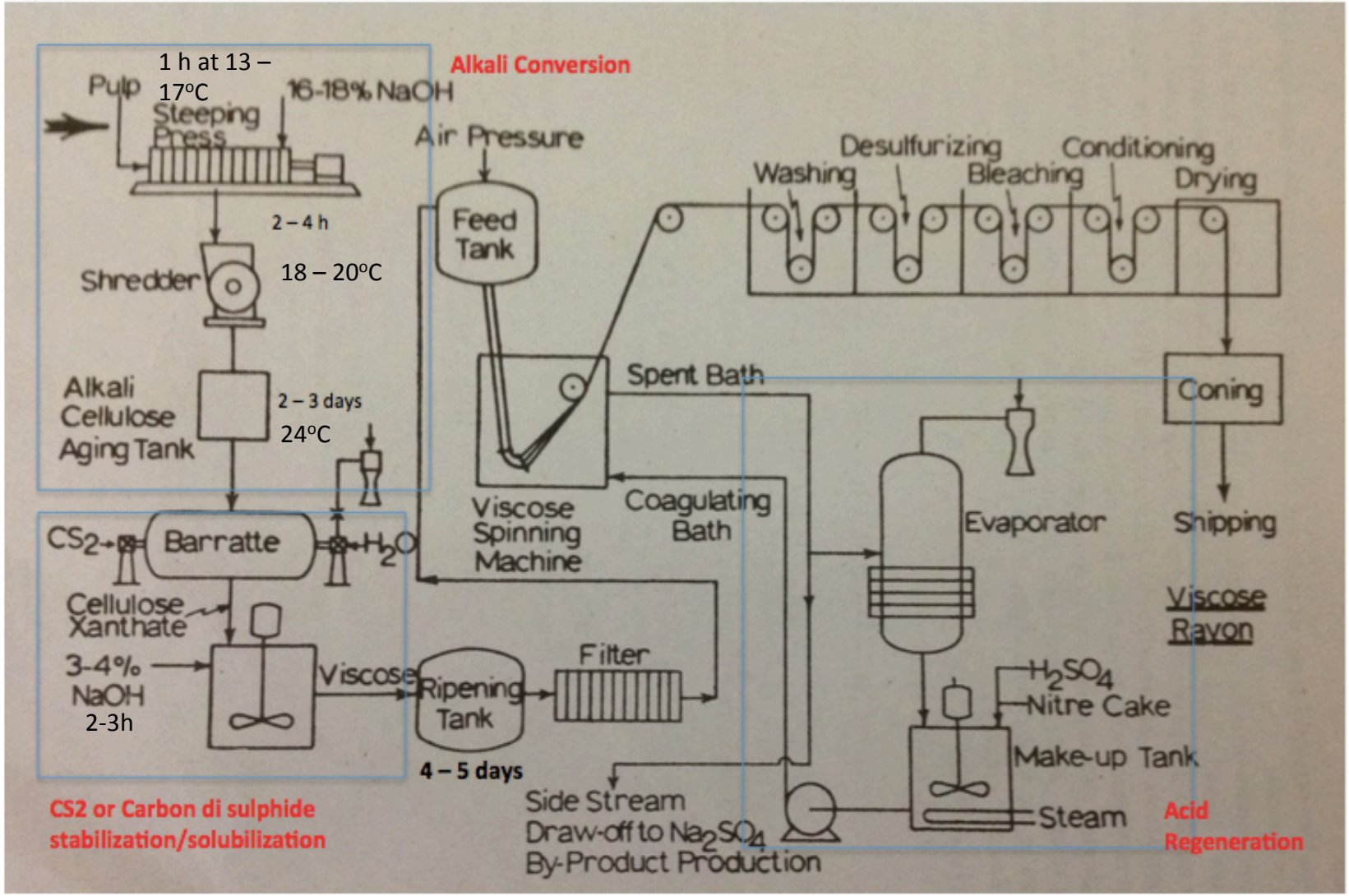
2. CS_2 Stabilization/Solubilization

   Alkali Cellulose + Carbon disulphide = Sodium Cellulose Xanthane

3. Acid Regeneration

   Sodium Cellulose Xanthane +Sulfuric Acid = Rayon + Carbon disulphide + Sodium bisulphate

Viscose Rayon



References

1. Dryden C. E, *Outlines of Chemical technology – for the 21st Century*, 3rd edition, East-West Press (2004)

2. Austin G. T, *Shreve's Chemical Process Industries*, 5th edition, Mc Graw Hill International editions (1984)

Thank you