CHAPTER 22

INDUSTRIAL CHEMISTRY

After completing this lesson, you will be able to:

- Describe the raw materials available in Pakistan for various chemical industries;
- Describe the chemical processes of addition and condensation polymerization
- Interpret difference between and chemical derived from them
- Describe the fractional distillation and refining of
- List the various raw materials petrochemical industry
- Identify the important fractions.
- Describe the basic building blocks processes in petrochemical technology.
- Describe the petrochemical process technology.
- List major petrochemicals,
- Describe the formation and use of PVC and Nylon.
- Describe preparation and application of various cosmetics like nail
- nail remover and lipsticks.

The exploitation of materials and energy in appropriate scale is called industrial chemistry.

Application of science and technology to enable humanity experiences the benefits of chemistry in areas such as food production, health and hygiene, shelter, protection, decoration, recreation and entertainment.

A) Introduction to the Chemical Industry

The chemical industry can also be classified according to the type of main raw materials used and/or type of principal products made. We therefore have industrial inorganic chemical industries and industrial organic chemical industries. Industrial inorganic chemical Industries extract inorganic chemical substances, make composites of the same and also synthesize inorganic chemicals.

Heavy in industrial organic chemical industries produce petroleum fuels, polymers, petrochemicals and other synthetic materials, mostly from petroleum.

Light organic industries produce specialty chemicals which include pharmaceuticals, dyes, pigments and paints, pesticides, soaps and detergents, cosmetic products and miscellaneous products.

The Structure of the Global Chemical Industry

We normally put a value to something according to how much it has cost us. Some things are of high value while others are of low value. For low valued products, you need to produce them in large volumes to make significant profit. This means that the raw materials are cheap and easily accessible. There is also an existing, relatively simple, and easily accessible processing technology. To sell a large volume of product, there must be a large market. This brings stiff competition which also makes the price to remain low.

We are now ready to describe the structure of the global chemical industry

Commodity Chemicals:

The global chemical industry is founded on basic inorganic chemicals (BIC) and basic organic chemicals (BOC) and their intermediates. Because they are produced directly from natural resources or immediate derivatives of natural resources, they are produced in large quantities.

In the top ten BIC, almost all the time, sulphuric acid, nitrogen, oxygen, ammonia, lime, sodium hydroxide, phosphoric acid and chlorine dominate. The reason sulphuric acid is always number one is because it. is used in. the manufacture of fertilizers, polymers, drugs, paints, detergents and paper. It is also used in petroleum refining, metallurgy and in many other processes. The top ranking of oxygen is to do with its use in the steel industry.

Ethylene and propylene are usually among the top ten BOC. They are used in the production of many organic chemicals including polymers.

BIC and BOC are referred to as commodity or industrial chemicals.

Commodity chemicals are therefore defined as low-valued products produced in large quantities mostly in continuous processes. They are of technical or general-purpose grade.

Specialty Chemicals:

High-value adding involves the production of small quantities of chemical products for specific end uses. Such products are called specialty chemicals.

These are high value-added products produced in low volumes and sold on the basis of a specific function.

In this category are the so-called performance chemicals which are high value products produced in low volumes and used in extremely low quantities. They are judged by performance Ind efficiency. Enzymes and dyes are performance chemicals. Other examples of specialty chemicals include medicinal chemicals, agrochemicals, pigments, flavour and fragrances, personal care products, surfactants and adhesives.

Specialty chemicals are mainly used in the form of formulations. Purity is of vital importance in their formulation. This calls for organic synthesis of highly valued pure chemicals known as fine chemicals

Fine Chemicals:

At times you will find that the raw materials for your product need to be very pure for the product to function as desired. Research chemicals are in this category as also are pharmaceutical ingredients. Such purified or refined chemicals are called fine chemicals. By definition they are high value-added pure organic chemical substances produced in relatively low volumes and sold on the basis of exact specifications of purity rather than functional characteristics.

The global market share for each type is roughly as follows:

Commodities	80%
Specialties	18%
Fine	2%

B) Raw material for the Chemical Industry

All chemicals are derived from raw materials available in nature. The price of chemicals depends on the availability of their raw materials. Major chemical industries have therefore developed around the most plentiful raw materials

The natural environment is the source of raw materials for the chemical industry.

Raw materials from the atmosphere

The atmosphere is the field above ground level. It is the source of air from which six industrial gases namely N2, 02. Ne, Ar, Kr and Xe are manufactured. The mass of the earth's atmosphere is approximately' $5x\ 1\ 0^{15}$ tons and therefore the supply of the gases is virtually unlimited.

Raw materials from the hydrosphere

Ocean water which amounts to about $1.5x\ 1\ 0^{21}$ litres contains about 3.5 percent by mass dissolved material. is a good source of sodium chloride, magnesium and bromine.

Raw materials from the lithosphere

The vast majority of elements are obtained from the earth's crust in the form of mineral ores, carbon and hydrocarbons. Coal, natural gas and crude petroleum besides being energy sources are also converted to thousands of chemicals.

Raw materials from the biosphere

Vegetation and animals contribute raw materials to the so-called agro-based industries. Oils, fats, waxes, resins, sugar, natural fibres and leather are examples of thousands of natural products.

Q1. Write a detailed note on safety management program of industries.

Answer

Process safety technology has played an important role in the chemical processing industries so that handling flammable and combustible liquids and gases could proceed without undesirable consequences. During the 1980s, the oil and gas industries, for example, recognized that process safety technology alone, without process safety management, would not prevent catastrophic incidents. With this in mind, a number of industry associations, such as, in the United States, the Centre for Chemical Process Safety (CCPS), the American Petroleum Institute (API) and the Chemical Manufacturers' Association (CMA), initiated programmes to develop and provide process safety management guidelines for use by their members.

Process Safety Management Requirements

Process safety management is an integral part of the overall chemical processing facility safety programme. An effective process safety management programme requires the leadership, support and involvement of top management, facility management, supervisors, employees, contractors and contractor employees.

Elements of the Process Safety Management Programme

There are a number of basic requirements which should be included in every chemical process safety management programme:

1) Process safety information

Process safety information is used by the process industry to define critical processes, materials and equipment. Process safety information includes all available written information concerning process technology, process equipment, raw materials and products and chemical hazards before conducting a process hazard analysis. Other critical process safety information is documentation relating to capital project reviews and design basis criteria.

2) Employee involvement

Process safety management programmes should include employee participation in the development and conduct of process safety analyses and other elements of the programme. Access to process safety information, incident investigation reports and process hazard analyses is usually provided to all employees and contractor employees working in the area. Most industrialized nations require that workers be systematically instructed in the identification, nature and safe-handling of all chemicals to which they may be exposed.

3) Process hazard analysis

After the process safety information is compiled, a thorough and systematic multidisciplinary process hazard analysis, appropriate to the complexity of the process, is conducted in order to identify, evaluate and control the hazards of the process. Persons performing the process hazard analysis should be knowledgeable and experienced in relevant chemistry, engineering and process operations. Each analysis team normally includes at least one person who is thoroughly familiar with the process being analyzed and one person who is competent in the hazard analysis methodology being used.

4) Management of change

Chemical process facilities should develop and implement programmes which provide for the revision of process safety information, procedures and practices as changes occur. Such programmes include a system of management authorization and written documentation for changes to materials, chemicals, technology, equipment, procedures, personnel and facilities that affect each process.

5) Operating procedures

Chemical processing facilities must develop and provide operating instructions and detailed procedures to workers. Operating instructions should be regularly reviewed for completeness and accuracy (and updated or amended as changes occur) and cover the process unit's operating limits.

6) Safe work practices

Chemical process facilities should implement hot-work and safe work permit and work order programmes to control work conducted in or near process areas. Supervisors, employees and contractor personnel must be familiar with the requirements of the various permit programmes, including permit issuance and expiration and appropriate safety, materials handling and fire protection and prevention measures.

7) Employee information and training

Chemical process facilities should use formal process safety training programmes to train and educate incumbent, reassigned and new supervisors and workers. The training provided for chemical process operating and maintenance supervisors and workers should be comprehensive.

Q2. What are Dyes? Discuss different Dyes.

Answer

A dye is a coloured compound, normally used in solution, which is capable of being fixed to a fabric. The dye must be 'fast' or chemically stable so that the color will not wash with soap and water, or fade on exposure to sunlight (ultraviolet light).

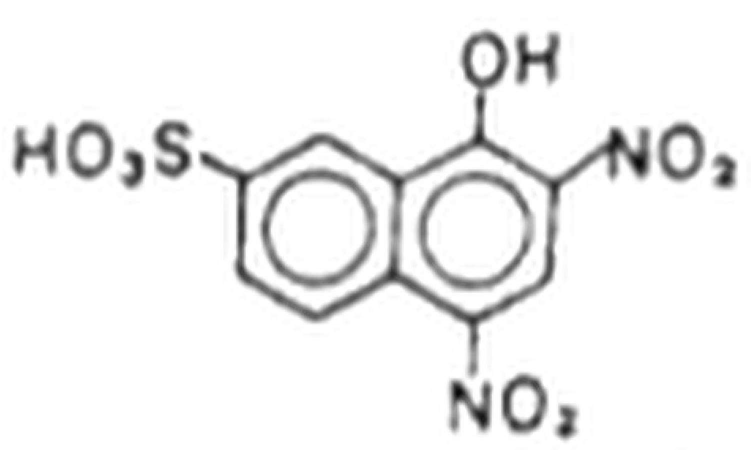
A dye owes its color to the presence of a chromophore and its fixing property to the acidic or basic auxochromic groups such as OH, S03H, NH2 NR2. etc. The polar auxochrome makes the dye water-soluble and binds the dye to the fabric by interaction with the oppositely charged groups of the fabric structure.

Classification of Dyes by structure

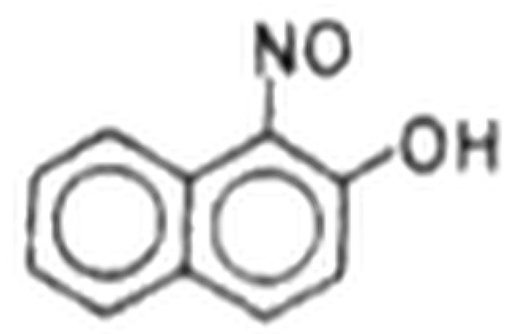
Dyes may be classified according to the type of chromophores present in their structures. This method of classification includes the following main types:

1) Nitro and Nitroso Dyes:

The NO_2 and NO groups are chromophores in this class of dyes. Examples are,



NAPHTHOL YELLOW S



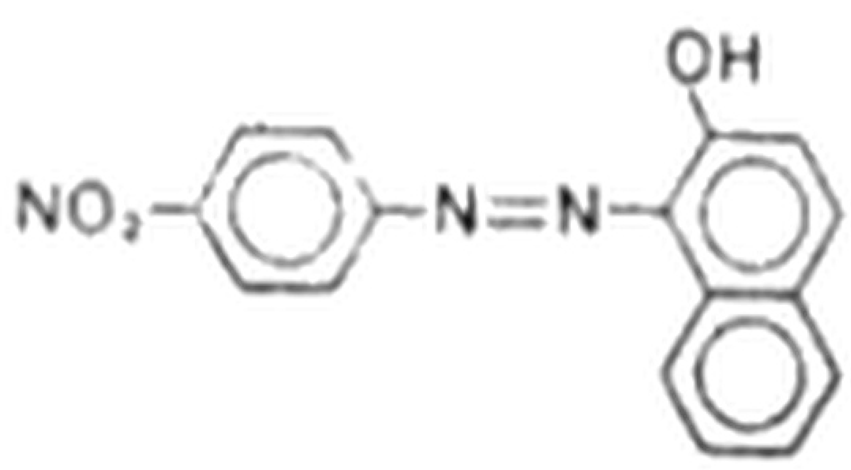
MORDANT GREEN 4

2) Azo Dyes:

The azo dyes contain one or more azo groups, -N=N- as the primary chromophore. The common auxochromres are NH_2, NR_2, OH, SO_3H, etc.

Azo dyes form the largest and most important group of synthetic groups of synthetic dyes. They are highly colored and can be prepared by diazotizing an aromatic amine and subsequent in both the diazonium salt and the coupling compound series azo dyes can be produced with almost any color. Examples are,

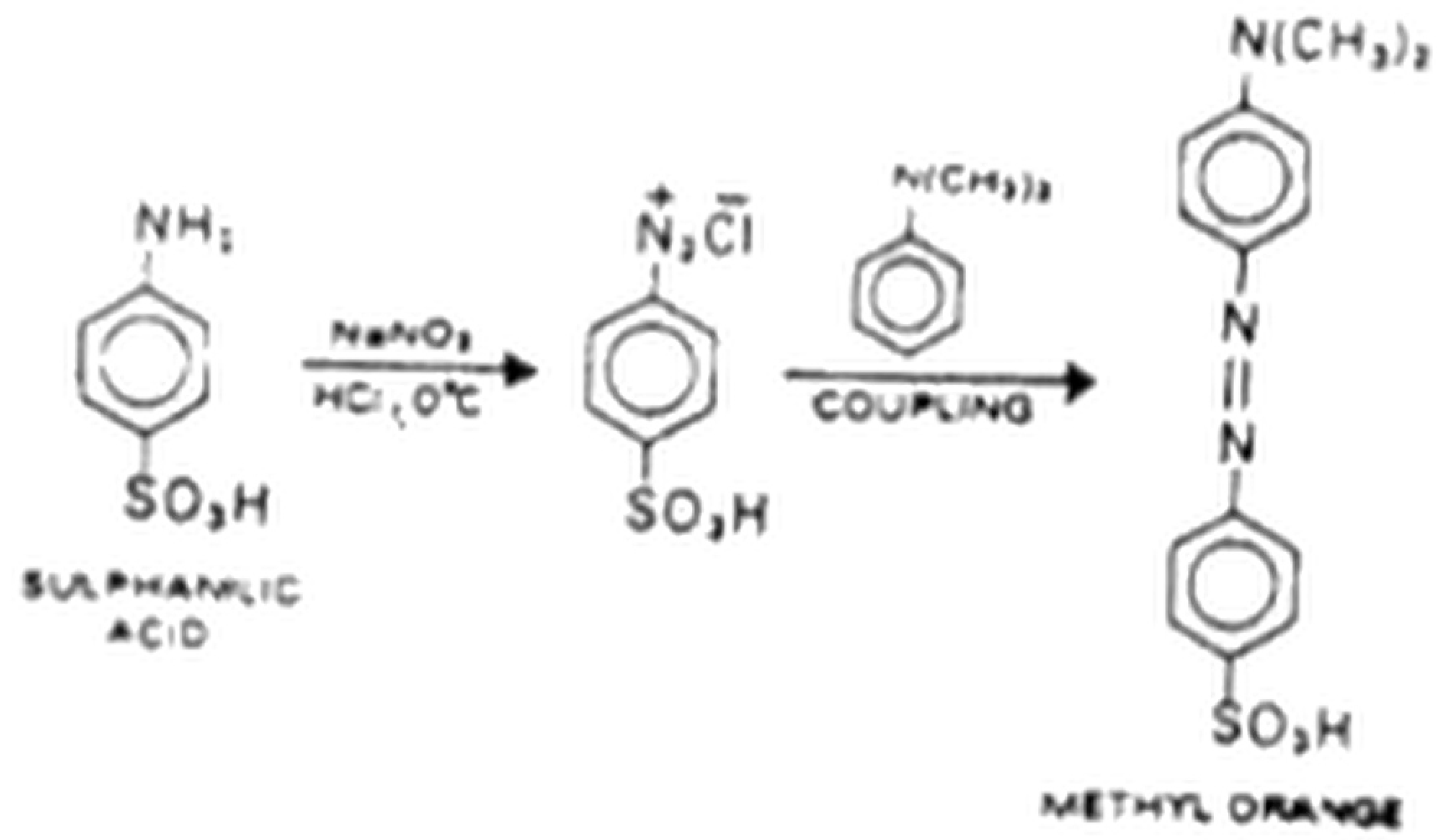
a) Para Red



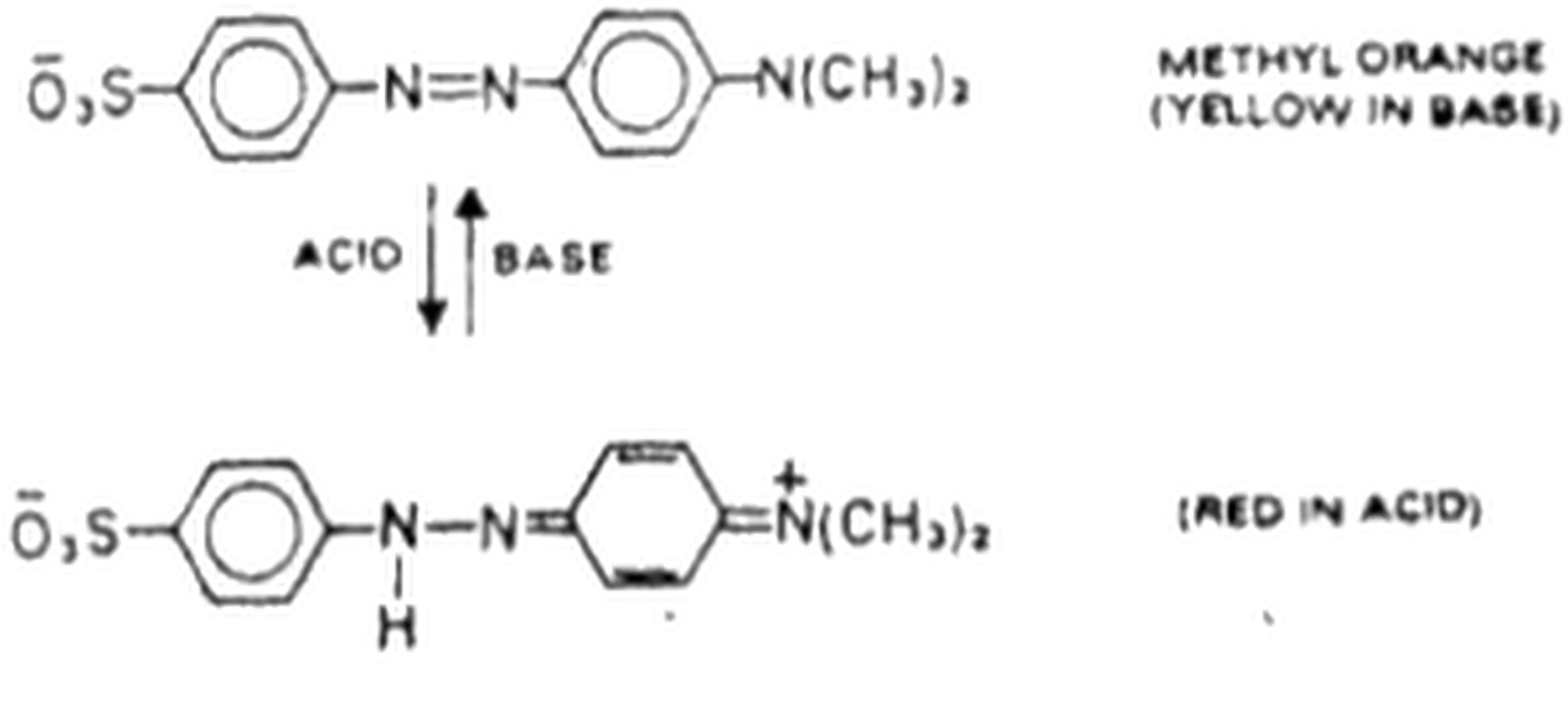
It was the first azo dye to be prepared. Para red is obtained by the reaction of diazotized p-nitroaniline with P—naphthol on fabric itself.

b) Methyl Orange:

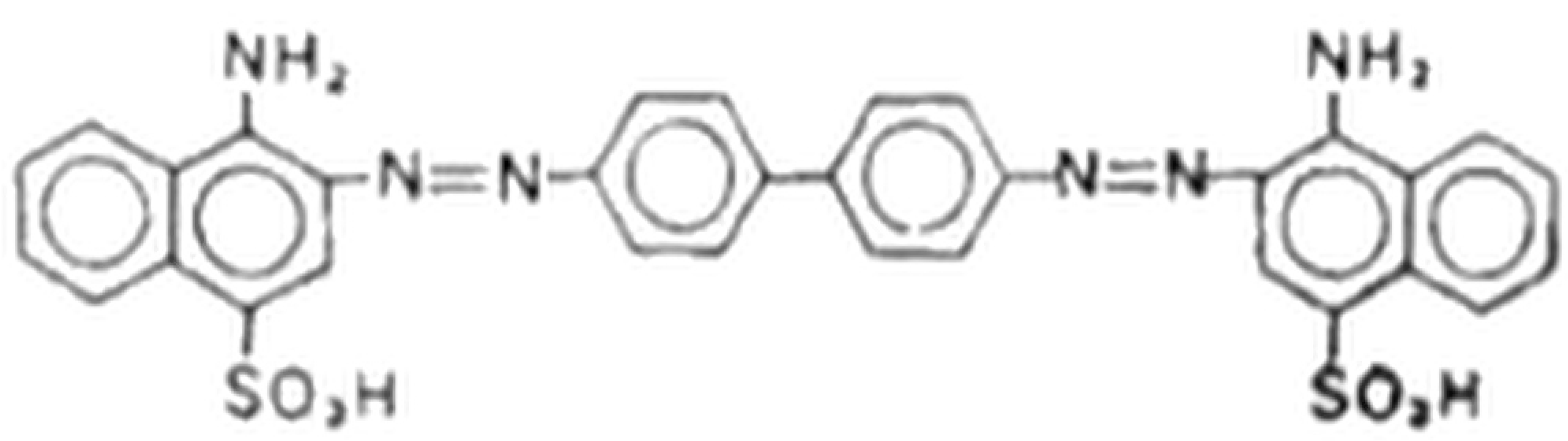
Methyl orange is obtained from sulphanilic acid by the following steps:



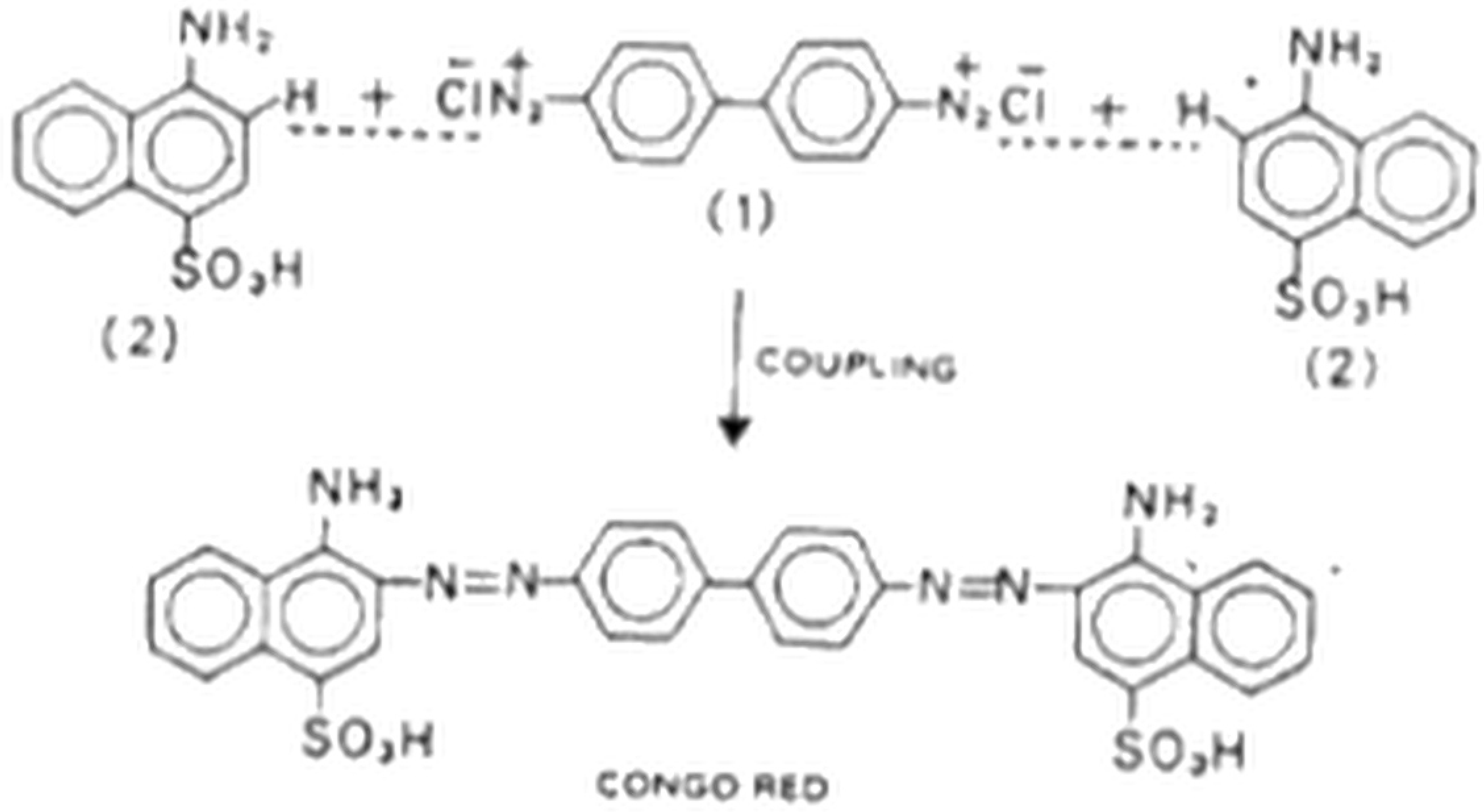
Methyl orange imparts orange color to wool and silk but the color is not fast to sunlight or washing. It is a valuable indicator for acid-base titrations because it gives yellow color in basic solution and red color in acid solution. The change in color is due to the change in the structure of the ions.



b) Congo Red



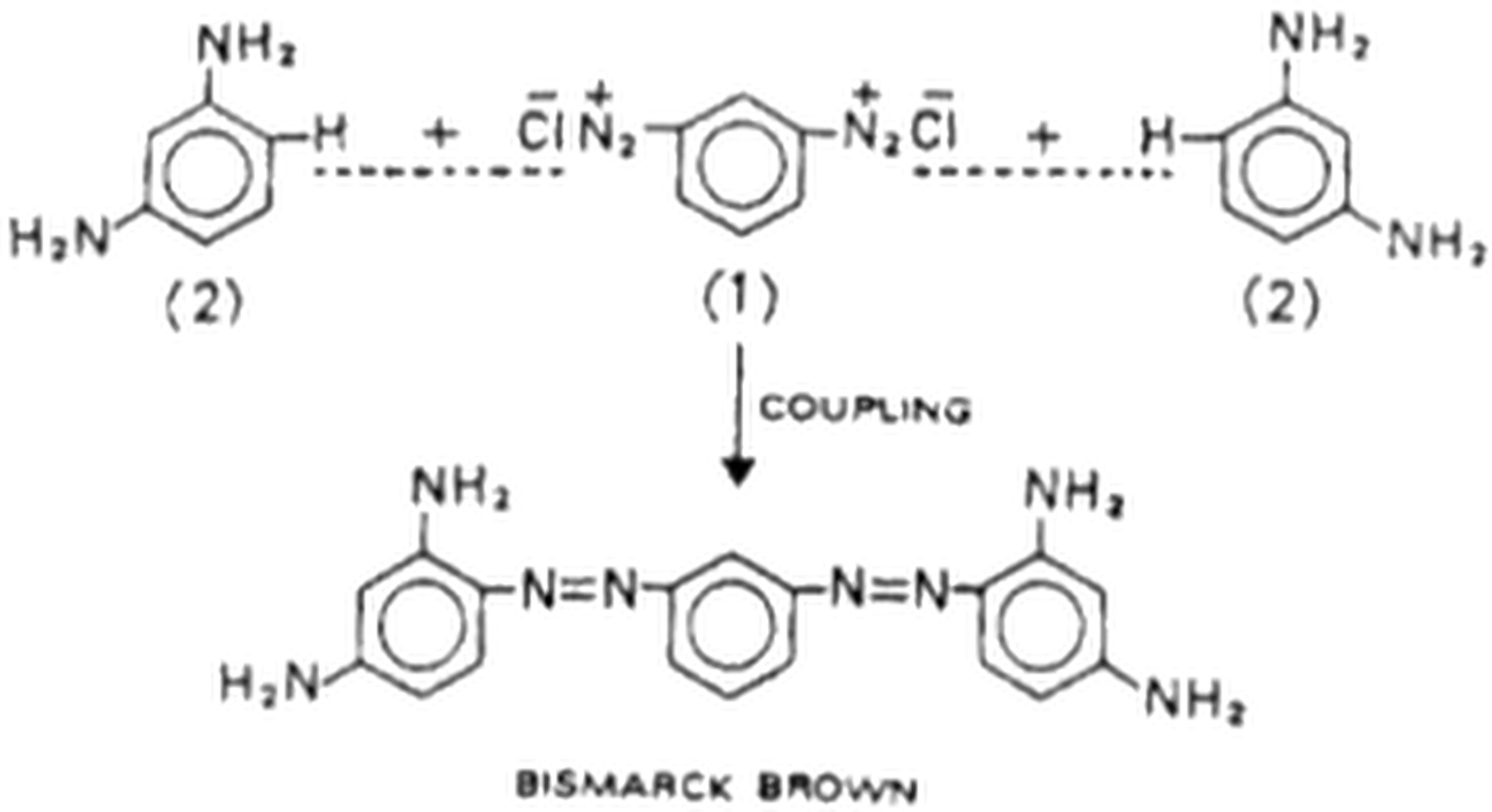
Congo red contains two azo groups. It is obtained by coupling tetrazotised benzidine (I) with two molecules of naphthionic acid (2).



It is a direct dye and its sodium salt is used for dying cotton red from aqueous solutions. Congo red is also used as an indicator, being red in alkali and blue in acid solutions.

d) Bismarck Brown

It is obtained by coupling tetrazotised m-diaminobenzene (I) with two molecules of mdiaminobenzene (2).

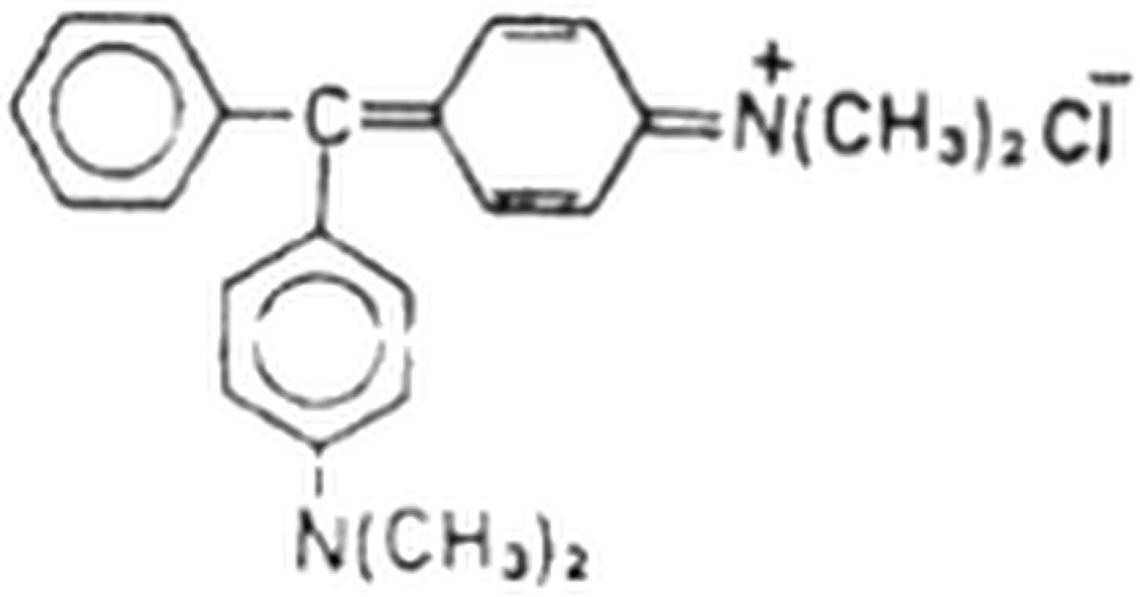


Bismarck brown is a brown dye used in boot polishes and for dyeing wool and cotton.

3) Triarylmethane Dyes:

in triarymlethane dyes, a central carbon is bonded to three aromatic rings one of which is in the quinoid form (the chromophore). The auxochromes are —NH2, -NR2 and -OH. Examples are:

a) Malachite Green

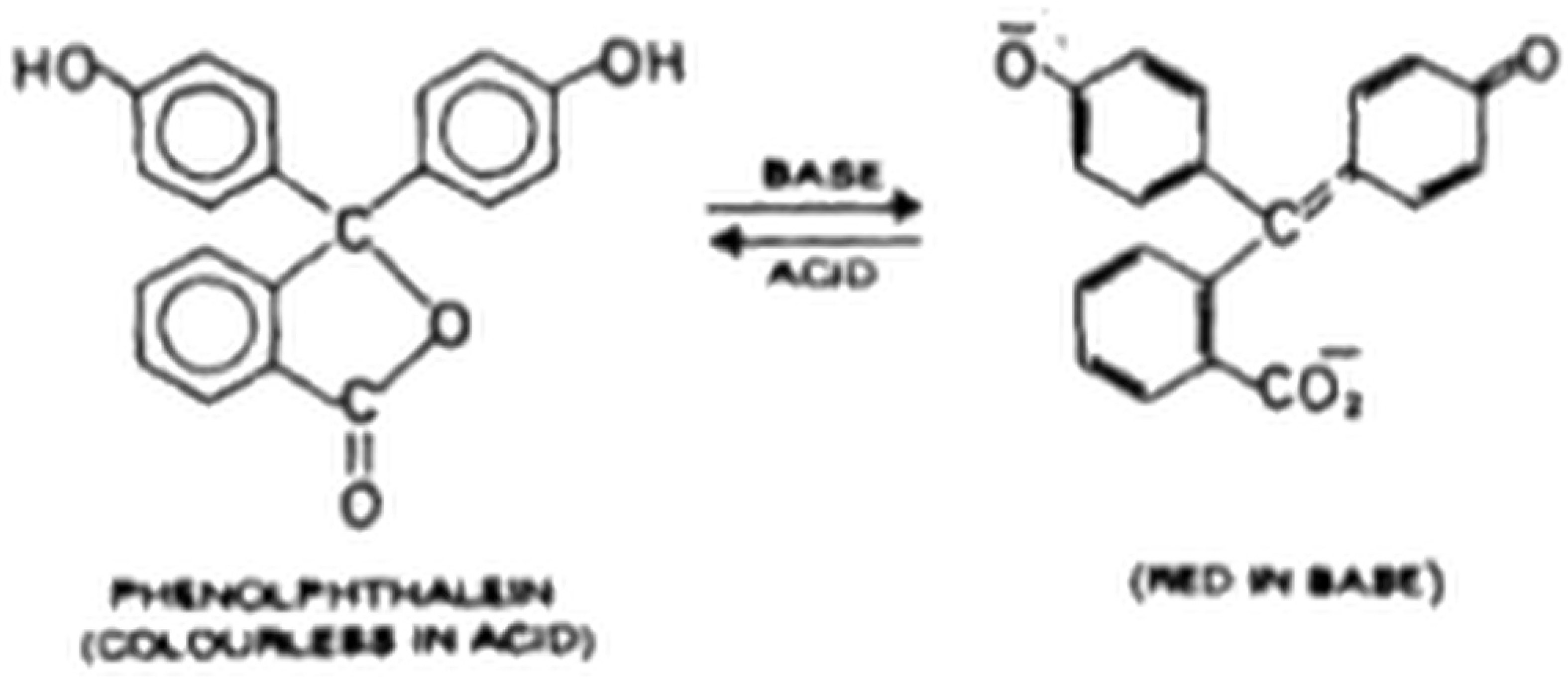


MALACHITE GREE

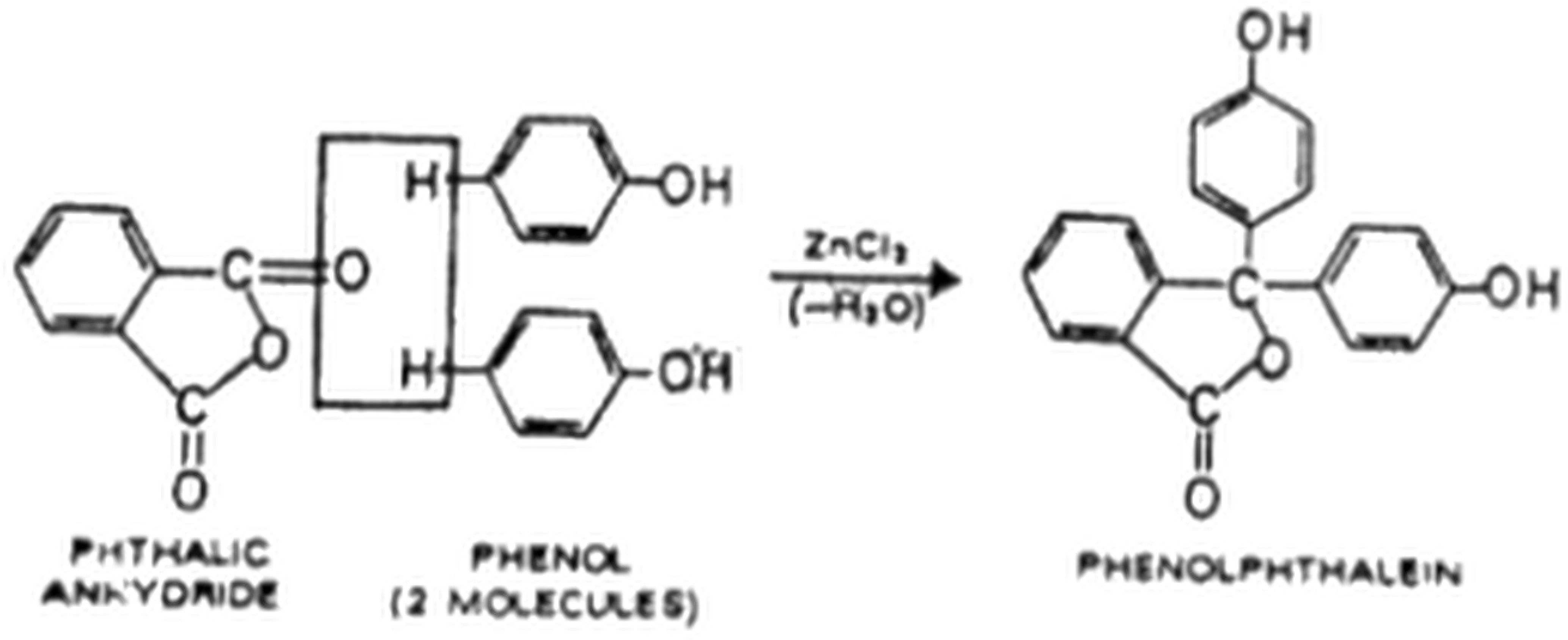
Malachite green has a deep green-blue color. Although the color fades in light, malachite green is used as a direct dye for wool and silk.

b) Phenolphthalein:

It is also a triarmylmethane dye but it is better known as an acid-base indicator.

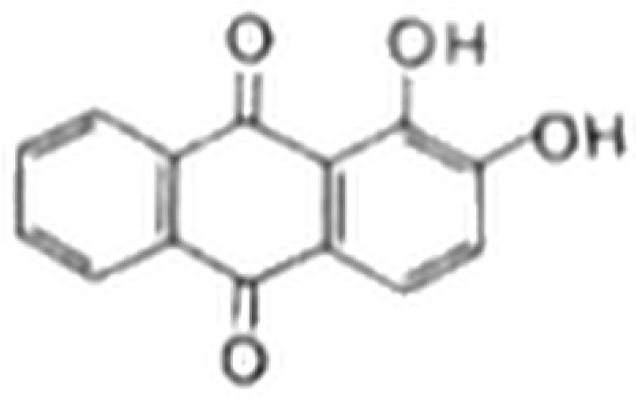


Phenolphthalein is prepared by heating phthalic anhydride (I mole) and phenol (two moles) in the presence of anhydrous zinc chloride at 120⁰C.



4) Anthraquinone Dyes:

The para quinoid chromophore is present in these anthracene-type dyes. Alizarin is a typical anthraquinone dye.

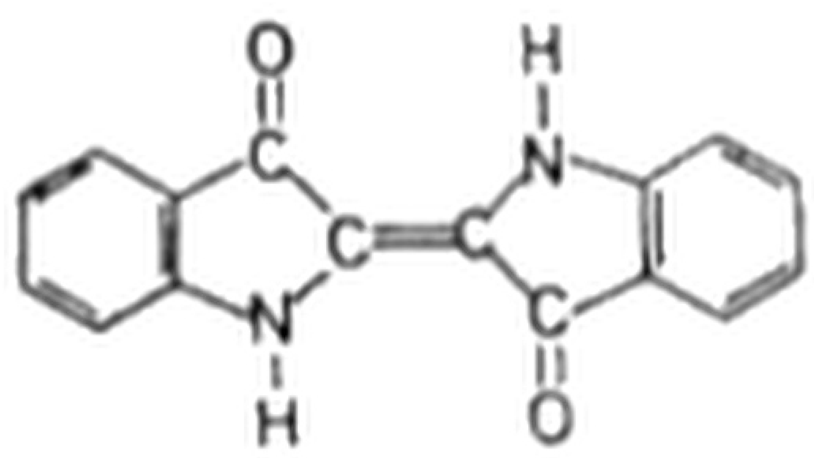


ALIZARIN

Alizarin forms ruby red crystals which dissolve in alkali to give purple solutions. It is used to dye wool and cotton.

5) Indigo Dyes:

Indigo is an example of the type of dyes which contain carbonyl chromophore.



INDIGO

It is a dark-blue crystalline compound, insoluble in water. It is used for dyeing cotton by the Vat Process.

Q3. Give classification of dyes by methods of application.

Answer

The chemical classification of dyes is of interest to the chemist but the dyer is concerned mainly with the application of dyes to fabrics. The method used for application in a particular case depends on the nature of both the dye and the fiber to be dyed. The dyes are often classified on the basis of technique employed for their application.

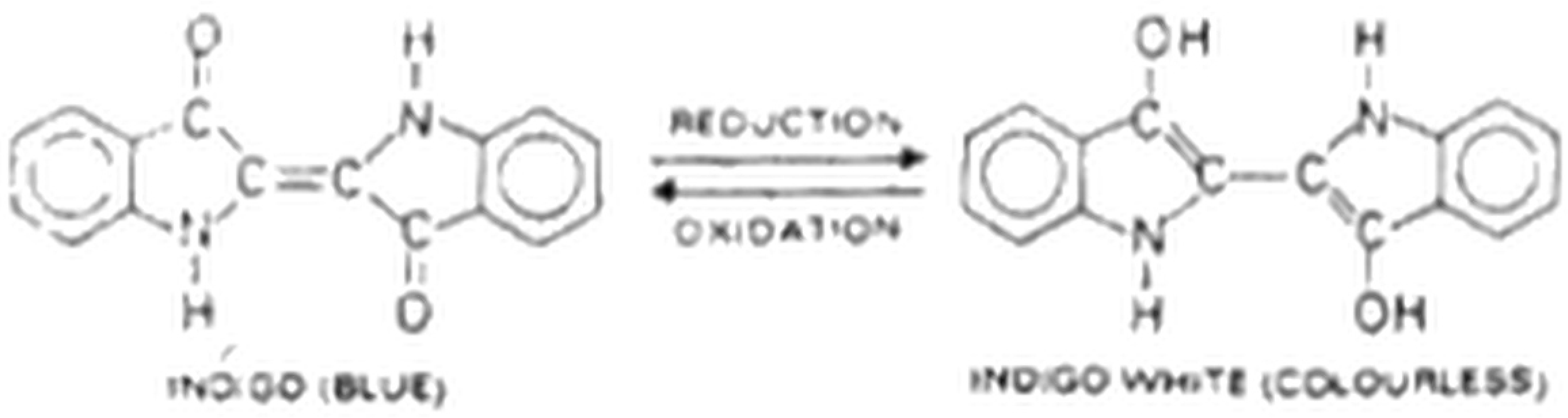
1) Direct Dyes:

These can be applied to a fabric by direct immersion in a water solution of the dye. A direct dye contains acidic or basic auxochrome which combines with the opposite polar group present in the chemical structure of the fiber. Wool and silk are readily dyed by this method. Martius Yellow, a typical direct dye, has the acidic auxochrome —OH which interacts with the basic-NH2 group of wool or silk.

$$\text{Fiber-}NH_2 + \text{HO-Dye} \rightarrow \text{Fiber-}NH_3^+ \ldots O^-\text{Dye (wool or silk)}$$

2) Vat Dyes:

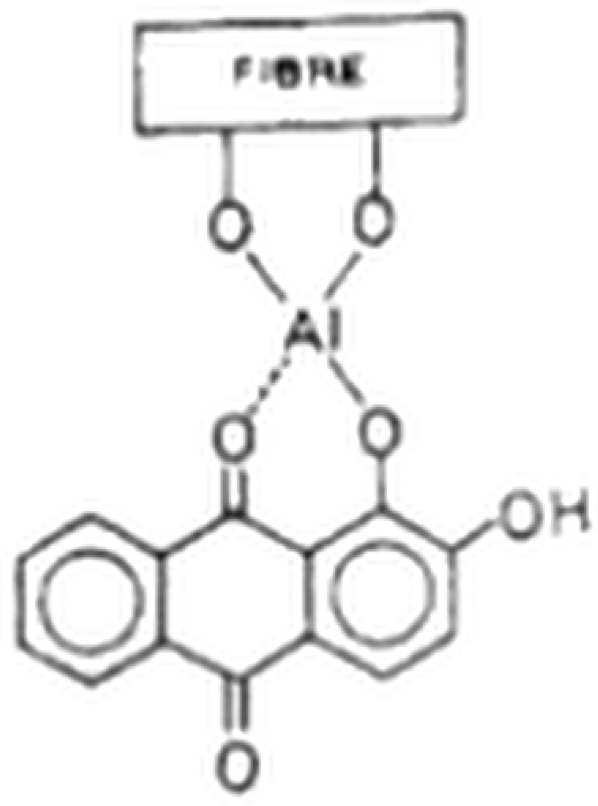
These dyes are insoluble in water but on reduction with sodium hydrosulphide in a vat form a colorless soluble compound which has a great affinity for cotton and other cellulose fibers. The cloth is soaked in the solution of a reduced dye and then hung in air, or treated with oxidants. As a result, the colorless compound is oxidized back to the insoluble dye which is now bound to the fabric. Indigo is a good example of a vat dye.



Indigo blue has auxochromes —OH which bind the dye fast to the cellulose fiber that contains ethereal oxygen and OH groups by hydrogen bonding.

3) Mordant Dyes:

This class of dyes has no natural affinity for the fabric and are applied to it with the help of salts e.g., oxides of aluminum or chromium. These salts are called Mordants. A fiber such as cotton is first treated with a mordant and then with the dye solution. The mordant forms an insoluble coordination complex between the fiber and the dye and binds the two. The insoluble complex compound appears in the form of lakes that are fast to light and washing. The mordant dyeing is the most suitable for wool and nylon. Alizarin is an example of a mordant dye.



4) Azoic Dyes (Ingrain Dyes).

In this method of dyeing, the water insoluble azo dye is produced in the fabric itself. The cloth is first soaked in the solution of a coupling reagent usually a phenol or naphthol.

Then it is immersed in the solution of an auxochromes. The azoic dyeing is particularly suitable for cotton and other cellulosic fiber but may also be used for nylon.

5) Disperse Dyes:

These dyes are insoluble in water but can be dispersed in a colloidal form in water. The fabric is immersed in the colloidal dispersion of the dye. The fine dye particles are absorbed into the crystal structure of the fabric. Disperse dyes are used with modem synthetic fabrics such as nylon, orlon, polyester and cellulose acetate.

Pesticides

A pesticide is any chemical which is used by man to control pests. The pests may be insects, plant diseases, fungi, weeds, nematodes, snails, slugs, etc. Therefore, insecticides, fungicides, herbicides, etc., are all types of pesticides.

Types of Pesticides

1) Insecticides

Insecticides are chemicals used to control insects. Often the word "insecticide" is confused '-Mth the word "pesticide. It is, however, just one of many types of pesticides. An insecticide may kill the insect by touching it or it may have to be swallowed to be effective. Some insecticides kill both by touch and by swallowing. Insecticides called Systemics may be absorbed, injected, or fed into the plant or animal to be protected. When the insect feeds on this plant or animal, it ingests the systemic chemical and is killed.

2) Miticides and Acaricides

Miticides (or Acaricides) are chemicals used to control mites (tiny Insecticides spider-like animals) and ticks. The chemicals usually must contact the mites or ticks to be effective. These animals are so numerous and small, that great care must be used to completely cover the area on which the mites live. Miticides are very similar in action to insecticides and often the same pesticide kills both insects and mites.

3) Fungicides

Fungicides are chemicals used to control the fungi which cause molds, rots, and plant diseases. All fungicides work by coming in contact with the fungus, because fungi do not "swallow" in the normal sense. Therefore, most fungicides are applied over a large surface area to try' to directly hit every fungus. Some fungicides may be systemic in that the plant to be protected may be fed or injected with the chemical. The chemical then moves throughout the plant, killing the fungi.

4) Herbicides

Herbicides are chemicals used to control unwanted plants. These chemicals are a bit different from other pesticides because they are used to kill or slow the growth of some plants, rather than to protect them. Some herbicides kill every plant they contact, while others kill only certain plants. It is of following types:

Nonselective herbicides are toxic to all plants. These are often used when no plants are wanted in an area. For example, nonselective herbicides could be used for clearing under guardrails or for total control of weeds in industrial areas.

Selective herbicides kill some plants with little or no injury to other plants. Usually selective types will kill either broadleaved plants or grassy plants. These are useful for lawns, golf courses or in areas with desirable trees. Some very selective herbicides may kill only certain plants in a group; for example, crabgrass killers on lawns.

5) Rodenticides

Rodenticides are chemicals used to control rats, mice, bats and other rodents. Chemicals which control other mammals, birds, and fish are also grouped in this category by regulatory agencies. Most rodenticides are stomach poisons and are often applied as baits. Even rodenticides which act by contacting the pest are usually not applied over large surfaces because of the hazard to domestic animals or desirable wildlife. They are usually applied in limited areas such as runways, known feeding places, or as baits.

6) Nematicides

Nematicides are chemicals used to control nematodes. Nematodes are tiny hair-like worms, many of which live in the soil and feed on plant roots. Very few of these worms live above ground. Usually, soil fumigants are used to control nematodes in the soil.

7) Molluscicides

Molluscicides are chemicals used to control snails and slugs. Usually the chemicals must be eaten by the pest to work. Baits are often used to attract and kill snails or slugs in an area.

8) Repellent

A repellent is a pesticide that makes a site or food unattractive to a target pest. They are registered in the same way other pesticides are and must be used according to the label. Insect repellents are available as aerosols and lotions and can be applied to skin, clothing, or plants to repel biting and nuisance insects. Vertebrate repellents are available as concentrates to be mixed with water, powders, and granules. They can be sprayed or painted on nursery crops, ornamental plantings, orchards, vineyards, vegetables, and seeds. Repelling deer, dogs, birds, raccoons, and others can protect sites from damage.

Q4. What are Petrochemicals? Give their classification.

Answer

The prefix "petro-" is an arbitrary abbreviation of the word "petroleum"; since "petro-" is Ancient Greek for "rock" and "oleum" means "oil". Therefore, the etymologically correct term would be "oleochemicals". However, the term oleochemical is used to describe chemicals derived from plant and animal fats.

Petrochemical Plant in the Kingdom of Saudi Arabia

Meanings:

Petrochemicals are chemical products derived from petroleum. Some chemical compounds made from petroleum are also obtained from other fossil fuels such as coal or natural gas, or renewable sources such as corn or sugar cane.

Note:

The fractional distillation, refining and important fractions of petroleum have already been discussed in section 15.2

Types/Classes of Petrochemical Raw materials (Building Blocks):

Petrochemical classes are:

a) Olefins including ethylene and propylene,

b) Aromatics

c) Synthesis Gas

Olefins and aromatics are the building blocks for a wide range of materials such as solvents, detergents, and adhesives.

Primary petrochemicals are divided into three groups depending on their chemical structure:

a) Olefins includes ethylene, propylene, and butadiene. Ethylene and propylene are important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber. Olefins are the basis for polymers and oligomers used in plastics, resins, fibers, elastomers, lubricants, and gels. At oil refineries olefins are produces mainly form hydrocarbons by chemical cracking such as steam cracking and by catalytic reforming.

b) Aromatics includes benzene, toluene, and xylenes. Benzene is a raw material for dyes and synthetic detergents, and benzene and toluene for isocyanates Manufacturers use xylenes to produce plastics and synthetic fibers. At oil refineries, aromatic hydrocarbons are mainly produced by catalytic reforming or similar processes.

c) Synthesis gas is a mixture of carbon monoxide and hydrogen used to make ammonia and methanol. Ammonia is used to make the fertilizer urea and methanol is used as a solvent and chemical intermediate.

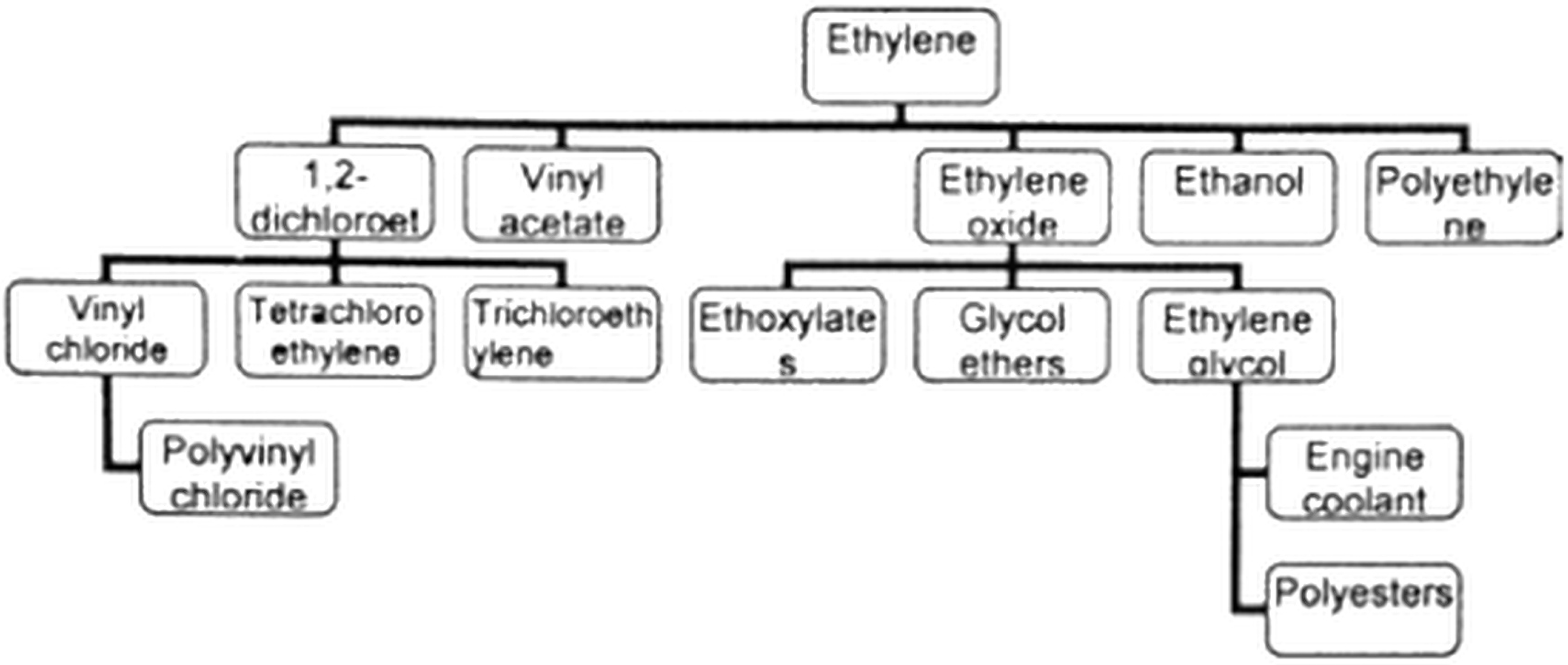
From these basic building blocks are made a very wide range of chemicals and other materials used in industry monomers, solvents detergents, adhesives etc. form the monomers, polymer or oligomers are products of plastics, resins fibres elastomers, certain lubricants and gels.

World is production of ethylene is around 110 million tons per annum of propylene 65 million tons and of aromatic raw materials 70 million tons. The largest petrochemicals industries are to be found in the USA and Western Europe, though the major growth in new production capacity is in the Middle East and Asia. There is a substantial interregional trade in petrochemicals of all kinds.

Note: Fractional Distillation and Refining of Petroleum has already been discussed under article No. IS. 1.1 at page No. 113-114.

List of significant petrochemicals and their derivatives

The following is a partial list of the major commercial petrochemicals and their derivatives:



Chemicals produced from ethylene

ethylene - the simplest olefin: used as a chemical feedstock and ripening hormone

i) polyethylene - polymerized ethylene

ii) ethanol - via ethylene hydration (chemical reaction adding water) of ethylene

iii) ethylene oxide - via ethylene oxidation

a) ethylene glycol - via ethylene oxide hydration

b) engine coolant - ethylene glycol, water and inhibitor mixture

c) polyesters - any of several polymers with ester linkages in the backbone chain

d) glycol ethers - via glycol condensation

e) ethoxylates

1. vinyl acetate

2. 1,2-dichloroethane

a) trichloroethylene

b) tetrachloroethylene - also called perchloroethylene; used as a dry-cleaning solvent and degreaser

i) vinyl chloride - monomer for polyvinyl chloride polyvinyl chloride (PVC) - type of plastic used for piping, tubing, other things

Chemicals produced from propylene

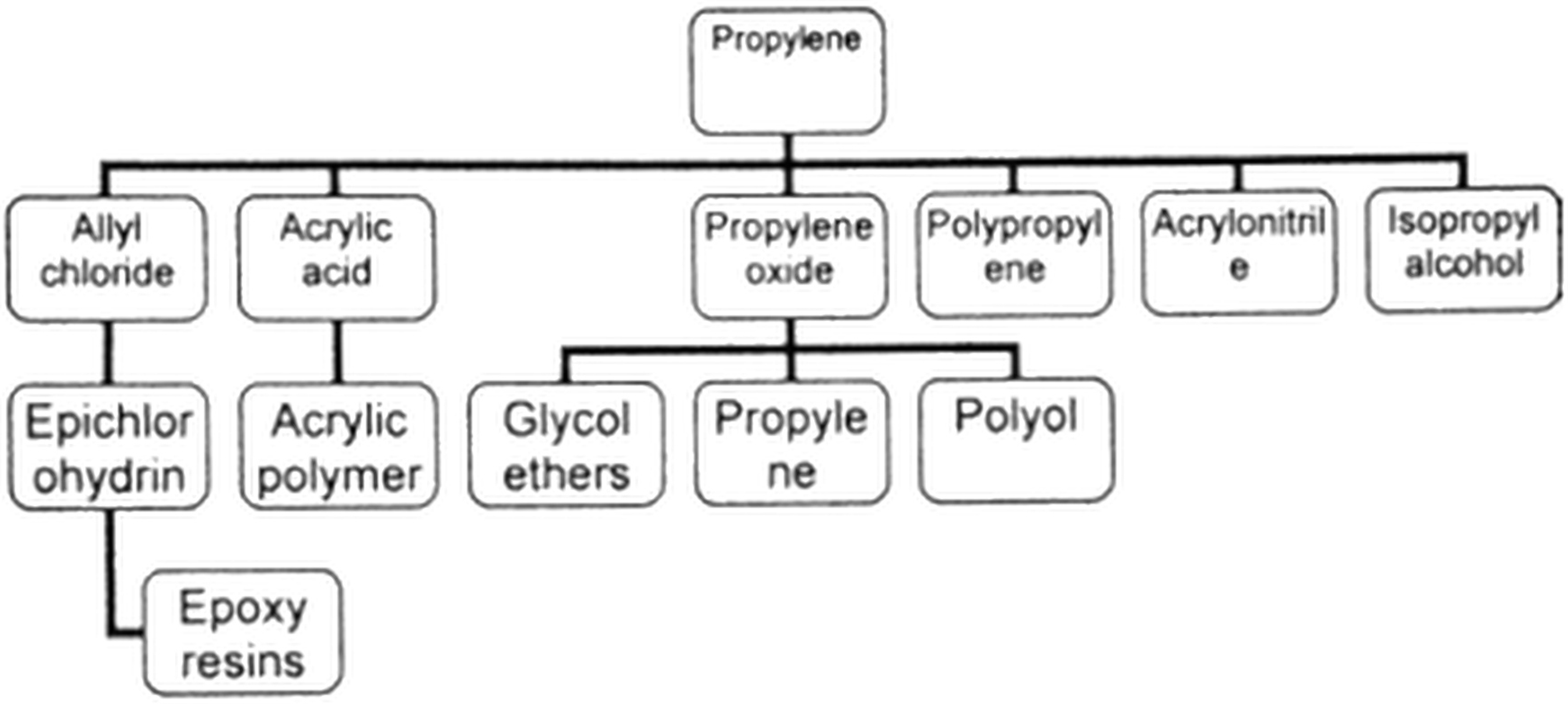
propylene - used as a monomer and a chemical feedstock

a) isopropyl alcohol - 2-propanol; often used as a solvent or rubbing alcohol

b) acrylonitrile - useful as a monomer in forming Orlon, ABS

c) polypropylene - polymerized propylene

d) propylene oxide



i) polyol - used in the production of polyurethanes

ii) propylene glycol - used in engine coolant and aircraft deicer fluid

iii) glycol ethers - from condensation of glycols

a. acrylic acid

i. acrylic polymers

b. allyl chloride -

i. epichlorohydrin - chloro-oxirane; used in epoxy resin formation

i) epoxy resins - a type of polymerizing glue from bisphenol A, epichlorohydrin, and some amine

Chemicals produced from benzene

a) benzene - the simplest aromatic hydrocarbon

i) ethylbenzene - made from benzene and ethylene

ii) styrene made by dehydrogenation of ethylbenzene; used as a monomer

iii) polystyrenes - polymers with styrene as a monomer

b) cumene - isopropylbenzene; a feedstock in the cumene process

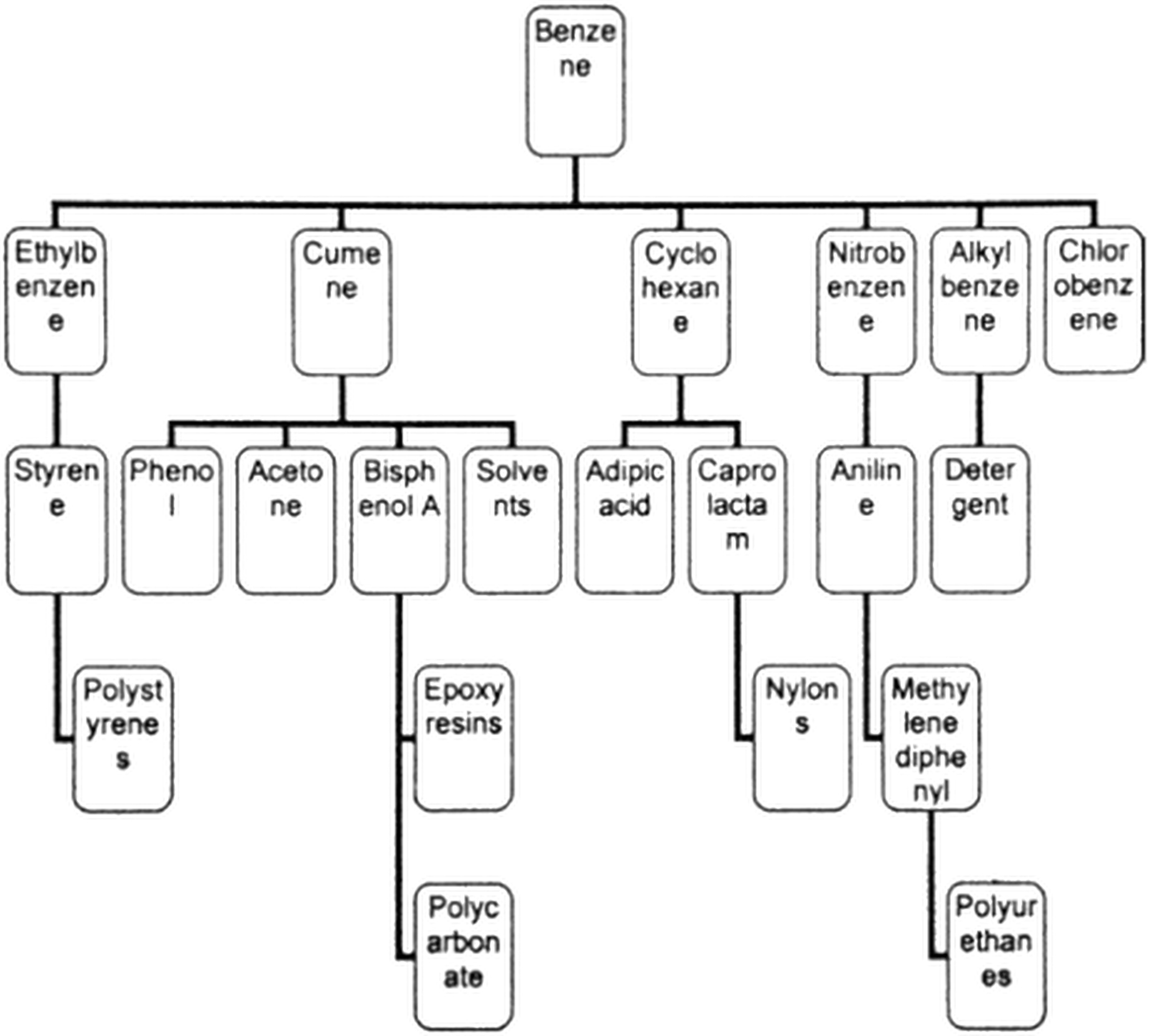
i. phenol - hydroxybenzene; often made by the cumene process

ii. acetone - dimethyl ketone; also, often made by the cumene process

iii. bisphenol A - a type of "double" phenol used in polymerization in epoxy resins and making a common type of polycarbonate

iv. epoxy resins - a type of polymerizing glue from

- bisphenol A, epichlorohydrin, and some amine
- polycarbonate - a plastic polymer made from bisphenol A and phosgene (carbonyl dichloride)



i) solvents liquids used for dissolving materials; examples often made from petrochemicals include ethanol, isopropyl alcohol, benzene, toluene, xylenes

a) cyclohexane - a 6-carbon aliphatic cyclic hydrocarbon sometimes used as a non-polar solvent

I. adipic acid - a 6-carbon dicarboxylic acid which can be a precursor used as a comonomer together with a diamine to form an alternating copolymer form of nylon.

- nylons - types of polyamides, some are alternating copolymers formed from copolymerizing dicarboxylic acid or derivatives with diamines

1.caprolactam - a 6-carbon cyclic amide

- nylons - types of polyamides, some are from polymerizing caprolactam

b) nitrobenzene - can be made by single nitration of benzene

II aniline - aminobenzene

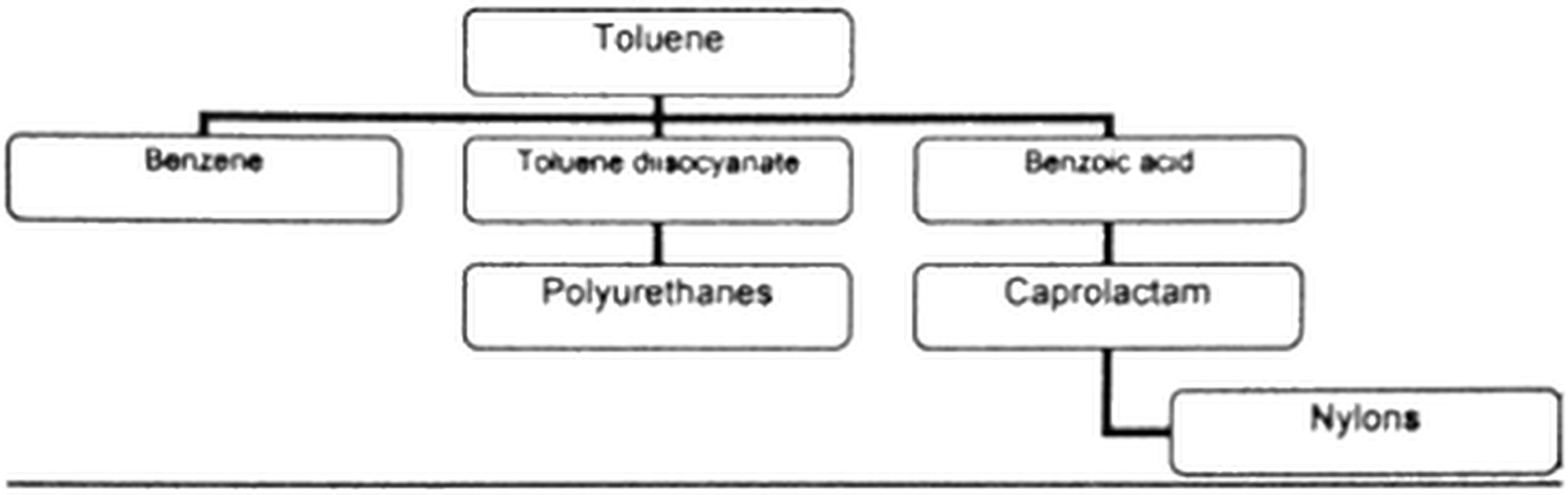
- methylene diphenyl diisocyanate (MDI) - used as a co-monomer with diols or polyols to form polyurethanes or with di- or polyamines to form polyurea
- polyurethanes

b) alkylbenzene - a general type of aromatic hydrocarbon which can be used as a precursor for a sulfonate surfactant (detergent)

111. detergents - often include surfactants types such as alkyl benzenesulfonates and nonylphenol ethoxylates

b) chlorobenzene

Chemicals produced from toluene



b) toluene - methylbenzene; can be a solvent or precursor for other chemicals

a) benzene

b) toluene diisocyanate (TDI) - used as co-monomers with diols or polyols to form polyurethanes or with di- or polyamines to form polyureas

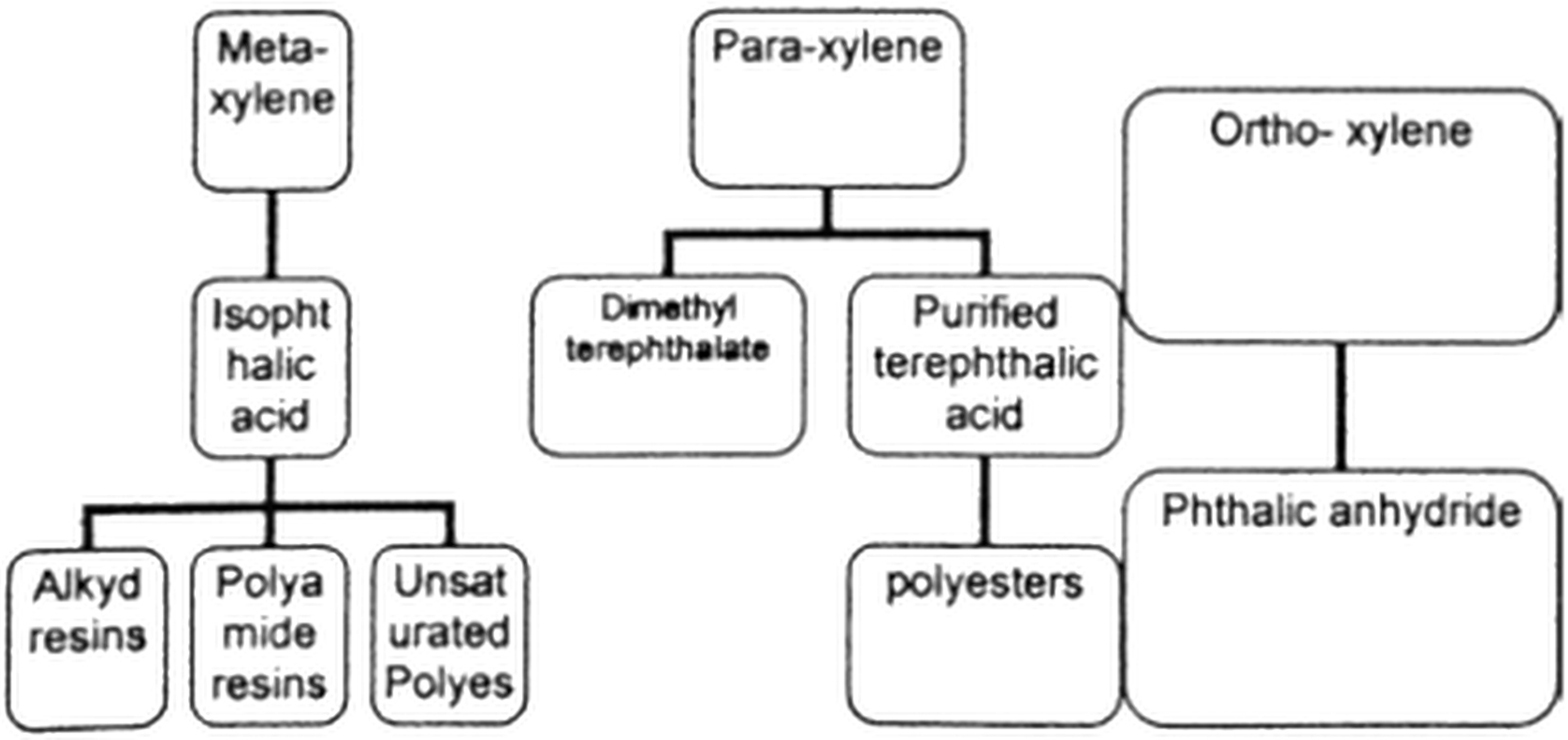
i) polyurethanes - a polymer formed from diisocyanates and diols or polyols

a) benzoic acid - carboxybenzene

ii) caprolactam

- nylon

b) Chemicals produced from xylenes



a) mixed xylenes - any of three dimethylbenzene isomers, could be a solvent but more often precursor chemicals

a) ortho-xylene - both methyl groups can be oxidized to form (ortho)phthalic acid

i) phthalic anhydride

b) para-xylene - both methyl groups can be oxidized to form terephthalic acid

i) dimethyl terephthalate - can be copolymerized to form certain polyesters

- polyesters - although there can be many types, polyethylene terephthalate is made from petrochemical products and is very widely used.

ii) purified terephthalic acid - often copolymerized to form polyethylene terephthalate

- polyesters

c) meta-xylene

i) isophthalic acid

- alkyd resins

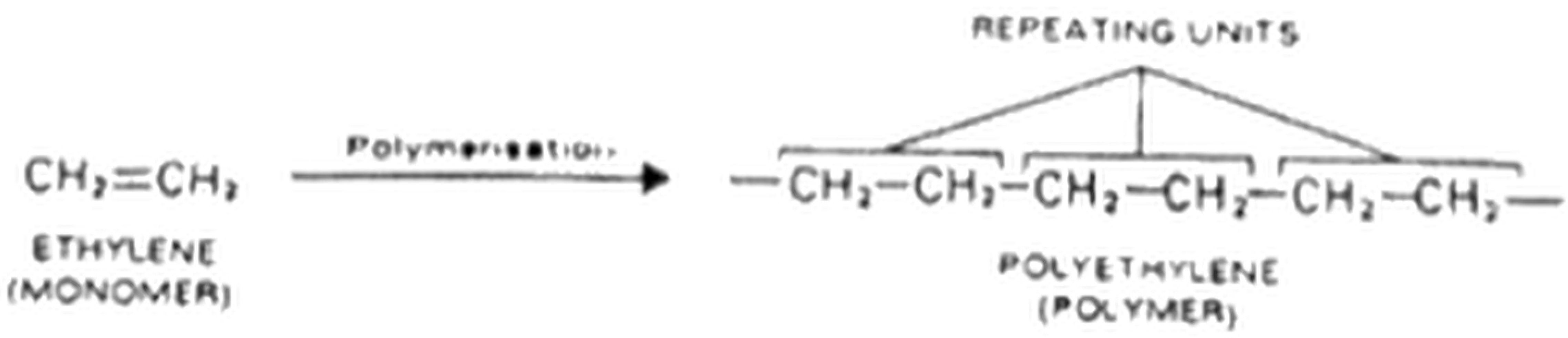
- Polyamide Resins
- Unsaturated Polyesters

Q5. What are synthetic polymers? Give their classification along with examples.

Answer

Polymers are high molecular weight compounds whose structures are made up of a large number of simple repeating units. The repeating units are usually obtained from low molecular weight simple compounds referred to as monomers. The reaction by which monomers are converted into polymers is known as polymerization.

The formation of polyethylene from ethylene is an example of polymerization reaction.



Polymers which are synthesized from only one kind of monomer are called homopolymers. Polymers which are prepared from more than one kind of monomer are called copolymers.

Classification of Polymers

There are two main types of polymers: Addition polymers and Condensation polymers.

i) Addition Polymers (Chain-Growth Polymers)

Addition polymers are formed by combination of alkenes monomers to produce a single huge molecule only. These reactions are catalyzed by peroxides or acids. The reactions require pressures of 1000 atmospheres at 2000C, much lower temperatures and pressures can be used with so called Ziegler Catalysts which consist of a trialkyl aluminum and titanium tetrachloride in an inert solvent.

1) Polyethylene (Polythene).

It is obtained by polymerizing ethylene. Polyethylene has been produced commercially since 1943. It is used in the manufacture of houseware such as buckets and dustbins, carpet backing, packing materials, and cable insulation.

Notice that the monomer (ethylene) contains a double bond and the polymer does not. The electrons of the monomer pi bond have moved and are used to link one monomer unit to another by sigma bonds as indicated by extended lines in abbreviated polymer formula. The backbone of the polymer consists of the carbon atoms that originally formed the double bonds. Nothing is lost. The monomers simply add to each other.

2) Polyvinyl Chloride (PVC).

It is obtained by polymerizing vinyl chloride. PVC is used in the manufacture of imitation leather, floor covering, corrugated roofing material and gramophone records.

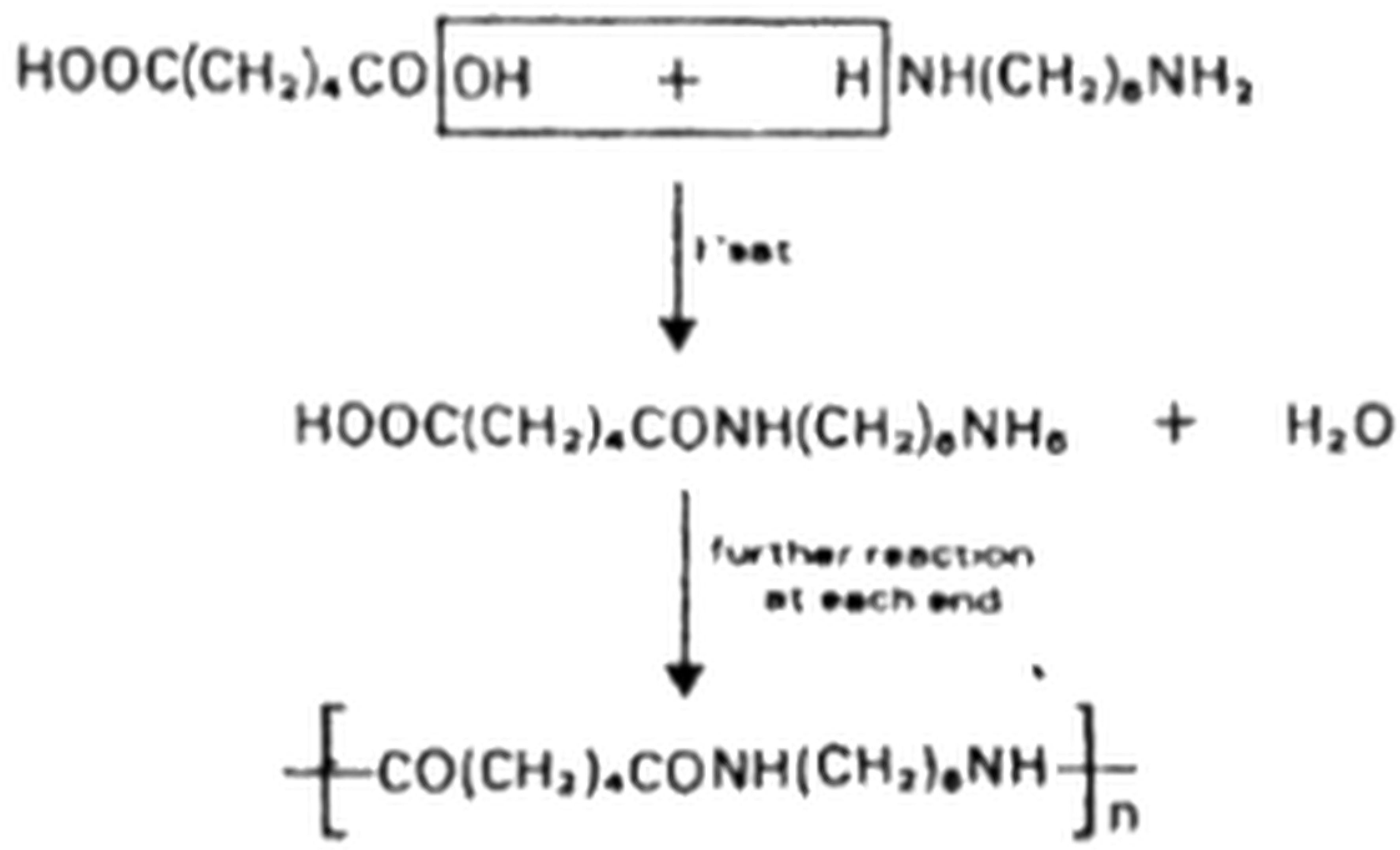
Vinyl chloride is obtained from acetylene by treatment with HCl in the presence of $HgCl_2$.

$$\underset{\text{Acetylene}}{HC\equiv CH} + HCl \xrightarrow{HgCl_2} \underset{\text{Vinyl chloride}}{CH_2=CH-Cl}$$

II) Condensation Polymers (step-growth polymers)

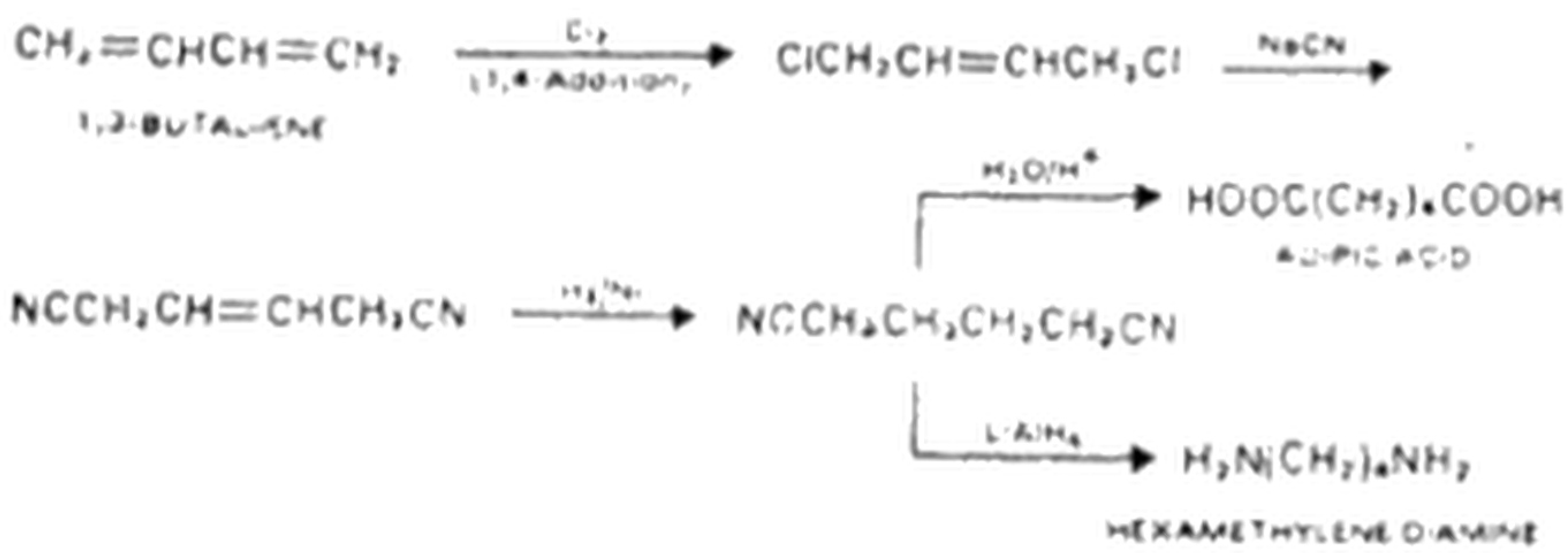
Condensation polymers are formed by combination of monomers with the elimination of simple molecules such as H20 or CH30H. There are two main types of condensation polymers: Polyesters or Polyamides. The most common example is:

Nylon-6,6 is the most important polyamide. It is obtained by heating adipic acid with hexamethylene diamine under nitrogen at 2000C. Nylon-6,6 derives its name from its starting materials, adipic acid and hexamethylene diamine, both of which have six carbons.



NYLON-6, 6

Both starting materials can be prepared from 1,3-butadiens as shown below:



Nylon-6,6 was developed as a synthetic fiber for the production of stocking and other wearing apparel. It was introduced to the public at the New York World's Fair in 1939. It is used to make fibers for clothing and carpeting, filaments for fishing lines and ropes, bristles for brushes, and molded objects such as gears and bearings.

THERMOPLASTIC AND THERMOSETTING POLYMERS

A thermoplastic polymer is one which softens on heating and becomes hard on cooling. A thermosetting polymer is one which becomes hard on heating it cannot be softened by heating.

Q6. Write a note on development of synthetic fibers. Give their uses also.

Answer

Nylon is the first synthetic fiber. Synthetic fibers are made from synthesized polymers or small molecules. The compounds that are used to make these fibers come from raw materials such as petroleum-based chemicals or petrochemicals.

These materials are polymerized- into a long, linear chemical that bond two adjacent carbon atoms. Different chemical compounds will be used to produce different types of fibers. There are several methods of manufacturing synthetic fibers but the most common is the Melt-Spinning Process. It involves heating the fiber until it begins to melt, then drawing out the molten fiber with tweezers as quickly as possible. The next step is to draw the molecules by aligning them in a parallel arrangement. This brings the fibers closer together and allows them to crystallize and orient. Lastly, is Heat-Setting. This utilizes heat to permeate the shape and dimensions of the fabrics made from heat sensitive fibers.

In general, synthetic fibers are created by forcing, usually through extrusion (the act or process of pushing or thrusting out to create objects of a fixed, cross-sectional profile) fiber, forming materials through holes (called spinnerets) into the air, forming a thread. Before synthetic fibers were developed, artificially manufactured fibers were made from cellulose.

Uses of synthetic fibres

Synthetic fibres are used for making

Clothes

Ropes

Nylon is used in making stockings, parachutes and other military equipment.

Fish nets

Carpets

Tents

Derclon is used in making rugs.

Glass fiber is used for:

- industrial, automotive, and home insulation (glass wool)

- reinforcement of composite materials (glass-reinforced plastic, glass fiber reinforced concrete)
- specialty papers in battery separators and filtration

Metallic fiber is used for:

- adding metallic properties to clothing for the purpose of fashion (usually made with composite plastic and metal foils)
- elimination and prevention of static charge build-up
- conducting electricity to transmit information
- conduction of heat

In the horticulture industry synthetics are often used in soils to help the plants grow better. Examples are:

- expanded polystyrene flakes
- urea-formaldehyde foam resin
- polyurethane foam
- phenolic resin foam.

Q7. Write a note on cosmetic chemistry. Discuss different cosmetic chemicals.

Answer

The global market for skincare and color cosmetics exceeded 53 billion dollars in 2002. The number of new products brought to market continues to expand exponentially. Cosmetic chemists are always looking for interesting and exotic ingredients that improve skin's appearance and health. A vast array of compounds is required to supply these products. The latest edition of the Cosmetics Toiletries and Fragrance Association (CTFA) Dictionary lists more than 10,000 raw materials. Every year hundreds of new ingredients are added to the list of those that have been used for centuries.

This particular topic is very vast but we will restrict ourselves in the following topics and discuss them one by one with a sufficient detail in each case:

l) Nail Polish 2) Nail Polish Remover

3) Lipstick 4) Hair dyes

1) Nan Polish

Background

Unlike many other cosmetics that have a history of hundreds or even thousands of years, nail polish (or lacquer, or enamel) is almost completely an invention of twentieth century technology. Nail coverings were not unknown in ancient times—the upper classes of ancient Egypt probably used henna to dye both hair and fingernails—but essentially, its composition, manufacture and handling reflect developments in modern chemical technology.

Modern nail polish is sold in liquid form in small bottles and is applied with a tiny brush. Within a few minutes after application, the substance hardens and forms a shiny coating on the fingernail that is both water- and chip-resistant. Generally, a coating of nail polish may last several days before it begins to chip and fall off. Nail polish can also be removed manually by applying nail polish "remover," a substance designed to break down and dissolve the polish.

Raw Materials

There is no single formula formal polish. There are, however, a number of ingredient types that are used. These basic components include:

1) Film forming agents e.g. Nitrocellulose
2) Resins and plasticizers e.g. castor oil, amyl and butyl stearate, and mixes of glycerol, fatty acids, and acetic acids
3) Solvents e.g. Butyl stearate and acetate compounds

4) Coloring agents e.g. "pearl" or "fish scale"

The manufacturing process includes following steps:

I) When properly and fully milled, the mixture is removed from the mill in sheet form and then broken up into small chips for mixing with the solvent. The mixing is formed in stainless steel kettles.

Caution:

This step is performed in a special room or area designed to control the hazards of fire and explosion. Most modem factories perform this step in an area with walls that will close in if an alarm sounds and, in the event of explosion, with ceilings that will safely blow off without endangering the rest of the structure.

I) At the end of the process, the mix is cooled slightly before the addition of such other materials as perfumes and moisturizers.

2) The mixture is then pumped into smaller, 55-gallon drums, and then trucked to a production line. The finished nail polish is pumped into explosion proof pumps, and then into smaller bottles suitable for the retail market.

2) Nail Polish Remover

Nail polish remover base commonly contains a mixture of two organic solvents acetone and ethyl acetate.

Acetone belongs to a group of organic molecules called ketones or alkenones. The proper name acetone is propanone. It is also sometimes called 2-propanone.

Ethyl acetate belongs to a group of organic molecules called esters or alkyl alkenoates. The proper name for ethyl acetate is ethyl ethanoate.

3) Lipstick and Chemical Composition

Lipsticks are simple in chemical composition, however complicated their application or effects. They are made up of three ingredients—a waxy or fatty base, a dye and a perfume.

There is no danger in the use of lipstick. In fact, for sensitive mucous membranes they are protective. Anyone can eat a lipstick with no more harm than eating a pat of butter.

Raw Materials The primary ingredients found in lipstick are

wax (The wax used usually involves some combination of three types—beeswax, candelilla wax, or the more expensive carnauba)

oil (such as mineral, caster, lanolin, or vegetable oil)

alcohol, fragrance and pigment,

Preservatives and antioxidants.

In general, wax and oil make up about 60 percent of the lipstick (by weight), with alcohol and pigment accounting for another 25 percent (by weight). Fragrance added to lipstick, accounts for one percent or less of the mixture.

The Manufacturing Process

The manufacturing process is easiest to understand if it is viewed as three separates

steps: melting and mixing the lipstick; pouring the mixture into the tube; and packaging the product for sale.

Melting and mixing

First, the raw ingredients for the lipstick are melted and mixed—separately because of the different types of ingredients used. One mixture contains the solvents, a second contains the oils, and a third contains the fats and waxy materials. The solvent solution and liquid oils are then mixed with the color pigments. After the pigment mass is ground and mixed, it is added to the hot wax mass until a uniform color and consistency is obtained.

Molding

Once the lipstick mass is mixed and free of air, it is ready to be poured into the tube. A variety of machine setups are used, depending on the equipment that the manufacturer has. The melted mass is dispensed into a mold, "up-side down" so that the bottom of the tube is at the top of the mold. The lipstick is cooled and separated from the mold, and the bottom of the tube is sealed. The lipstick then passes through a flaming cabinet (or is flamed by hand) to seal pinholes and improve the finish.

Labeling and packaging

After the lipstick is retracted and the tube is capped, the lipstick is ready for labeling and packaging. Labels identify the batch and are applied as part of the automated operation. The final step in the manufacturing process is the packaging of the lipstick tube. There are a variety of packaging options available.

4) Hair dye

History:

I) Hair dye is one of the oldest known beauty preparations, and was used by ancient cultures in many parts of the world. Records of ancient Egyptians, Greeks, Hebrews, Persians, Chinese, and early Hindu peoples all mention the use of hair colorings.

2) Early hair dyes were made from plants, metallic compounds, or a mixture of the two.

3) Rock alum, quicklime, and wood ash were used for bleaching hair in Roman times. Henna was known in many parts of the world; it produces a reddish dye.

4) Mary different plant extracts were used for hair dye in and Asia before the advent of modern dyes.

5) Indigo, known primarily as a fabric dye (see section 22.3), could be combined with henna to make light brown to black shades of hair dye.

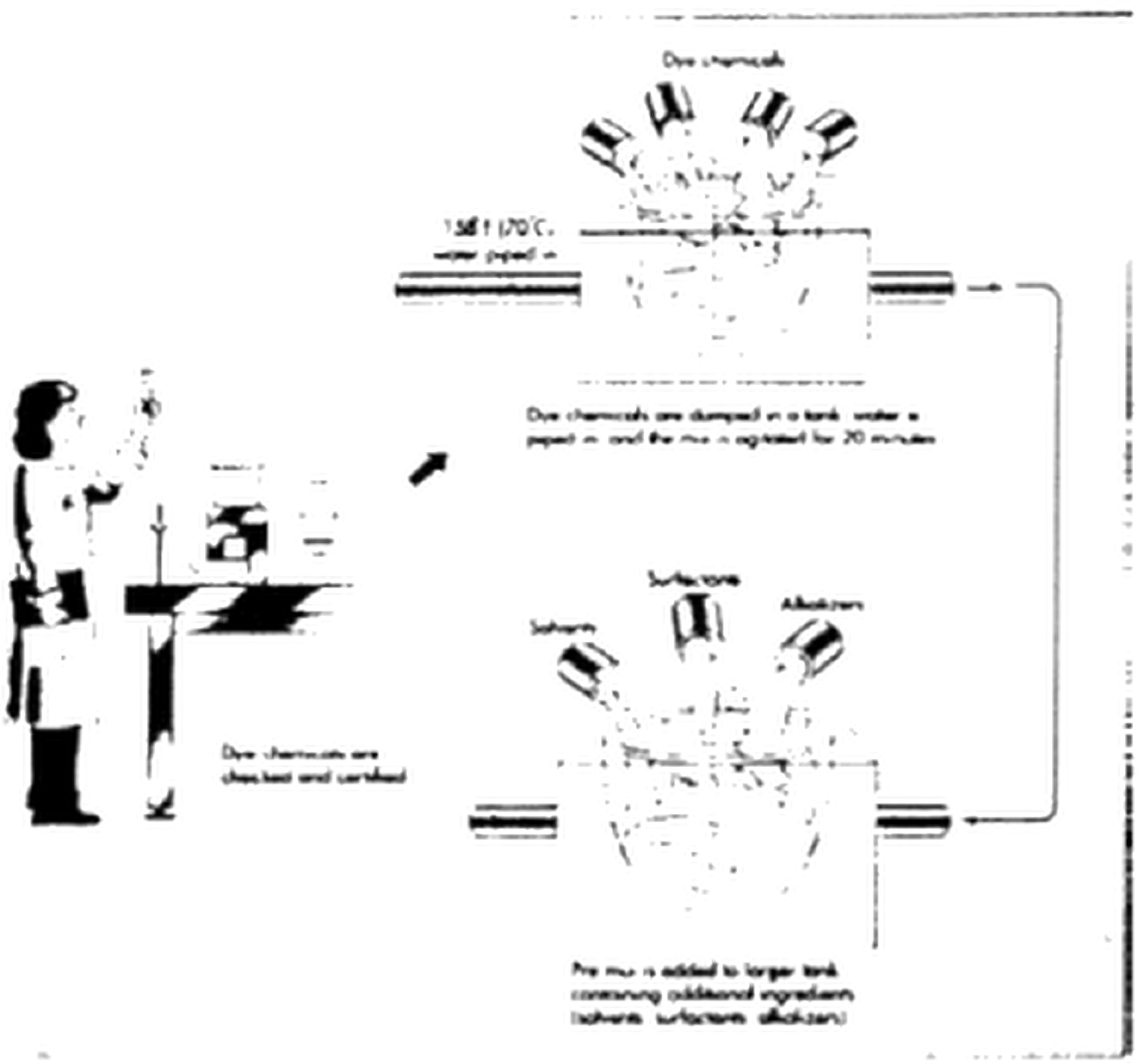
6) An extract of the flowers of the chamomile plant was long used to lighten hair, and this is still used in many modern hair preparations.

7) The bark, leaves, or nutshells of many trees were used for hair dyes. Other dyes were produced from walnut leaves or nut husks.

Modern Age:

Preparations such as these were the only hair dyes available until the late nineteenth century. Hydrogen peroxide was discovered in 1818, but it was not until 1867 that it was exhibited at the Paris Exposition as an effective hair lightener. A London chemist and a Parisian hairdresser began marketing a 3% hydrogen peroxide formula at the Exposition as eau defontaine dejouvence golden (golden fountain of youth water), and thiewas the first modern chemical hair colorant.

Advances in chemistry led to the production of more hair dyes in the late nineteenth century. The first synthetic organic hair dye developed was pyrogallol,



a substance that occurs naturally in walnut shells.

Raw Materials

In general, hair dyes include:

l) Dyes e.g. 4-amino-2-hydroxytoluene

2) Modifiers e.g. resorcinol

3) Antioxidents e.g. sodium sulfite

4) Alkalizers e.g. ammonium hydroxide

Beyond these basic chemicals, many different chemicals are used to impart special qualities. They may be shampoos, fragrances, chemicals that make the formula creamy, foamy, or thick, or contribute to the overall action of the formula.

Hair dyes are usually packaged with a developer, which is in a separate bottle. The developer is most often based on hydrogen peroxide, with the addition of small amounts of other chemicals depending on the manufacturer.

The Manufacturing Process

The manufacturing process includes the following steps

1. First of all chemicals must be tested to make sure they are what they are labeled. Then weigh the chemicals accurately.
2. Further there chemicals are mixed in preheated water other solvents. The premix is agitated for about 20 minutes.
3. The pre mix is then added to a large tank, containing the other ingredients of the hair dye.
4. After getting proper consistency this mixture is delivered to a tank where it is filled in bottles labeled caped, pack with developer and then distributed in the market.

Q8. What are Adhesives? Give their types & uses also.

Answer

Adhesives are meant to stick things together. An adhesive is a compound that adheres or bonds two items together. Adhesives may come from either natural or synthetic sources. Adhesives are nature product; it is also manufactured in Factories. Some modern adhesives are extremely strong, and are becoming increasingly important in modern construction and industry.

Types:

a) Natural adhesives: are made from inorganic mineral sources, or biological sources such as vegetable matter, starch (dextrin), natural resins, animal skin. They are often referred to as bio adhesives.

b) Synthetic adhesives: Elastomers, thermoplastic, and thermosetting adhesives are examples of synthetic adhesives.

c) Drying adhesives: These adhesives are a combination of ingredients suspended in a solvent. White glue and rubber cements are members of the drying adhesive family. As the solvent evaporates, the adhesive hardens.

d) Contact adhesives: Contact adhesives must be applied to both surfaces and allowed some time to dry before the two surfaces are pushed together. Some contact adhesives require as long as 24 hours to dry before the surfaces are to be held together

e) Hot Glue: Also known as "hot melt" adhesives, these adhesives are thermoplastics; they are applied hot and simply allowed to harden as they cool. These adhesives have become popular for crafts because of their ease of use and the wide range of common materials to which they can adhere. The glue gun melts the solid adhesive and then allows the liquid to pass through the "barrel" of the gun onto the material where it solidifies.

f) UV and light curing adhesives: UV and light curing adhesives consist essentially of low or medium molecular weight resins.