CH0204 Organic Chemical Technology

Lecture 13

Chapter 4 Synthetic Fibers

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Overview of topics

Chapter 4 Synthetic Fibers

1. Rubber – SBR
2. Leathers
3. Dyes and intermediates

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Rubber

Rubber is an elastomer (elastic polymer) which returns to original dimensions when stretched considerably from its original shape.

Under the broad classification, the rubbers are grouped as

1. Natural rubber
2. Synthetic rubber

Rubber

Natural Rubber, is an elastomer(an elastic hydrogen polymer) that was originally derived from latex, a milky colloid produced by some plants.

Synthetic Rubber, is a type of artificial elastomer, invariably a polymer. Synthetic rubber serves as a substitute for natural rubber in many cases, especially when improved material properties are required.

Constituents of rubber

1. Natural rubber – *cis*-1, 4-polyisoperene
2. Synthetic rubber – styrene, butadiene, polychloroprene (neoprene) and the isoperene

Rubber

Classification of rubber based on ASTM
(American Standard for Testing Materials)

Class	Type
Class I	Elastomers (a) Vulcanaizable (1) Diene rubber (2) Nondiene rubber (a) Non vulcanizable
Class II	Hard Plastics
Class III	Reinforcing resins
Class IV	Paint vehicles

Rubber- Abbreviations

ABR	Acrylate - butadiene
BR	Butadiene
CR	Chloroprene (Neoprene)
IR	Isoperene, Synthetic
NR	Natural rubber
NBR	Nitrile-butadiene
NCR	Nitrile-chloroprene
NIR	Nitrile-isoperene
PBR	Vinyl pyridine butadiene
SBR	Styrene-butadiene

Rubbers

Neoprene

Is a a family of synthetic rubbers that are produced by polymerization of chloroprene.

Neoprene exhibits a good chemical stability and maintains flexibility over a wide temperature.

Used in laptop sleeves, orthophedic braces and automative fan belts

Rubbers

Styrene Butadiene Rubber (SBR)

A Synthetic rubber derived from two monomer namely, Styrene and Butadiene.

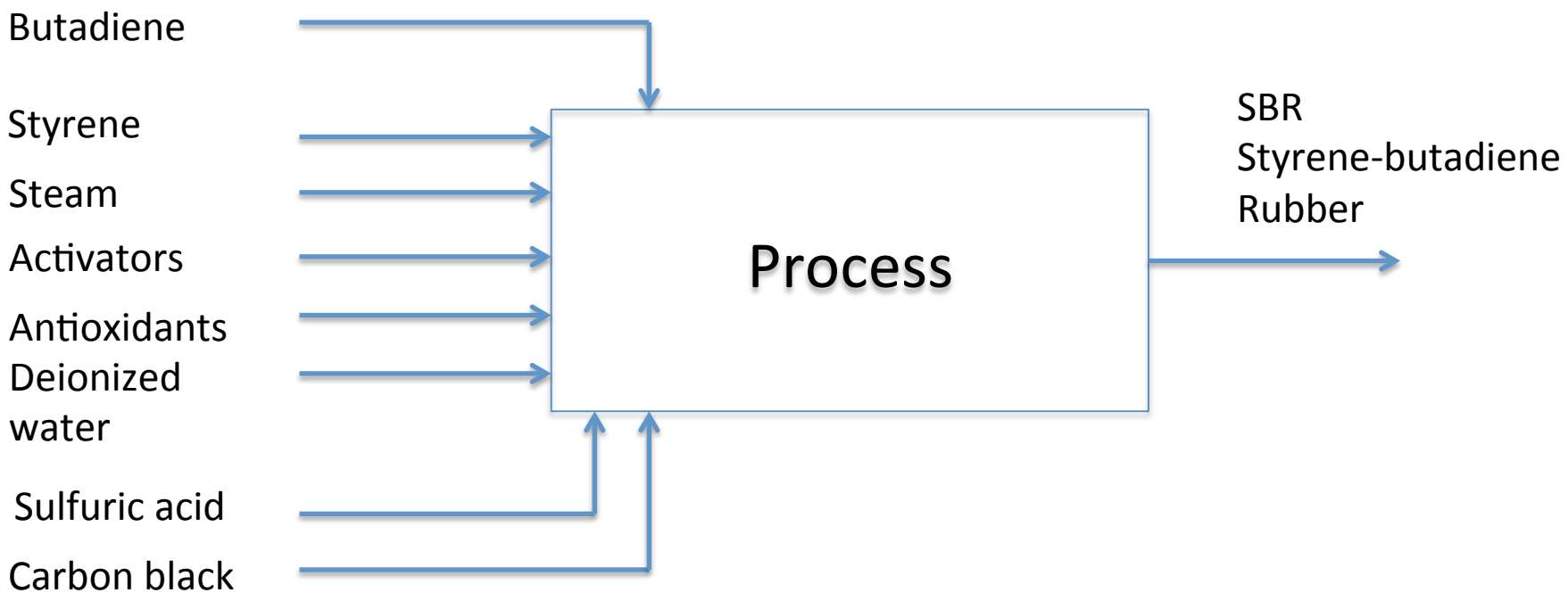
The mixture of these two monomers are polymerized in two ways:

1. Emulsion polymerization
2. Suspension Polymerization

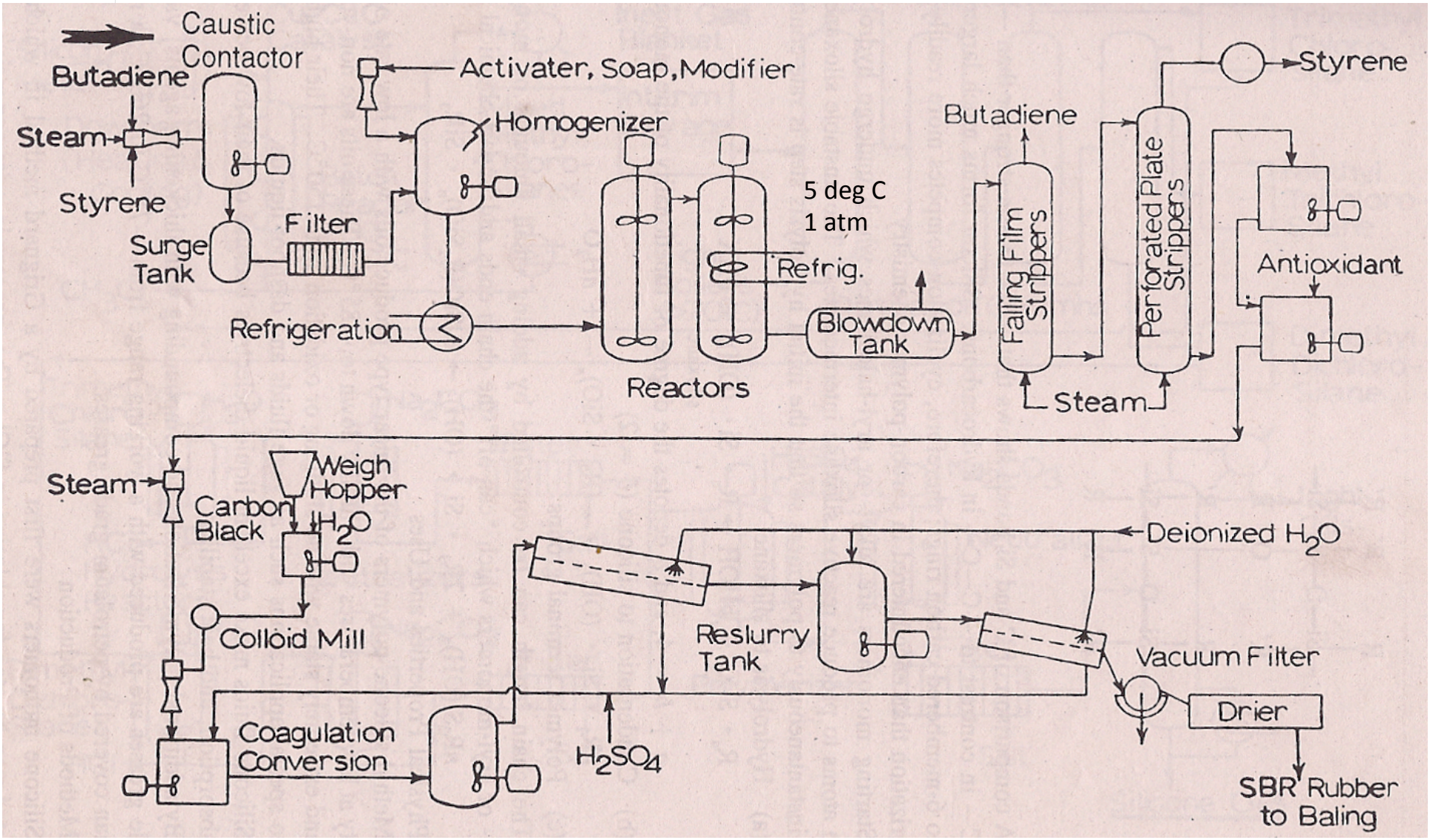
Used for the manufacture of car tires, shoe heels and soles, sealing agents in buildings etc..

Styrene-butadiene (SBR) production

Method of production - Emulsion polymerization



SBR


Caustic
Contactor
Butadiene
Steam
Styrene
Surge
Tank
Filter
Activater, Soap, Modifier
Homogenizer
Refrigeration
5 deg C
1 atm
Refrig.
Reactors
Blowdown
Tank
Butadiene
Falling Film
Strippers
Perforated Plate
Strippers
Styrene
Antioxidant
Steam
Steam
Weigh
Hopper
Carbon
Black
H_2O
Colloid Mill
Deionized H_2O
Reslurry
Tank
Vacuum Filter
Drier
Coagulation
Conversion
H_2SO_4
SBR Rubber
to Baling

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Leather

Leather is a durable and flexible material created via the tanning of putrescible animal rawhide and skin, primarily cattle hide.

It can be produced through different manufacturing processes, ranging from cottage industry to heavy industry.

Tanning leather involves a process which permanently alters the protein structure of skin so that it cannot ever return to rawhide.

Types of tanning process used in commercial production of leather are

1. Vegetable tanning
2. Chrome tanning

Leather

Vegetable tanning

Vegetable tanning is chiefly used for heavy leathers, for soles and belts

Skin + tannin ⟶ **leather** + sugar

Tannins are the complex mixtiure of glucosides of various polyphenols derived from vegetables

Vegetable tanning is carried out in vats of 8 x 7 ft vats, 5 0r 6 ft deep, which contains tan liquors and hides.
In particular, it is very helpful in filling up the pores of hides resulting in stiffened leather.

Leather

Chrome Tanning

Chrome tanning is usually carried out in two process

1. One is one bath process – uses basic chrome sulphate
2. Two bath process – uses sodium dichromate

Leather

Major Steps

Feed Preparation

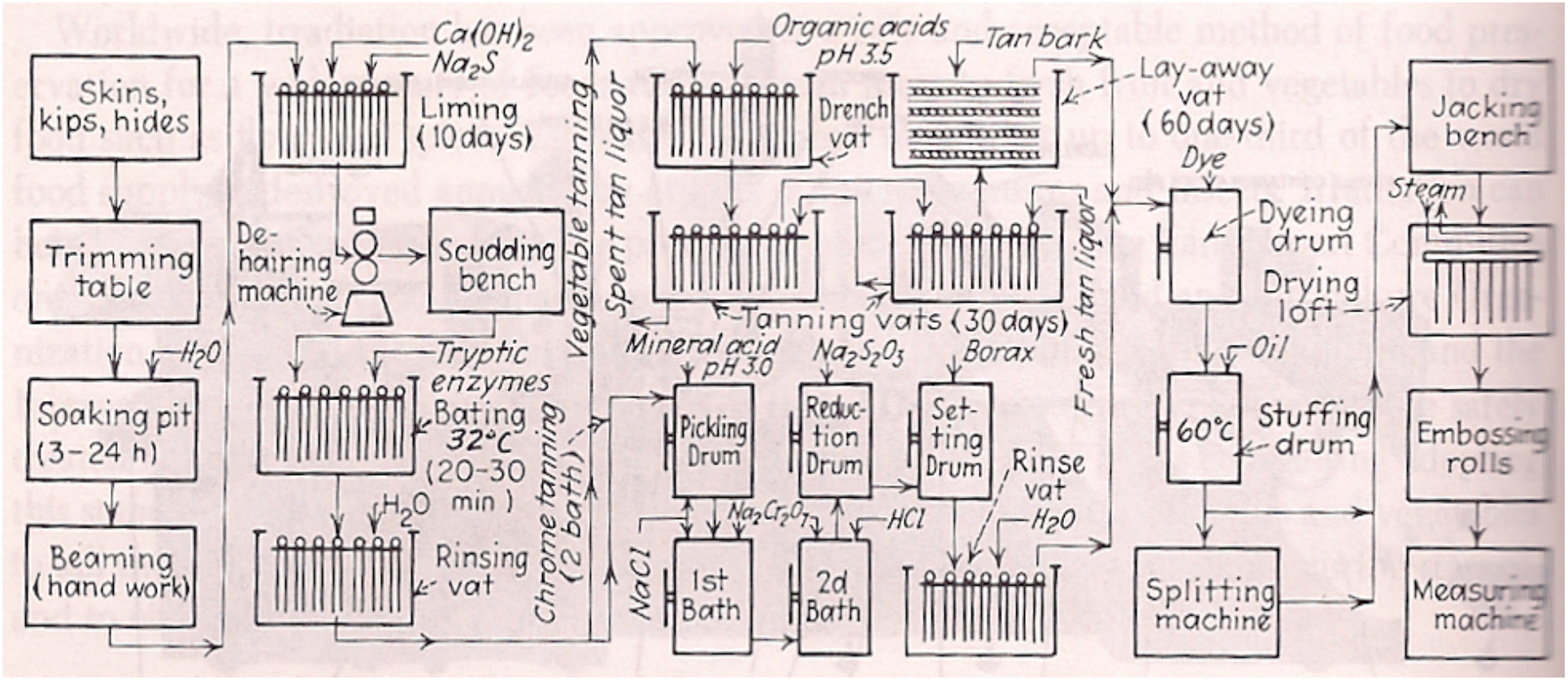
Grading, Trimming and hair removal of skin, kips and hides

Tanning

A process which permanently alters the protein structure of skin so that it cannot ever return to rawhide

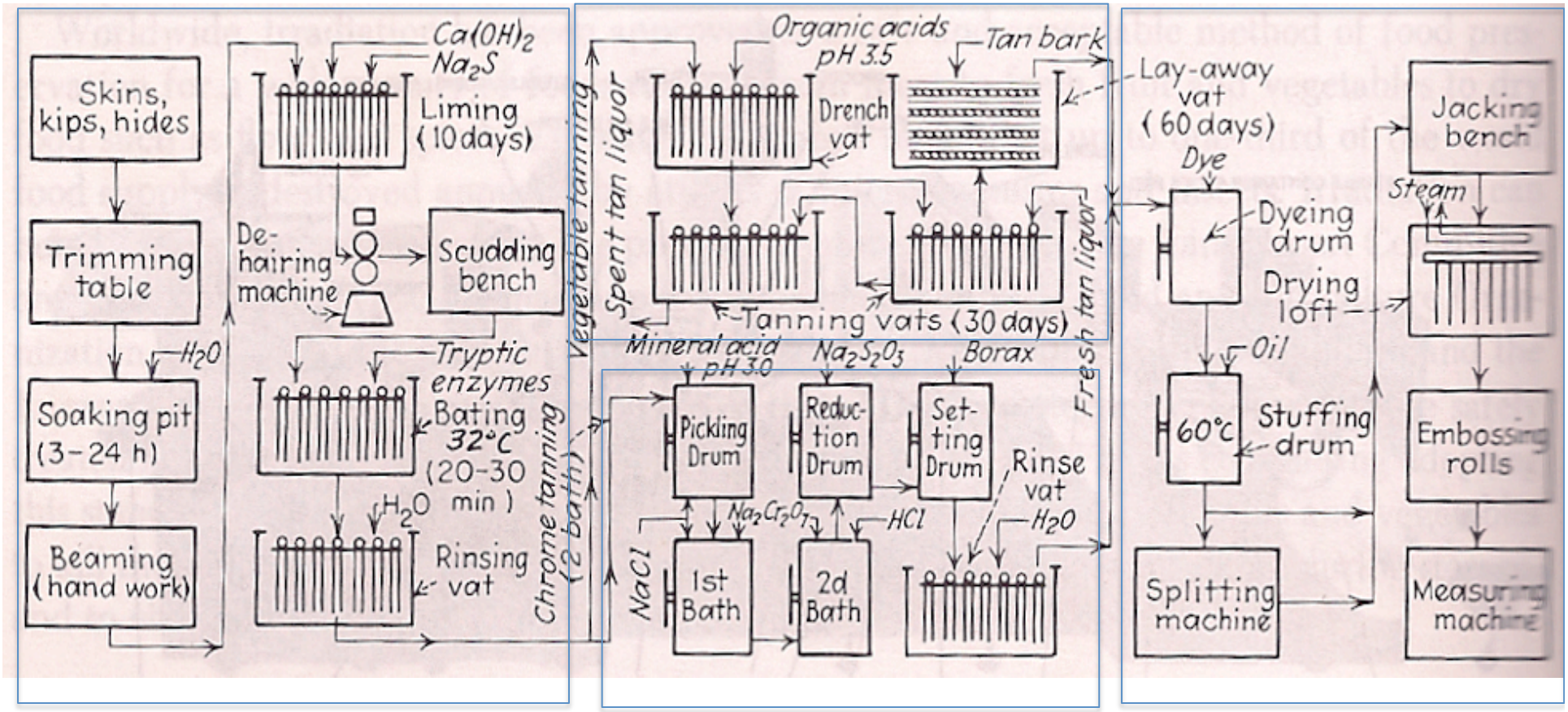
Finishing

Leather-Chromium or Vegetable tanning



Leather-Chromium or Vegetable tanning

Vegetable Tanning



Feed Preparation

Chrome Tanning

Finishing

Dyes and Intermediates

Generally dyes have complicated structure which are made by reaction involving building blocks known as *intermediates*.

Most of these (intermediates) are aromatic compounds with substituent groups such as $–NH_2$, -OH, $-NO_2$ and SO_3H which alter the reactivity of the acyclic compound and then sometimes the color of the dye.

Intermediate are not used just for the manufacture of dyes, but for all types of organic work where complex structure are build up.

Dyes and Intermediates

Both inorganic and organic materials are needed to make dyes and intermediates, but the backbone of the raw material sequence is

Petroleum → aromatic hydrocarbon → aromatic hydrocarbon → intermediates → dyes

Dyes and Intermediates

Aniline and Nitrobenzene

Aniline (Amino benzene-$C_6H_5NH_2$)

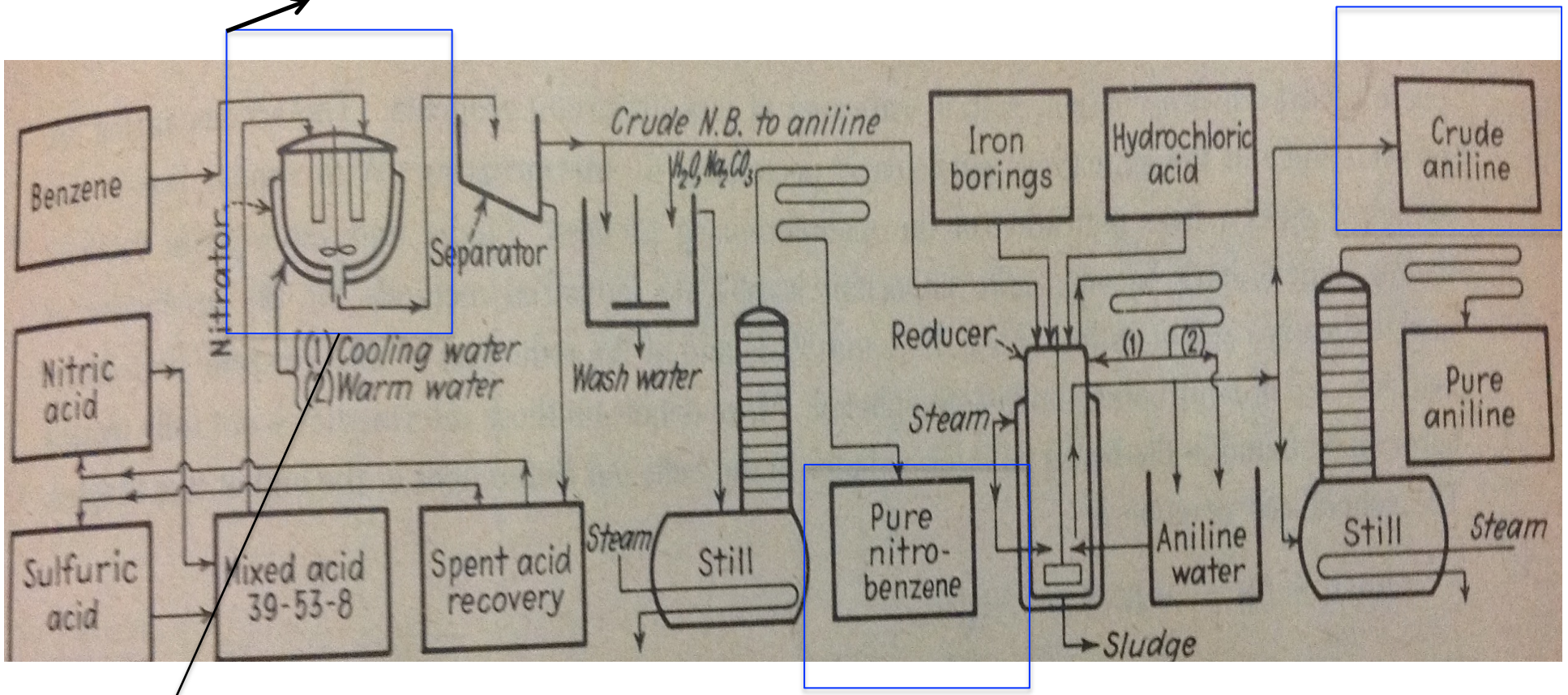
Aniline is colorless, it possesses an unpleasant odor like a rotten fish

Nitrobenzene ($C_6H_5NO_2$) – Water Soluble pale yellow oil

Dyes and Intermediates

Jacketed CSTR
Temperature – 50°C
Rate of reaction (15 – 20 min)

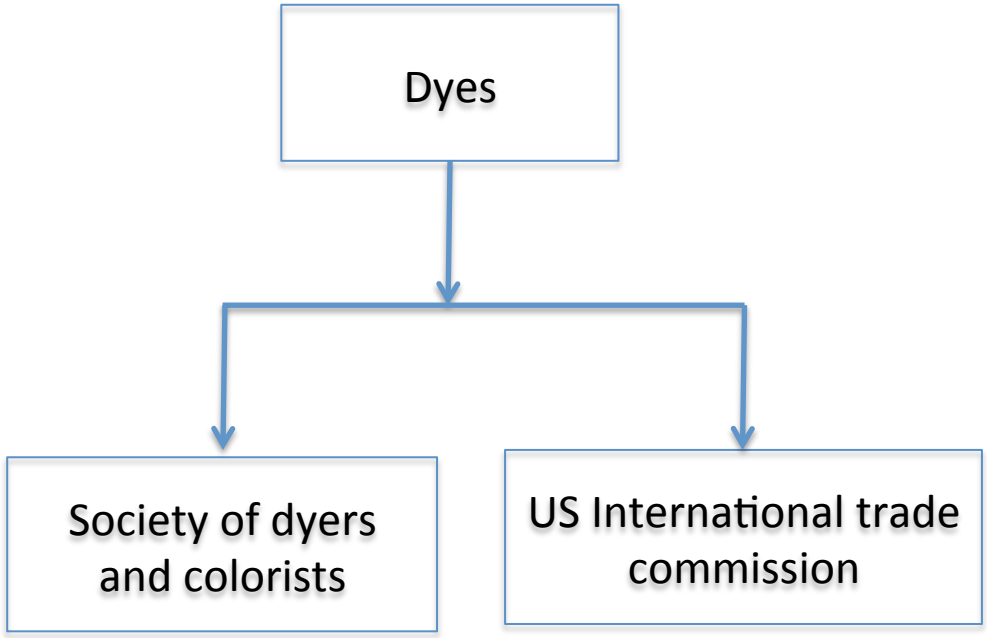
Aniline (Amino benzene-$C_6H_5NH_2$)
Aniline is colorless, it possesses an unpleasant odor like a rotten fish



$C_6H_6 + HNO_3 \longrightarrow C_6H_5NO_2 + H_2O(H_2SO_4)$ ΔH = -113 kJ

Nitrobenzene ($C_6H_5NO_2$) –
Water Soluble pale yellow oil

Dyes and Intermediates



Society of dyers and colorists - CI

1. Nitoso
2. Nitro
3. mono-, dis-, tris-
4. Azoic
5. Stilbene
6. Carotenoid
7. Diphenyl methane
8. Triaryl methane
9. Xanthene
10. Acridine
11. Quinoline
12. Natural organic coloring matter
13. Synthetic organic coloring matter

US International trade commission

1. Acid dyes
2. Azoic dyes
3. Basic dyes
4. Direct dyes
5. Disperse dyes
6. Fiber-reactive dyes
7. Fluorescent dyes
8. Food, drug and cosmetic colors
9. Mordant dyes
10. Solvent dyes
11. Sulfur dyes
12. Vat dyes

US International trade commission

1. Acid dyes

These acids derive their name from their insolubilities in acid baths. They are used for dyeing protein fibers such as wool, silk and nylon; also leather and paper. Usually they are azo, triarylmethane or anthraquinone complexes.

2. Azoic dyes

These are "ice colors" made right on the fiber by coupling diazotized materials while in contact with the fibers. Low temperature keeps the diazonium compound from decomposing until ready to couple. These are brilliant and long-lasting and are used primarily printing cotton

US International trade commission

3. Basic dyes

Basic dyes are mostly amino and substituted amino compounds soluble in acid and made insoluble by the solution being made basic. Most are triarylmethane or xanthanes. These can be used to dye wool or cotton with a mordant but are usually used for duplicator ink, carbon paper and typewriter ribbons. In solvents other than water they form writing and printing inks

4. Direct Dyes

Direct dyes are used to dye cotton directly, i.e. without addition of a modrant (a substance used to set dyes on fabrics, also improves the fastness of the dye to stick on fabrics) . These are generally a group of azo dyes and their solubility in the dye bath is reduced by aading salt. $\beta - Naphthol$ is the most common developing agent

US International trade commission

Dyes	Groups	Uses
1. Acid dyes	are azo, triarylmethane or anthraquinone complexes.	Dyeing fibers such as wool, silk and nylon; also leather and paper
2. Azoic dyes	Diazonium compound	Printing on cotton
3. Basic dyes	Amnio, tryarylmethanes or xanthanes	Dye wool or cotton. Used for duplicator inks, carbon paper and typewriting ribbon
4. Direct dyes	*β*-Napthol, diazonium	Dye cotton without mordant, mixed cotton, wool and silk

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