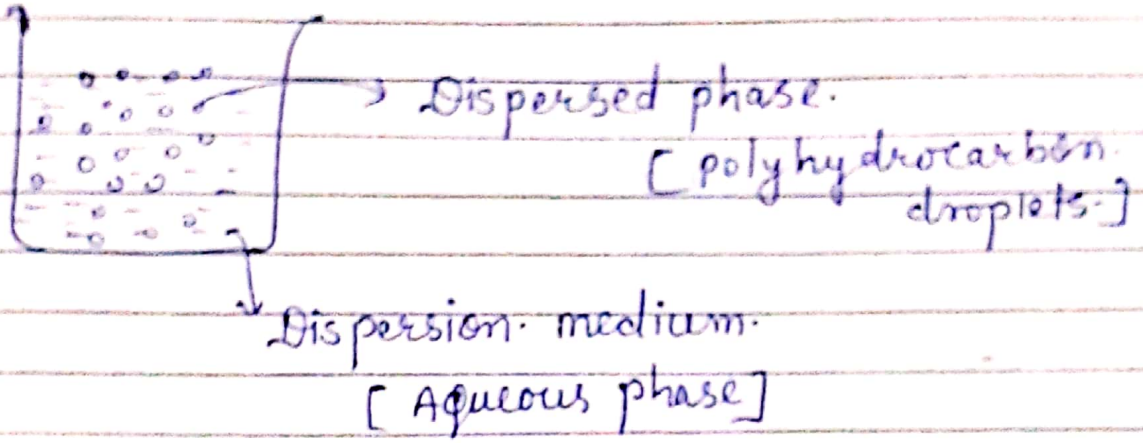
UNIT - I

Latex :- Latex is emulsion of polyhydro-
- Carbon droplets in aqueous solution/medium.
- Latex define as a stable colloidal dis-
- persion of a polymeric particle in an esse-
- ntially aqueous medium.



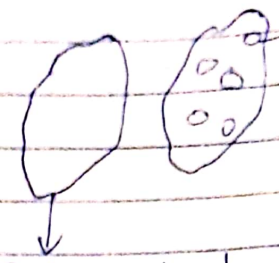
- Like colloidal solution.
- It is colloidal dispersion of negetively charge particle

Natural latex is obtained from - Rubber plant [Havea Brasiliensis]

Havea Brasiliensis → is para rubber tree.
Family - Euphorbiaceae.

Latex, collected from Tree, process is known as Tapping and its sap like extract known as latex, it is primary sorce of Natural latex., Natural Rubber.

Seeds of plant →
like Carnucle and usually are globalt in shape



Rubber plant seeds

Rubber Tree seeds Complyte germination in 10-15 days,

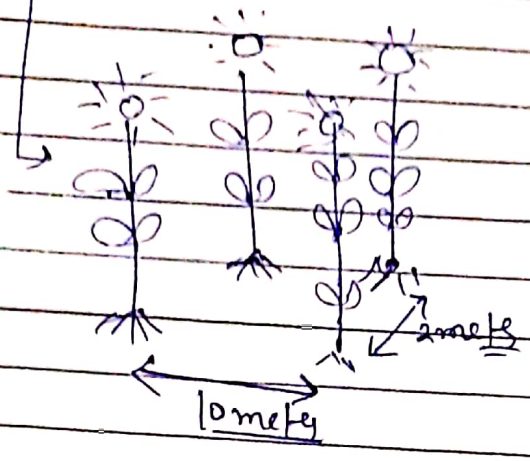
plantation

from Seeds	from Budding
→ has Seedling Rubber,	Budding Rubber
· 60% latex	has .. 85% To 90% latex
40% Water.	10% — 15% Water
	Better & fast Rusult

Rubber tree →
Havea, Guayule, ficus elastaton, Castilloa Elastica, parthenium argentatum, Landolphia.

Havea - is most popular Rubber tree

Hevea tree



Distance when planting
(2 x 10 mets)

Because → more leaves grow
& long leaves

Tapping processing time ---- 5 AM TO 9 AM
OS right.

* Fresh latex pH, approximately is 7, The latex Coagulates when pH is lowered to around 4.8-5, fresh latex is Coagulates Spontaneously within few hours of leaving the tree, Because Reduction of pH due to degration of Carbohydrates present in latex by Bacteria and hydrolysis of the lipid Substance To fatty acid and its Interaction with metal ions are the chief reason for this Coagulation,

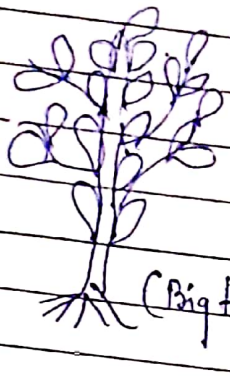
Composition of fresh latex as follows

	%
(TSC) Total Solid Content	36 %
(DRC) Dry Rubber Content	33 %
Proteins	1–1.5 %
Resins	1–2.5 %
Ash	1 %
Sugars	1 %
Water	~~Add to 100%~~ (Generally 30–35 %)

Advantage of Latex :→

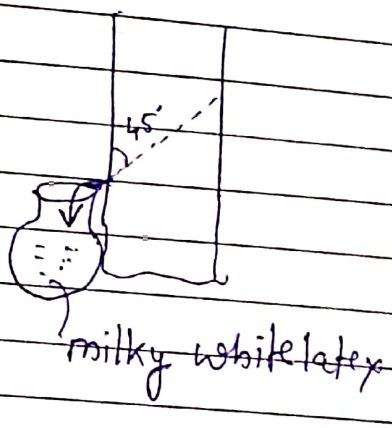
- Low Viscosity so Easy to Shape
- light equipment of Simple Construction for processing
- Low energy Requirements,
- No - Heat generation during processing [ultra - accelerator - Low temp. curing
- Unbroken rubber -- Better physical & Ageing properties

Flow chart of Field Latex to RSS sheet...



Havea Brasiliensis

(Big tree)



Collect latex
[process known as
Tapping]

Preservation of field latex
Anonia, Na Sulphate,
formalins etc.....

Sieving (60 mesh)

Cog Coagulated.
By H Cook

↓

Storage

↓

Compression [under 2 Roll mill]

↓ plain mill
groove mills

Wafes Remove

↓

Sheet of latex

↓

Load on trolley

↓ 60°C

Smoke house for (week)

↓

Bradding

↓

Weight

↓

Pack

35 kg Bale....

↓

Dispatch to Rubber industries.

preservation :-

The latex is to be preserved immediately After collection, against rise in acidity By Bacterial putrification.

Among the preservatives used, Ammonia is most commonly used owing to certain Advantages like... removal by blowing Air or Reaction with HCHO

Recently Sodium pentachlorophenate is being used along with small amount of Amonia...

Commen preservatives

→ NH_3 , pottash, formalin, Sodium Sulphit, Boric asid,

Stability of NR Latex :-

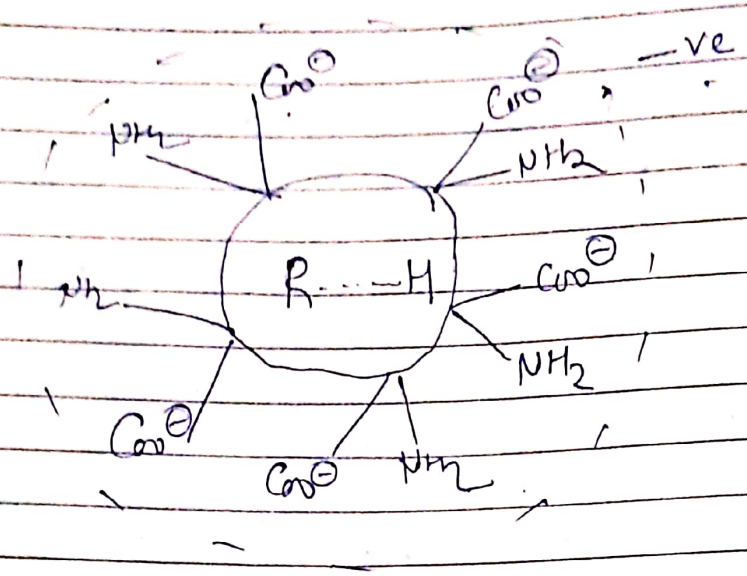
Latex Consist of fine particles of Size 20-20000 nm, and Covered by electrical charged. -Repulsion Betweens the particle and layer of adsorbed Water giving a mechanical Barier,

Reason for unstability :→

Mechanical agitation Impigment of two particle - Coalesconce (आपस में मिलना)

Reduction in electrical charge due to pH.

formation of Insoluble Soap By Reaction with metal ions.



Stability of NR latex

- Reduction of free surface energy Between the polymer particle interface
- By imparting charge of on the particle of same polarity.
- By putting some Heavy SEETHING layer (उबलना हुआ) of tightly Bound water molecules.

⇒ Concentration of latex

In this process Eliminates most of the Non Rubber Constituents, This is done By 4 following methods,

(a) Creaming
(b) Centrifugation
(c) electrodecantation
(d) evaporation.

(a) Centrifugation :→ The Rotating Bowl of the Centrifuge is generally fitted inside

With a number of metallic dise. As the Bowl Rotate at high speed 6000 rpm, the mass of latex is broken up into thin conical Shells the latex is fed to the machine from a constant head to ensure uniform flow The Cream Centrifuge towards the axis of Rotation.

In which → Centrifugal force are used.
Centrifugal Latices are Commercially available as high Amonia (HA; minimum 0.6% Amonia) and low and low Amonia Type 0.3%.

(b) Evaporation :→
Evaporation latex Concentrate is made by heating suitably preserved latex without Skin formation on the surface. The stabilizers used are generally KOH soap and/or glue.
A suitable evaporator consist of a jaketed drum rotating along the axis, steam is admitted in the jacket and Hot air inside over the latex surface., a hollow cylinder Rotating along the drum surface avoid Skin formation.
Evaporated latex has high stability & used for adhesive and latex/cement Compo-sites,

(c) Creaming
latex particle are ligher then serum in which they are suspended
Have tendency to go up on the surface

Creaming agent Amonium alginate, tamarind seed gum, Irish moss and locust bean gum, make the particles to form loose aggregates.

Bulk field latex → Ammoniated to 1%

↓

Creaming Agent 3% with little soap → Stirred for an hour

↓

Left to stand for 40 hrs → Serum is run off

↓

Cream stirred and Amoniated further

↓

Batches are Blended for uniformity.

(D) Electrodecantation :-

Depends of (-ve) charge on surface of Rubber particle, electric current is passed, Rubber particle move towards the Anode..

Difference between Natural latex and Synthetic latex.

Natural latex	Synthetic latex
→ is more durable	→ is durable
→ is ecofriendly	→ is cheaper
→ is hypoallergenic	→ is hypo allergenic
→ is dust milte resistant	→ is dustmite resistant
→ stay fresh and cool at night	→ stay fresh & cool at night → Suport Back & joint

Latex grades

	Type	Sourse
①	Ribbed smoke sheet	Coaglated field latex, [finalization in smoke House]
②	pale crepe	Coagulum of Natural latex liquid.
③	Estate Brown. Crepe.	Estate cuplum tree lace
④	Thin Brown Crepe	Cuplumb, wet slab, freelace unsmoked sheet,
⑤	Thick Blanket Crepe	—"—
⑥	plate Blok crepe	—"—
⑦	pure smoked blanket Crepe	Remilled RSS & RSS Cutting.

Natural Rubber :-

Rubber tapping the milky white liquid latex is collected from rubber trees in a cup by By making a slight V-cut on the tree barks The collected latex is washed, filtered and reacted with acid to Congeal (Coagulate) the rubber particle

It is created by Enzymatic process by many plants.

Belonging family → Euphorbiaceae

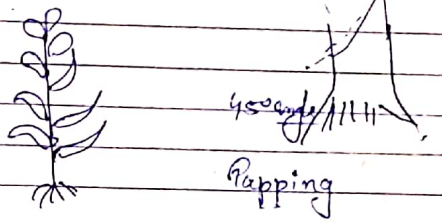
Climatic Condition →

Avg temp. 25°c–28°c

@ 80% Humidity

Outline Manufacturing Diagram of N.R.

Rubber tree → Rubber Latex → Latex Collected in Cups



Coagulated Cup lumbs formed into slabs

Through Vehicle [Rubber slabs are sent to factories.

Shreading (machines)

Washing

Creping

Hanging

Shreading (dried sheet)

Drying

Lab test

Palletised Rubber Block

Rubber packed for Distribution

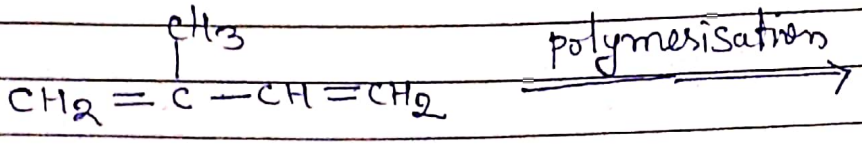
Store in Warehouse.

Rubber used by Factories Around World wide.

Area @ World wise → [South eastern Asia]

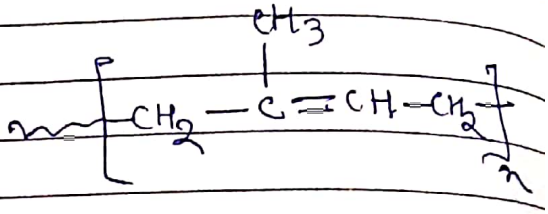
Contry → malesia, Indonesia, china, Srilanka, Vietnam, india etc...

NR - [chemical structure.]



[Isoprene]

2, Methyl 1, 3 Butadiene



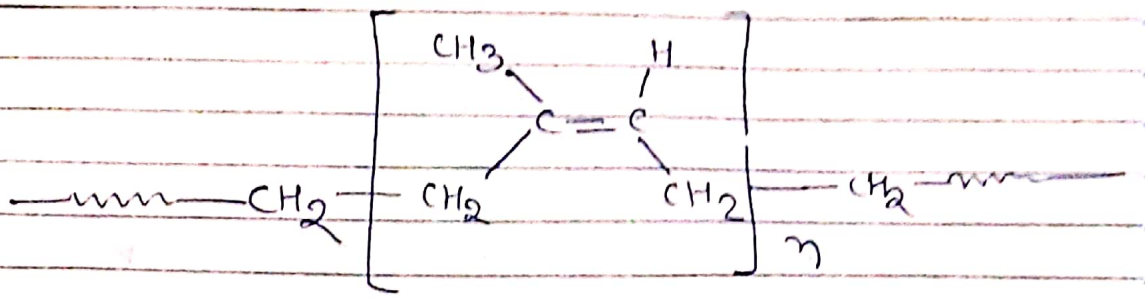
poly isoprene

Importance :-

(I) unsaturation
(II) Non polar
(III) Methyle Bulky group
(IV) 99 % < Content [poly cis-1,4 isoprene] & Som may be Bonded also non isoprene structural unit proteins, Amino Acids, phaspholipids in Macromolecules Backbone.
(V) final packing - sheet form
- Block form

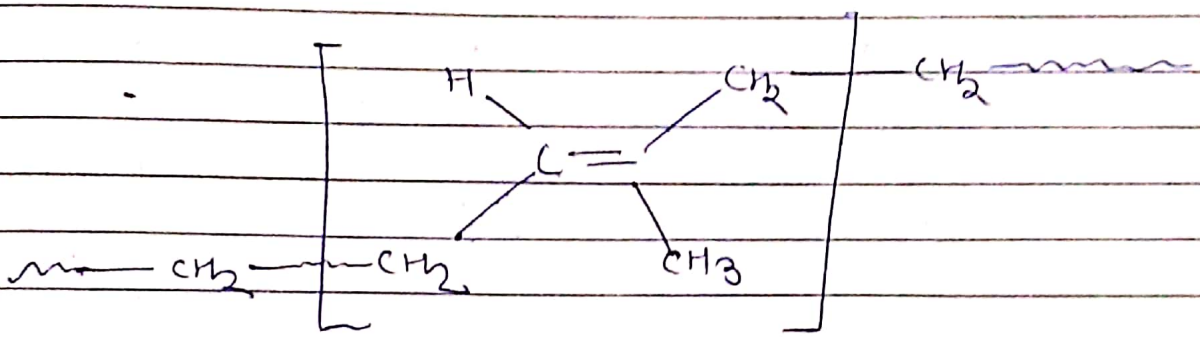
In polyisoprene → Trans 1,4 polyisoprene is. Dominant isomer in Gutta-percha or Balata,

* Poly - cis - 1,4 isoprene



(Poly - cis - 1,4 isoprene.)

* Trans - 1,4 isoprene.



(poly Trans 1,4 isoprene.)

⇒ Physical properties of NR

Density = 0.92 gm/cc
Refractive index 1.52 @ 20°C
Molecular Weight 2 lac - 5 lac
[200000 - 500000]
Dielectric Constant : 2.37
Volume Resistivity = 10^{15} ohms/cc
Tg = - 75 °C

⇒ Advantages :-

poor resistance to cut,
Better, Good Tensile strength.

Technically Specified Rubber (TSR)

TSR was started by malesia in 1965 with the Introduction of SMR (standard malaysian Rubber)

TSR Grade →

SMR L	SMR GP	
SMR WF	SMR 10	TSNR-10
SMR CV	SMR 20	TSNR-20
SMR LV	SMR 50	TSNR-50
SMR 5		

SMR L, SMR 5 → Dirt Content 0.03%

GP → Bottom → ~~Dirt Content~~ ~~increase~~

Properties	SMR L, WF, CV, LV,	SMR 5	SMR 10,	SMR 20,	SMR 50,
Dirt content @ 40 mesh.	0.03 %	0.05 %	0.10 %	0.20 %	0.50 %
Ash Content	0.50 %	0.60	0.75	1.00	1.50 %
Nitrogen Content (%)	0.60 %	0.60 %	0.60 %	0.60 %	0.60 %
Volatile matter	0.80 %	0.80 %	0.80 %	0.80 %	0.80 %

OTHER TYPES OF NATURAL RUBBER

* Hevea plus MG Rubber →
These are chemically modified grade of Natural Rubber, prepared by graft polymerization of methyl methacrylate in NR Rubber Concentrate.
This is available in latex or dry rubber form.
Two Grade are prepared Viz, MG30 and MG49 contains 30% and 49% of PMMA respectively.
→ Dry MG Rubber used in Adhesive
→ Latex MG is blended with normal latex to Achieve films with improved modulus & tear.

* ENR [Epoxidized Natural Rubber]
it is produced by reaction of latex with perfor-mic acid formed in situ.
ENR gives rise to improved air impermeability and resistance to oil
ENR also has good adhesive properties useful for Rubber to metal bonding.

* Thermoplastic Natural Rubber [TPNR.]
it is prepared by Blending of NR and polypropylene / polyethylene & different proportions to give Rubber with different stiffness properties.

potential application includes footwear, Sport goods, Seals hoses, bumpers, spoilers and Car body protection strips.

Natural Rubber are different from Synthetic

Due to .... is obtain from Natural Source ...(tree)
have high gum ; green tack and highest T.S.

Created by Enzymatic process in plant...

SBR

STYRENE BUTADIENE RUBBER.

SBR is World's oldest Synthetic Rubber, it is developed in 1930's,

it is copolymer of styrene and butadiene normally contain 23% bound styrene

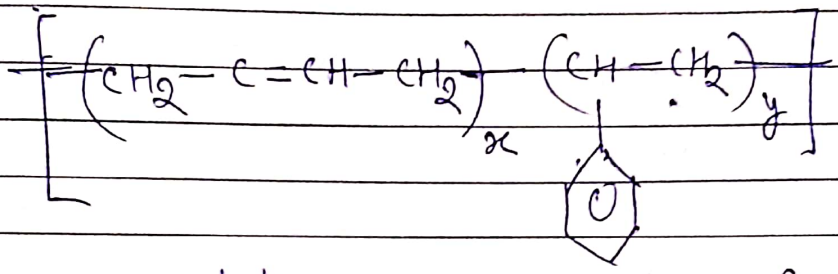
it is prepared by emulsion & solution polymerisation

it is not hardned with storage

It is a slow curring Rubber

good Abrasion resistance (due to hard)

Structure :-



Butadiene. Styrene (23%)

Butadiene production

(1) from n-Butanes.

The n-Butanes are obtained from C_3-C_4 Streams from the cracking of petroleum crude propane & Isobutane are separated by fractionation and isobutene is removed by absorption in 65% Sulphuric acid

1 Butene

$$CH_2=CH-CH-CH_3 \longrightarrow CH_2=CH-CH-CH_2 + H_2$$

$$CH_2=CH=CH-CH_3 \longrightarrow CH_2=CH-CH=CH_2 + H_2$$

2 Butene

Typically a mixed stream containing 1 Butane & 2 Butene is preheated to 650°C & mixed with Superheated steam, and finaly made Butadiene

2.- production of Butadiene from Ethyle Alcohol

$C_2H_5OH \longrightarrow CH_3-CHO + H_2$

$2\,CH_3-\underset{H}{\overset{O}{C}} \longrightarrow CH_3-CH-OH-CH_2-CHO$

(Acetaldo)

$CH_3-CH-CH-CHO$

(Crotonaldehyde)

$CH_3-CH=CH-CHO + CH_2-OH \longrightarrow$

$CH_3-CH=CH-CH_2-OH + CH_3CHO$

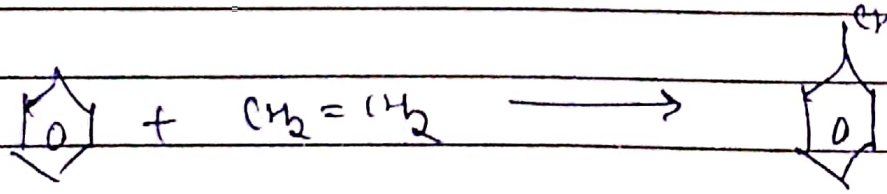
Crotylalcohol

$CH_3-CH=CH-CH-OH \longrightarrow CH_2=CH-CH=CH_2$

[Butadiene]

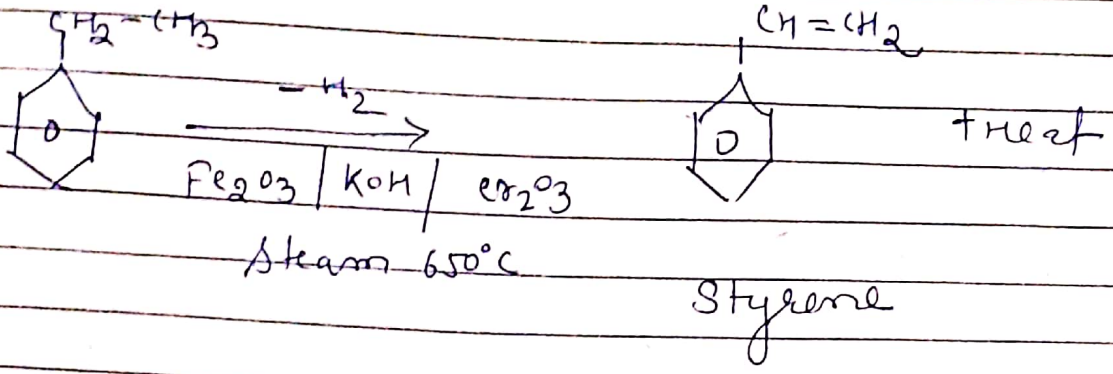
Styrene :→

Styrene is produced from ethyl benzene, which is produced by alkylating Benzene with ethylene



↓

Dehydrogenation of ethyle benzene

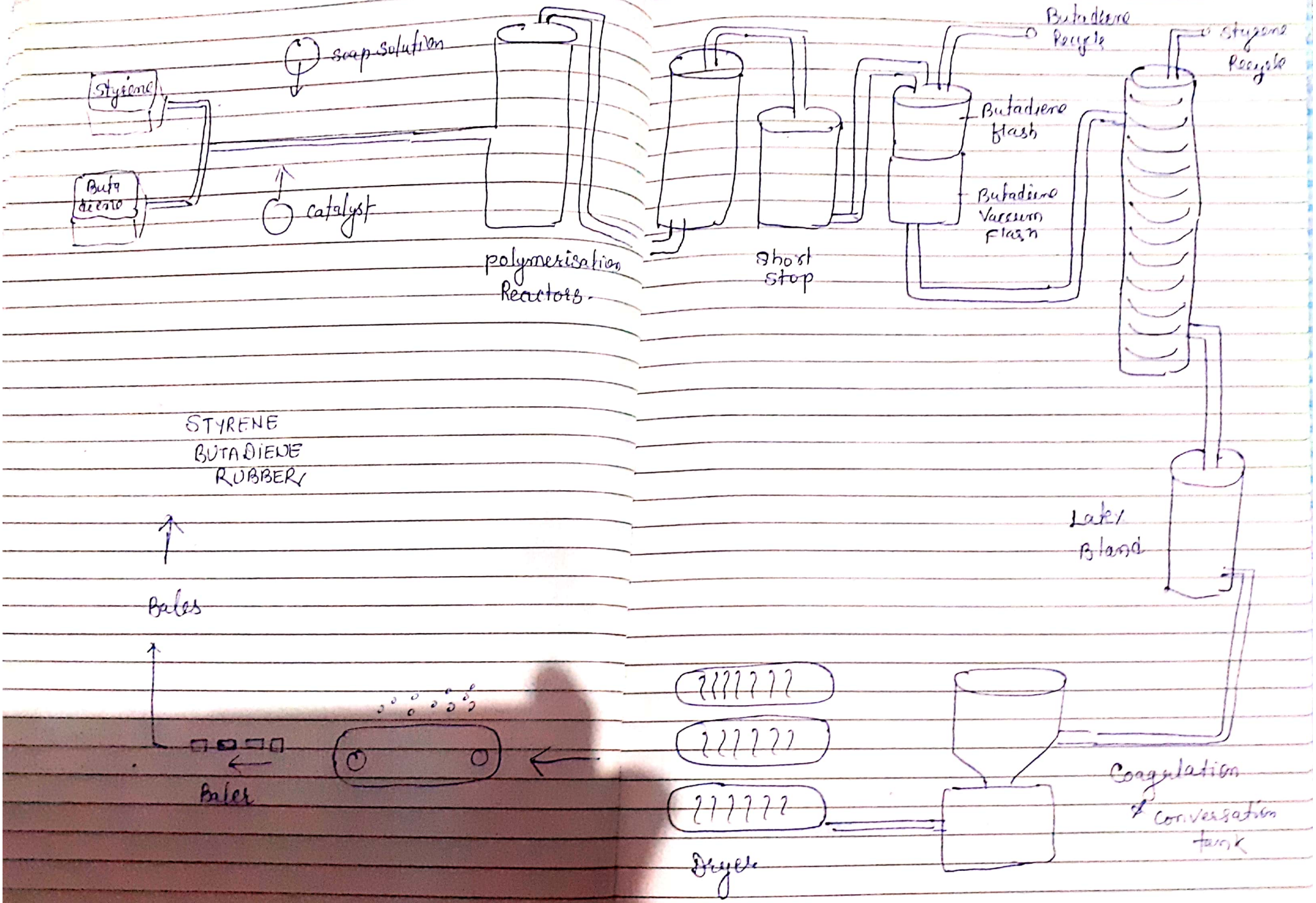


Emulsion polymerisation of SBR.

Emulsion polymerisation is done at two - Pempreture 50°C and 5°C The polymer obtained at 50°C is called a hot polymer and the other one is called THe cold polymer.

General purpose SBR is manufactured by reaction of Aqueous emulsion of butadiene and Styrene in the presence of soap solution, polymerisation initiator and regulators to form a high molecular weight Copolymer with elastic properties This can be prepared with Pechnique also, But the properties of a solution SBR slightly Varies from that of an emulsion SBR.

outline manufacturing process --- (P.T.O)



properties of SBR

(i) Tg of SBR is = ~53°c
(ii) Density = 0.94
(iii) Mooney viscosity = 35-55

ADvantage of SBR

(i) Better resistance to reversion
(ii) higher resistance to abrasion at high speed.
(iii) Better resistance to ageing specially at high temprature
(iv) Better resistance to flex fatigue
(v) Excellent impact strength

Disadvantage of SBR

(i) Necessity to use reinforcing fitter.
(ii) poor resistance to ozone, sun light.
(iii) very little resistance to oils, gassoline, hydrocarbon solvents.

GRADE of SBR Rubber

All Hot & Cold polymerised SBR. with or without oil and or C-Black are classified by IISRP (International Institute of Synthetic Rubber producers.) under the following Series,

1000 - Hot polymerised non pigmented Rubbers

1500 - Cold polymerised non pigmanted rubber.

1600 - Cold polymerised Carbon Black - oil Rubber master Batches. 14 phr or less of oil.

1700 - Cold polymerised oil Rubber master Batches

1800 - Cold polymerised C-Black - oil rubber master Batches containing more than 14 phr of oil

1900 - miscellaneous dry polymer master Batches.

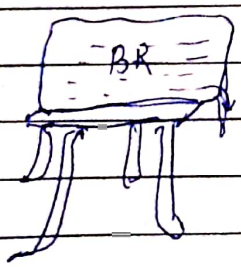
Not → Solution SBR provide low - Rolling resistance →

3. PBR [POLY BUTADIENE-RUBBER]

→ polybutadiene is a homopolymer of Butadiene (C_4H_6)
→ It is prepared either by Solution or Emulsion polymerisation.

→ $T_g = -100°C$
→ Density = 0.91 To 0.92
→ it is crystalize Because of the Stereoregularity in microstructure

→ Good Wet Traction
→ poor Behaviour on mills
→ mostly used with NR & SBR (Blend)
→ This Blended, shows higher extrusion rate
→ poor tack,
→ poor Road grip of tyre tread (A feature Related to the high Resilience)
→ poor tear & tensile strength Compare with NR & SBR
→ BR has tendency to cold flow



flow during storage.

Advantages

- Low Temprature flexibility
- Heat Ageing resistance
- High resilience at low deformation.
- ozone resistance
- Ability to accept higher level of filler and oil with less deterioration of in properties.
- good Abrasion resistance

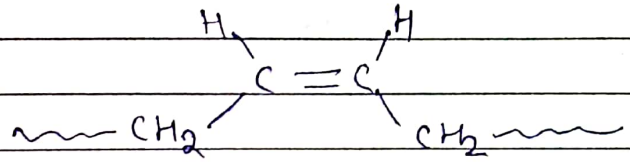
Chemical structure →

$$n\ CH_2=CH-CH=CH_2 \xrightarrow{\text{polymerised}} \sim\{CH-CH=CH-CH_2\}_n\sim$$

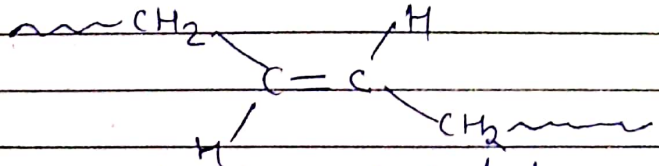
Butadiene.

Structure

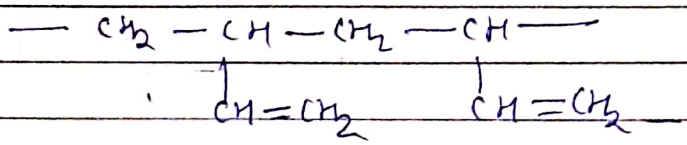
(I) 1,4 Cis - poly Butadiene



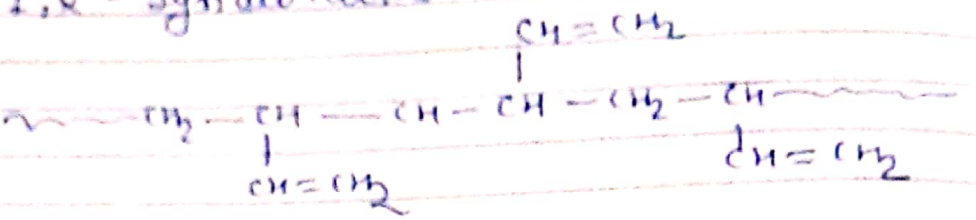
(II) 1, 4 Trans - poly Butadiene -



(III) 1, 2 - iso tactic poly Butadiene



(iv) 1,2 - Syndiotactic



⟹ Manufacturing process

The monomer Solvent purified & Dried the Catalyst is prepared seperatly and added to reaction Vessels Containing monomer & Pure Solvents, When the desired degree of polymerisation is reached the Catalyst inactivated., The unreacted Solvent is Removed & polymer is recovered & Washed dried & Balled --

GRADE →

Dry polymer --	1200-1249
oil extended ---	1250 - 1299
Black master Batch.. -	1300 - 1349
Oil Black. master Batch -	1350 - 1399
latex ---	1400 - 1449
miscellaneous ~	1449 - 1499

Disadvantages

- poor processibility if used alone
- Necessity to used Reinforcing fillers
- very little resistance to heat and ozone
- very little resistance to oil and gasoline hydrocarbon Solvents --

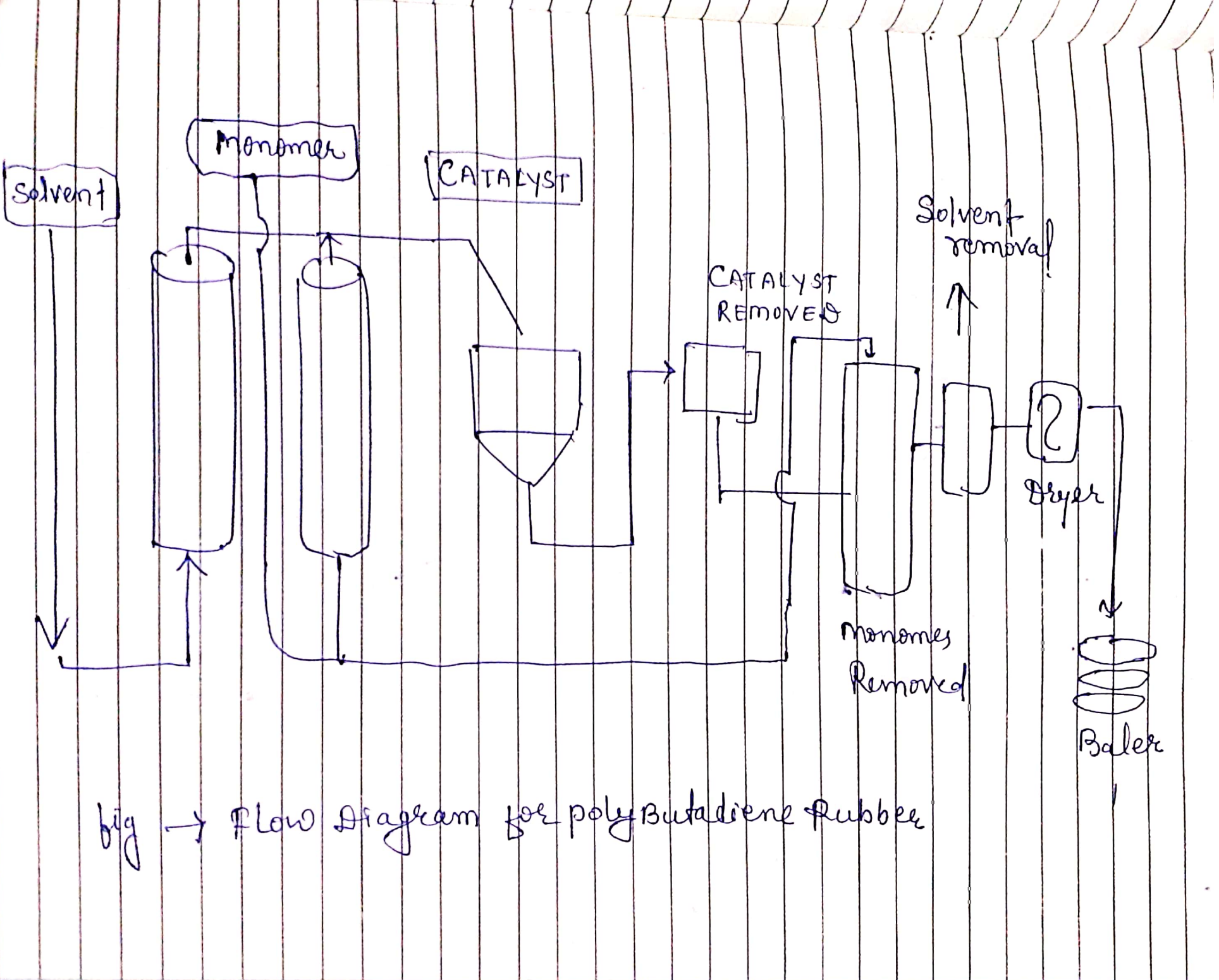
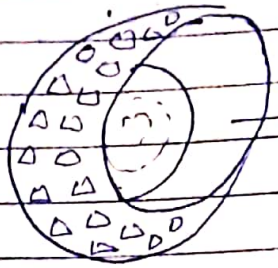


fig → Flow Diagram for polyButadiene Rubber

Application of polymer Blend



Major Tyre sectors

(I)

NR / BR Blend

- Truck Tyre Tread (RIB)
- Steel Cord Coating

Truck Tyre Side Wall

(II)

SBR / BR Blend

- Car Tyre tread
- light Tyre (Truck tyre Tread)

(III)

NR / SBR Blend

- Car tyre tread Compound
- LCV Tread Compound
- Bead Compound

Special purpose Rubber / other Rubbers.

ACM → Acrylic Rubber
EPDM → Ethylene propylene Rubber
IIR → Butyle rubber
NBR → Nitrile Rubber
CR → Chloroprene Rubber
CIIR → Chlorinated Butyle Rubber
BIIR → Brominated Butyle Rubber
AEM → Ethylene - Acrylate Rubber
HNBR → Hydrogenated Nitrile Rubber.
CSM → Chlorosulphonated polyolefins.
T → polysulphide Rubbers,

[MQ, VMQ, PMQ, PVMQ,] → Silicone Rubber

FKM, CFM → Fluro / Fluoro Rubber

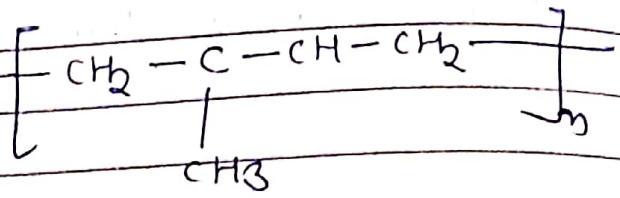
FVMQ → Fluorosilicone Rubber,

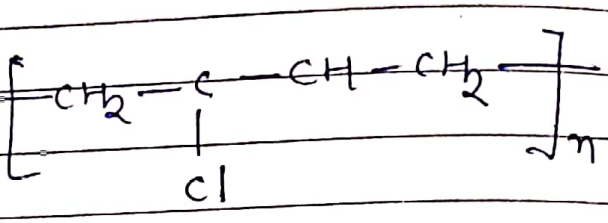
① CR

[Neoprene]

POLY CHLORO PRENE RUBBER,

polychloroprene Rubber is first synthetic Special purpose Rubber.

polyisoprene → 

polychloroprene Rubber → 

- polychloroprene rubber is manufactured by emulsion polymerisation technique.
- it is also known as chloroprene.

properties →

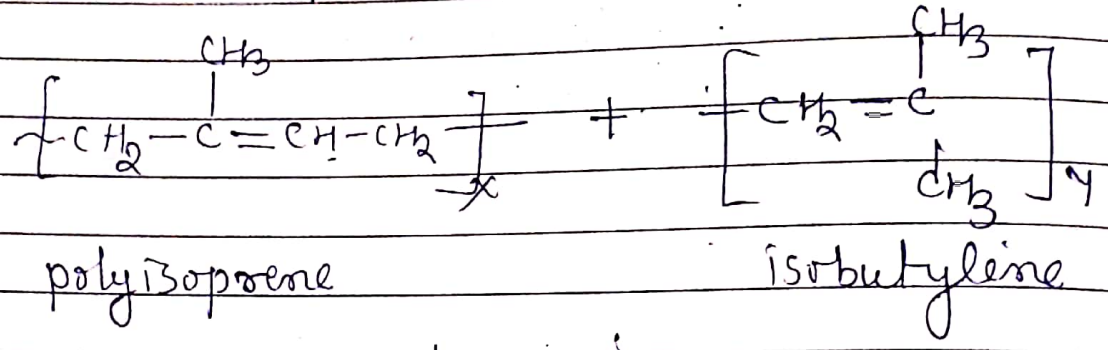
- CR rubber has good resistance to O_2 & O_3
- good physical properties over a wide range of curing temp.
- polychloroprene rubber has "heat memory" (minimum during processing stages avoid Scorch)
- resistance to flam (flamo resistance)
- The Rubber is resistance to bacterial attack
- it has lower gas permeability than NR,
- CR has poorer electrical resistance than NR. But resistance to Corona crack.

Uses of CR :-

- Hoses of chemical & Cover for Hose (oil.)
- gaskets.
- O-rings (Heat resist. properties)
- Diaphragms.
- Special purpose Conveyors in Coal mines.)
- Transmission V or timing Belts.

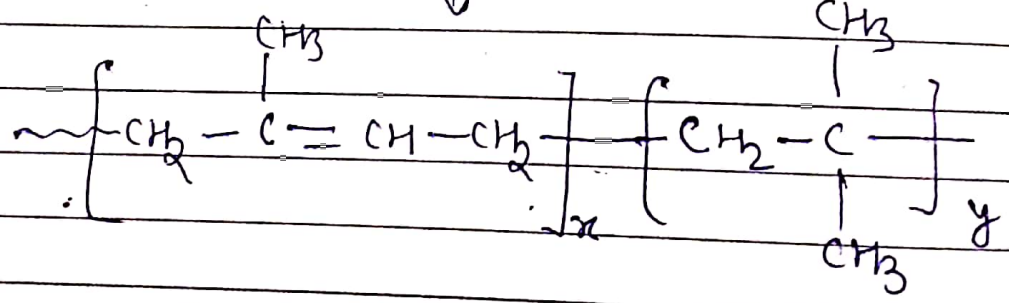
(2) IIR
(Isobutyleine - isoprene Rubber)
Butyle Rubber.

→ Butyle Rubber is produced by Co-polymerising isobutyleene with small amount of isoprene.
→ it has extremly low permeability to gases and moisture. Because very few (low) double bond.



polyisoprene isobutyleine

x = 1%
y = 99%



[IIR]

→ The small amount of unsaturation is included to furnish the necessary sites of Sulfur Vulcanisation.

Major- suppliers of this elastomers in the united states are Exxon chemical company and cities Surlic company.

Flow Diagram of Butyle Rubber production:→

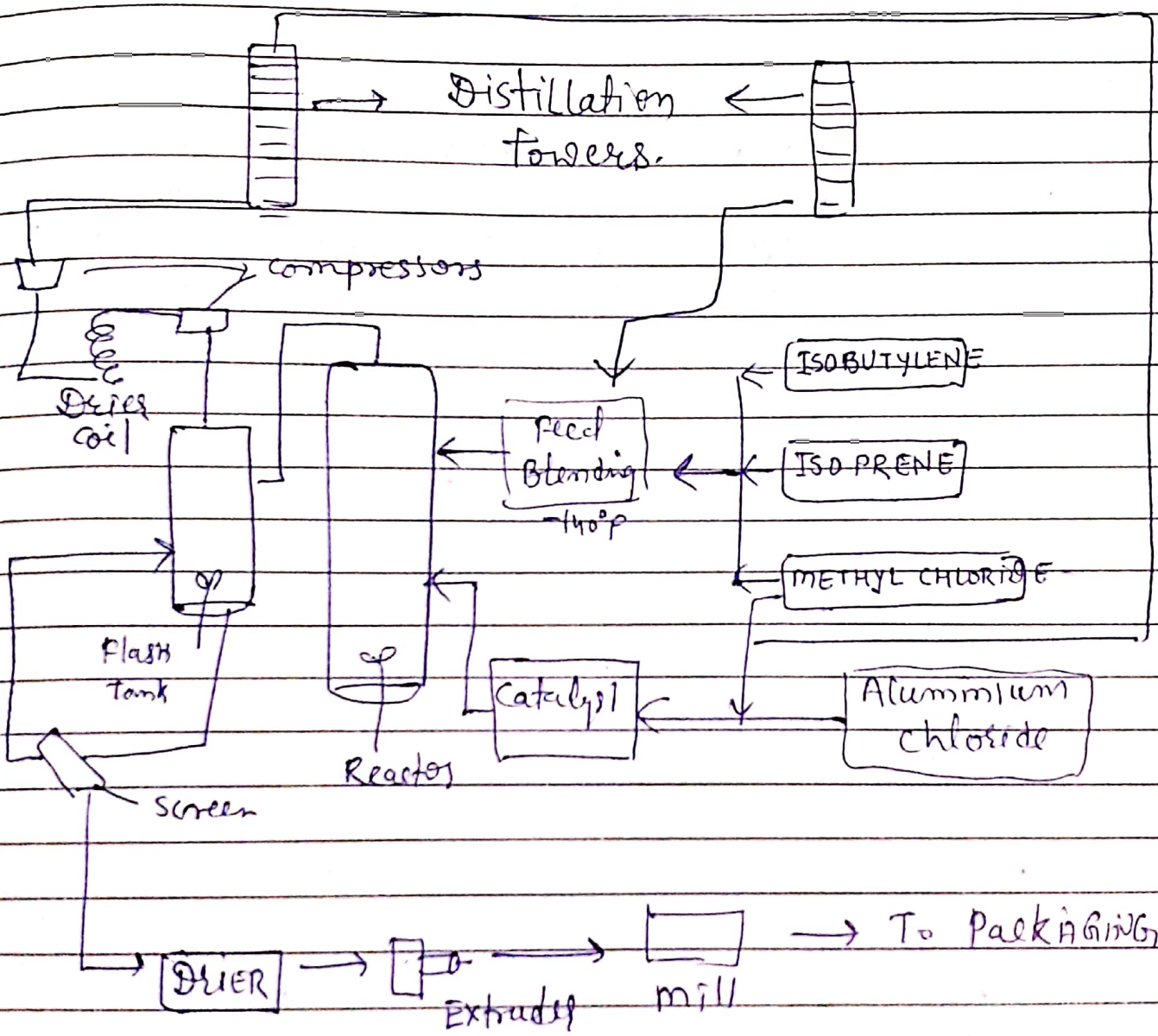


fig → flow Diagram for Butyle Rubber production.

GRADE →

(I) at low unsaturation (0.6 – 1.27%)
used where max. resistance to ozone, weather flexing and chemical required, But is slow curing grade

exa → irrigation tubing, tank lining, roof coverings cable insulation, gaskets

(II) Medium unsaturation (1.5 – 2 mole %)
This is the largest Consumption grade. Higher unsaturation gives faster q- curing and higher m.w gives higher fillers loading and greater Compounding latitude

Exa - Inner tubes,
Tyre curing bladdess
Shock absorbers,
hoses,
pedal pads, weathes strips, bushing
Rediator hoses, floor mats.

(III) high unsaturation (above 2% mole)

This is faster curing grade. it gives very good heat resistance; used for
Rain coats seals,
Conveyor belts; Footwear.
gaskets

process aids →
Butyle is highly ↑saturated rubber so plasticizer are also highly saturated. & oil – paraffin process oil used

and with resin cure → Rubber,

Typical formulation, (exa:)

Butyle – 100 phr	The polyisobutylene portion provide a high degree of impermeability to Butyle, which leads to an exclusive use in inner tubes. The CH_3 group clustering
GPF Black – 70 phr	
paraffin oil – 25 phr	
Zinc oxide – 5 phr	
St. acid – 2 phr	
TMTD – 1 phr	
MBT – 0.5 phr	
Sulphur – 1.5 phr	

– around the backbone packs. The molecules tightly to prevent any seepage of air.

Types
- Bromobutyle
- chlorobutyle

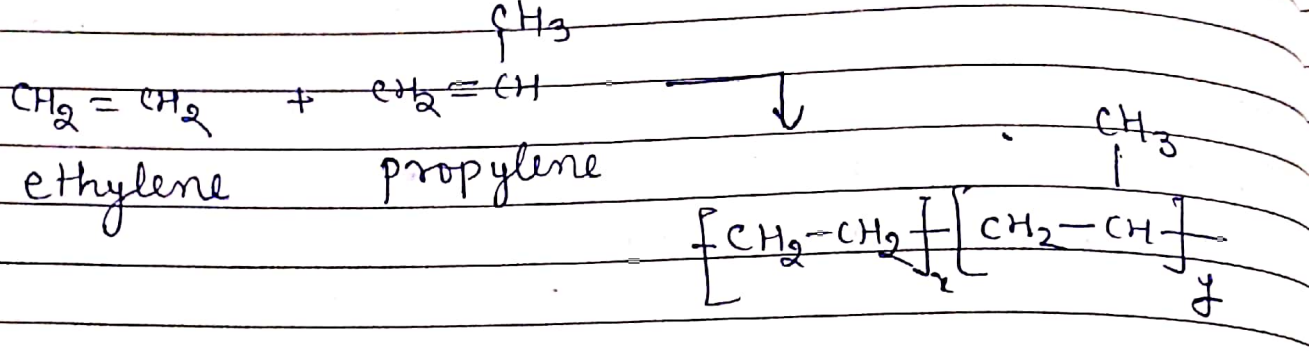
Properties
- Excellent gas impermeability.
- very good electrical insulation properties.
- Good Gum Tensile strength
- Good heat resistance...

③ EPDM

Ethylene propylene terpolymer

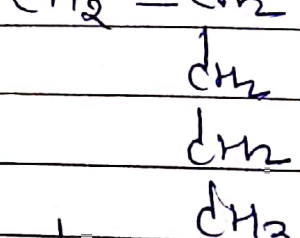
Crecklless Rubber.

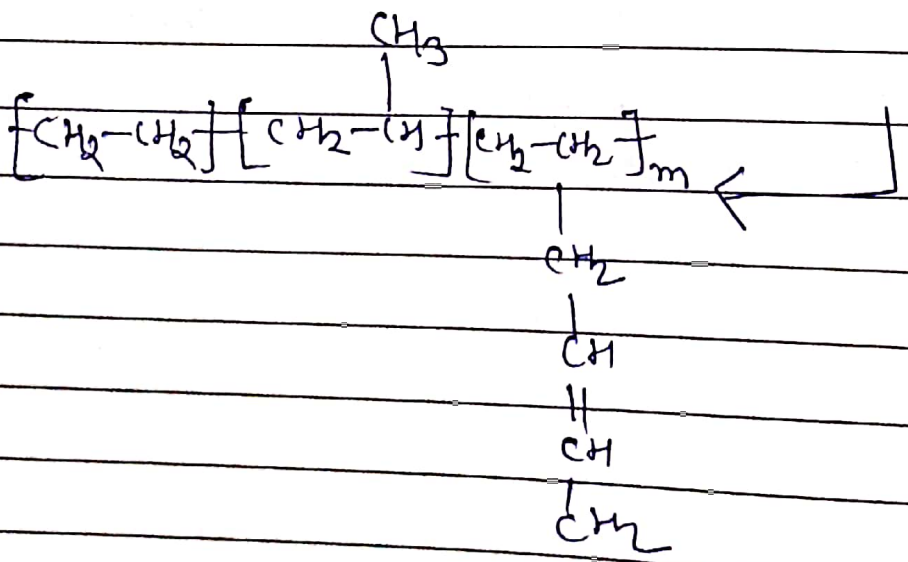
These are copybrer of Ethylene and propylene. Containing in addition a small amount of a diene for unsaturation, just enough for unsaturation, just sulphur Vulcanisation. EPDM can also be Vulcanized with peroxide Vulcanizing agent.



Ethylene propylene Rubber -

+





EPDM (2 to 10% mole unsaturation)

The Double bond is not in main polymer but pendent to it, This accounts for it EPDMs, good weather and ozone resistance, if and when oxygen react with the double bond, there is no chain scission of the polymer backbone, hence no cracking of Rubber.

Because the various chain unit are Randomly arranged in the chain, EPDMs do not crystallize on stretching and require a reinforcing filler to develop high strength,

EPDMs, are very hard at room temprature,

EPDM Applications.

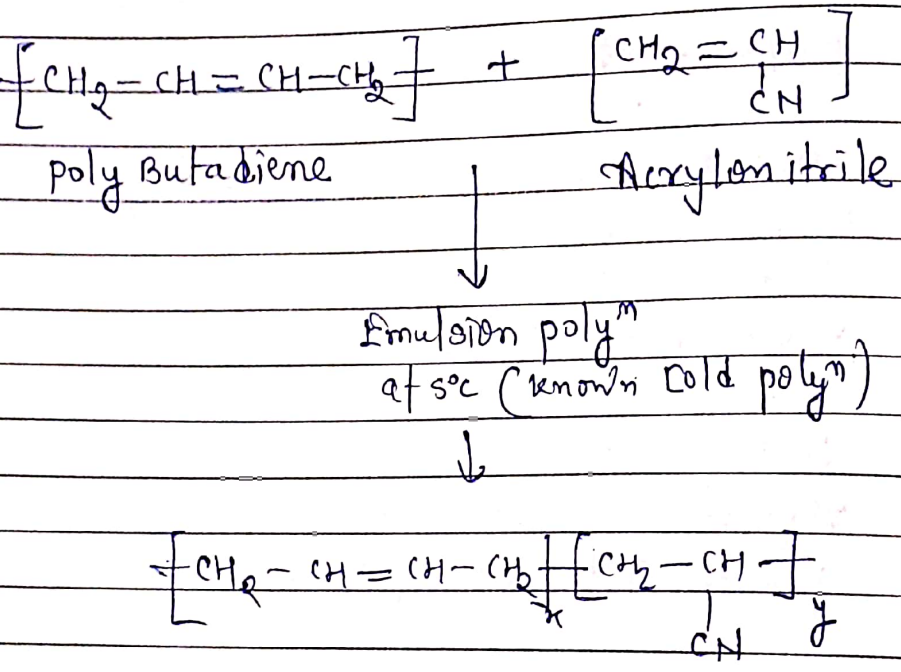
→ use in - Cable insulation & jacketing
Radiator hose,
electricale cable,
Washing machine hose,
Seals,
dock fenders,
Window profille & door,
White sidewall of tyre,

(4) NBR

Nitrile Rubber

Nitrile Rubber is a copolymer of two monomer Butadiene and Acrylonitrile.

The Acrylonitrile content Varies 20 to 50 % range depanding on the grade, The ACN content only makes the polymer polar and hence resistance to non polar mineral oils, grease and petrols.



x = 50% – 80% range,

y = 20% – 50% range,

Properties :-

⇒ In NBR, the ACN contents only makes the polymer polar — So Excellent oil resistance

⇒ Good fuel resistance,

→ Abrasion resistance
→ poor tear resistance
→ Solvent resistance.

⑤ HNBR (HSN or ENM)
Hydrogenated Nitrile - Butadiene Rubber

Compeletely hydrogenated NBR s have a fully Saturated polymer chain & can be cross -linked with peroxides, the Vulcanizate gives The highest resistance to hot air, and hot oils That can be achieved with NBR s.

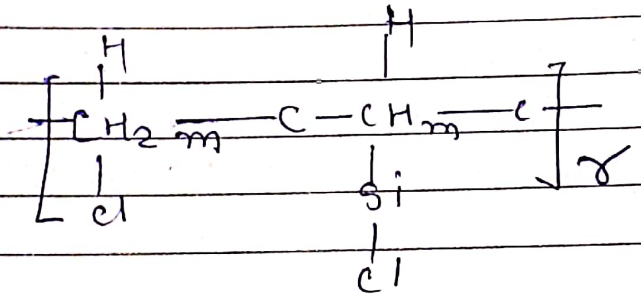
(6) CSM

chloro sulphonated polyethylene.

CSM is a Synthetic Rubber prepared by chloro-sulfonation of polyethylene.

(7)

- The resulting polymer is extremely stable chemically, and its Vulcanizates possess - outstanding resistance to ozone, as well as excellent flame oil, heat & weather & abrasion resistance.



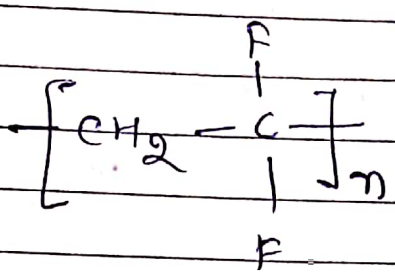
Curative - metallic oxide | Epoxy resin

properties → resistance to Burning chemicals, oil Ageing

Uses → Cables, hoses, molded goods.

(7) FKM / FFKM
Flurocarbon rubber / elastomer.

Fluoroelastomer are highly specialized products, That as class show the best resistance to all Rubber to attack heat, & chemicals and solvents & Excellent steam resistance.



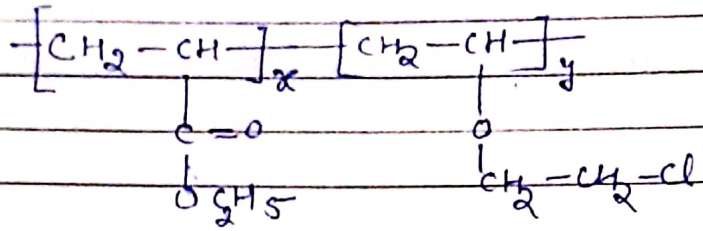
Heat & ageing resistance 1000hr@220°C :
Shaft seals in cars, Components in aircrafts & rockets.

properties
→ steam resiste.
→ high temp. Compression set resistance.
→ resistance to heat, light, ozone, solvents,

(8) ACM

polyacrilic rubbers

polyacrilics are high heat & oil resistance. specially elastomers.



x/y = 20 or more

polyacrylic rubbers have two major component.

① 95 To 99 % polymer in backbone.

② reactive cure-site comprising 1 To 5 % of the polymer.

The backbone is made of monomeric acid esters.

primary curatives → Thiourea, Di or polyamine

Acid acceptors.

properties → Good heat oil & ozone resist 1000hr @ 160-170°C

use → oil seals, o-rings, oil hoses.

Ex: ACM. rubbers.

Image. find - as. refer below.

(9) Silicone Rubbers

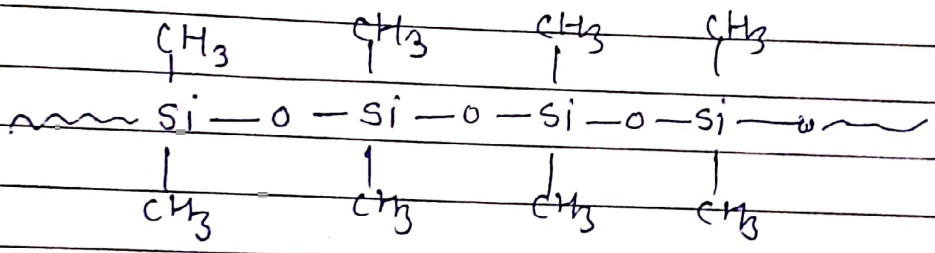
Silicone Rubber is considered as an organo-mineral high polymer called poly-siloxan. having the general formulla [RR'SiO] and consisting of alternating silicon and oxygen atoms in the main chain.

Silicone rubber is available form →

(i) silicone rubber is available form.

(a) Solide elastomer
(b) Sponge
(c) potting resin
(d) Sealant
(e) adhesive

Rubber has structure is-



The Si- atom in the polymer chain can carry other side groups resulting different types of properties & side groupe is vinyl.

properties.

(1) low temp. flexibility
(2) Radiation Resistance
(3) heat oil & solvent resistance.

• Curing Agent / curative / Vulcanisation

Vulcanisation is the process by which mainly plastic Rubber is converted into elastic Rubber or hard rubber.

The process which involves chemical linking of polymer chain is called "cross-linking"

The cross linking of S-atoms, C-C-bond, polyvalent organic redical or polyvalent-metal ions.

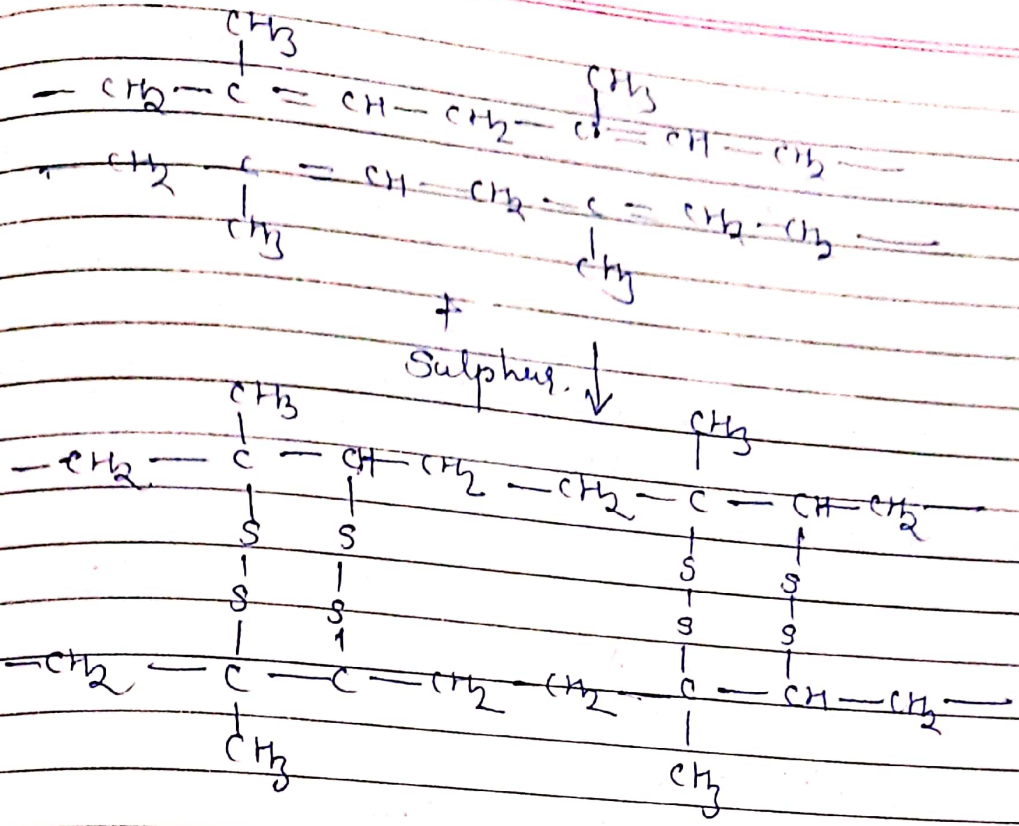
Due to vulcanization the long rubber molecule become crosslinked and 3 dimensional network is formed.

Due to increase the properties

(i) Rubber loses its Packiness,
(ii) Become insoluble in solvents,
(iii) more resistant to deterioration cased by heat, light.

Increase in

→ T.S.T
→ Toughness,
→ hardness increase
→ permanent set decrease
→ it has excellent resilience,
→ it prosesses low water absorption tendency.
→ it has higher resistance to oxidation & weak & tear abrasion,
→ it is better electrical insulator.



Types of Sulpher

(i) Rhombic / soluble

(ii) Amorphous / insoluble

(i) Rhombic (soluble)

This is an allotropic form of Sulpher, which occures as an S_8

This is soluble in CS_2 and also in Rubber.

Temp. ↑	Solubility ↑
NR at R. Temp.	1 %
80°C	4.5% ↑
120°C	10% ↑

of mixxing temp. is high the proportion of Sulphur dissolved at high temprature tends to crystallize out and diffuse to surface when cooled know blooming

(Reduction in building tack during processing)
cheaper & widely available.

(ii) Amorphous sulphur. / Insoluble sulpher :→
Allotropic form, occur in polymeric form with
M.wt 100000 To 300,000 (1lack to 3lac) range
formed by rapid cooling of molten sulpher or
precipitation from aqueous solution of sulphur
derived acids.

Insoluble is CS_2 & Rubber also therefore
has no tendency to bloom.

Imp Vulcanization system.
(I) Conventional system (CV)
(II) Semi efficient system (S-EV)
(III) Efficient vulcanization system (EV)

(I) Conventional system :→
in the case →
→ high proportion of sulphur — (1.5 - 3 phr)
→ low amount of accelerator (1 - 1.5 phr)
→ The network formed mainly polysulphidic bond

→ In these systems, these cross link will decompose at eleveted temp. leading to loss of cross linking and network containing modification.
The network ineffecrently crosslinked.

(ii) Semi-Efficient crosslinked systems,

Having efficient cross-linking (monosulphide links.) in between EV system & CV systems.

In this - S. or sulphur donors and accelerator phr at levels intermeadiate between those of EV and CV systems,

→ cross linking have thermal stability

(iii) Efficient systems.

In which -

Small amount of sulphur (0-0.5 phr)

high proportion of accelerator (2-6 phr)

have the final network crosslinked with mainly monosulphide bonds,

Such network have excellent thermal stability

	Typical CV system	SEMI EV	EV systems
polysulphide bond %	65	40	0
Disulphide % bond	25	25	25
monosulphide bond %	10	35	75