

Temp  $\rightarrow$  (295 K - 330 K)

## Chemical Engineering

$\rightarrow$  Milk  $\rightarrow$  Emulsion.

Co has both calorific value and (net and gross)

Crashol  $\rightarrow$  Alcohol and Petrol

Euler number  $\rightarrow$  Inertia force  
pressure

Dynamic Viscosity  $\rightarrow$   $m L^{-1} T^{-1}$

weight  $\rightarrow$  buoyancy + drag

Prandtl number  $\rightarrow$  Momentum diffusivity  
Thermal diffusivity

$$\frac{L}{U} = \frac{1}{U_D} + R_F$$

In absorber  $\rightarrow$  Operating line lies above equilibrium line

Multi stage tray tower: Rofflux ratio  $\downarrow$

$\rightarrow$  Infinite trays and max. reboiler heat load.

Striping section in cont-distillation column

$\rightarrow$  Liquid is enriched with high boiling  
rectifying section

$\rightarrow$  Vapor is enriched with high boiling

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Electricity Maps (or)

→ 3 Way catalyst is feasible in lean mixture  
(stoichiometric)

Dividing tall packed tower into sections

→ Avoid channelling.

→ Rate of adsorption  $\propto \frac{1}{T}$

→ Uniform concentration  $\rightarrow$  Murchison efficiency =  $\rho_{\text{om}}^2$   
efficiency

→ Rate of extraction in leaching  $\propto T$

→ Concentration of rubber latex  $\rightarrow$  Agitated film over packt

→ Not a continuous leaching equipment

•  $\Rightarrow$  Pachuca tanks

→ MEA absorbs  $H_2S$

→ Gaseous diffusion process  $\rightarrow$  Isotopes of uranium

→ Raschig rings  $\rightarrow$  packing used in industry

→ Plate efficiency  $\rightarrow$  A function of mass transfer between liquid and vapor

→ Cor chart  $\rightarrow \log P$  vs  $T$

→ Chemisorption  $\rightarrow$  An reversible phenomenon

→ Back trapping  $\downarrow$  tray efficiency

- Absorbance factor ( $A$ ) in absorber  $\Rightarrow \text{eye} \rightarrow 1$
- Toward diaphragm  $\downarrow$  tray spacing  $\uparrow$
- channeling  $\rightarrow > 8:1$
- Raoult's law applies to  $\rightarrow$  solvents

$$W \cdot T - AST \rightarrow +ve$$

- P-controller has maximum offset
- Composition of alloys  $\rightarrow$  Polarograph.
- Vane motor  $\rightarrow$  flow rate of river.

- Single tank system  $\rightarrow T \cdot f \Rightarrow \frac{R}{TS+1}$
- Bowden tube  $\rightarrow$  Secondary  
Cable  $\rightarrow$  Primary element) element
- frequency response method containing transportation lag stability of a control system
- Optical radiation pyrometer  $\rightarrow 800^{\circ}\text{C} - 1200^{\circ}\text{C}$
- Positional controller  $\rightarrow$  high loads
- P-I control  $\rightarrow$  eliminates offset
- first empirical temp scale  $\rightarrow$  Fahrenheit scale
- Mass spectrometer  $\rightarrow$  Composition of isotopes analysis
- Introducing I control  $\rightarrow$  reduce offset
- Hot wire anemometer  $\rightarrow$  Not a composition measuring instrument
- Decay ratio  $\alpha \frac{1}{\text{overshoot}}$

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→ Boro mercury in glass thermometers  $\rightarrow$  Nata 2<sup>nd</sup> order  
→ Stabilizing time  $\rightarrow$  95% of ultimate value

→ Trip point of water

( $273^{\circ}\text{K}$ ,  $32^{\circ}\text{F}$ ,  $492^{\circ}\text{R}$ )

→ 1<sup>st</sup> order system response  $\rightarrow (0, \infty)$

→ Phase margin  $\rightarrow 180^{\circ}$  - phase lag

→ Wrong stats ( $\text{CO}_2$  is the strongest paramagnetic gas)  
 $\text{O}_2$  is the strongest paramagnetic gas

→ Psychrometer  $\rightarrow$  Humidity of gases

→ CSTR  $\rightarrow$  Auto open valve controller instead acting  
→ Photo electric pyrometer  $\rightarrow (800 - 1800^{\circ}\text{C})$

Number of poles in  $\frac{1}{s^2 + 2s + 1} \rightarrow 3$

Bowden gauges  $\cong 2$  gauge

Dynamic characteristics  $\rightarrow$  (Reproducibility, Dead zones, static error)

High fidelity  $\rightarrow$  Desirable characteristic

Static characteristic  $\rightarrow$  Drift

Phase shift  $\rightarrow (-45^{\circ})$

(for 1mm and 1rad/min)

- freezing point of mercury  $\rightarrow -38.9^\circ$  ( $-39^\circ - 350$ )
- Load cells  $\rightarrow$  Weight measurement
- Amplitude ratio for the sinusoidal response of 1<sup>st</sup> order system is  $< 1$
- Transportation lag is 1 (Amplitude ratio)
- Helium in thermometer  $\rightarrow < 0^\circ C$
- Dynamic error  $\rightarrow 2AT$  for ramp input in 2<sup>nd</sup> order system
- Open loop T.F  $\rightarrow$  Nyquist stability method.
- Alphathon measures pressure  $> 3$  millions
- $$\frac{2s+1}{4s} \rightarrow 1^{\text{st}} \text{ order} \cdot \text{T.F}$$
- Oil  $\rightarrow$  Used in hydraulic controllers
- Unbound input T.F  $\Rightarrow \frac{1}{s^2}$
- Manometer  $\rightarrow$  Gauge pressure
- Pitot tube  $\rightarrow$  static pressure
- Barometer  $\rightarrow$  absolute pressure
- Amplitude ratio of 0.1  $\rightarrow -20$  decibels
- Mercury barometer  $\rightarrow$  Atmospheric pressure

Magnetic flow meter  $\rightarrow$  Not a Variable area flowmeter

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$\rightarrow$  Platinum - Platinum Rhodium  $\rightarrow$   $-50^{\circ}\text{C}$ . Temp

$\rightarrow$  Variable area Flowmeter

(Piston type motor, Rotomotor, Orifice and tapered plube motor)

$\rightarrow$  Copper - constantan thermocouples  $\rightarrow$  Least temp

$\rightarrow$  Resist ratio  $\rightarrow$  Integral time measurement

$\rightarrow$  Thermocouple in thermal well

$\Rightarrow$  Multiple 1<sup>st</sup> order system

$\rightarrow$  12, 0.6, 0.12

## ICRE

$\rightarrow \frac{1}{k_{\text{eff}}} = \frac{1}{k} + \frac{1}{k_g}$ , Knudsen diffusion  $\propto \sqrt{T}$

$\rightarrow$  half life period  $\Rightarrow \frac{0.693}{k}$

$\rightarrow$  Higher free energy ( $A \cdot E$ )  $\rightarrow$  slows rate of reaction.

$\rightarrow$  Eddy diffusivity in liquid for PFR  $\Rightarrow 0$

$\rightarrow$  CSTR  $\rightarrow$  Auto thermal reaction.

$\rightarrow$  Negative catalyst  $\rightarrow$  reduce rate of reaction.

$\rightarrow$  Autoclave  $\rightarrow$  High pressure batch reactor

Unit of  $E_f \Rightarrow ^{\circ}\text{K}$

$\rightarrow$  Invasion of conc. sugar  $\rightarrow$  Bimolecular reaction with 1<sup>st</sup> order

$\rightarrow$  Glucose  $\xrightarrow{\text{Zymase}}$  Ethyl alcohol

$\rightarrow$  Effectiveness factor of catalyst  $\rightarrow$  Porodiffusion

$2A \rightarrow B$  (CSTR and PFR products)

$\rightarrow$  Conversion high is PFR

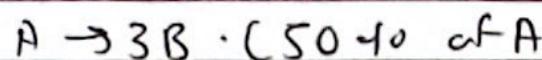
$\rightarrow$  for  $10^{\circ}\text{C}$   $\gamma \Rightarrow 2$ ,  $30^{\circ}\text{C}$  to  $70^{\circ}\text{C}$   
 $\gamma \Rightarrow 16$  times

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$$\rightarrow 0.144$$

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$$\tau = \frac{2}{k} = 512$$



$\rightarrow$  Mole fraction of A is  $\frac{1}{4}$

$\rightarrow$  Half-life period is independent of initial conc of reactants

$\rightarrow$  Variation of one concentration term  $\rightarrow$  1<sup>st</sup> order  
 $- \frac{\epsilon}{RT}$

Transition state theory  $\rightarrow k \propto T \cdot e^{-\frac{E}{RT}}$

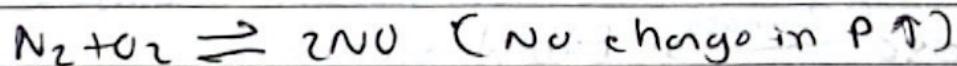
$\rightarrow$  PFR  $\rightarrow$  presence of lateral mixing

ice  $\Rightarrow$  water pressure increase

$\rightarrow$  More water will be formed.

Radioactive decay  $\rightarrow$  1<sup>st</sup> order kinetics:

$\rightarrow$  Step input signal response  $\rightarrow$  C-curve



$\rightarrow$  As the chemical reaction proceeds,

$\hookleftarrow$  the ratio of reaction  $\downarrow$

Physical adsorption  $\rightarrow 1000 \cdot \frac{k_{cal}}{kg \text{ mols}}$

$\rightarrow \tau_A = k_c(A)(B) \rightarrow V \downarrow \frac{1}{4} \text{ times}$

$\rightarrow \tau \rightarrow 16 \text{ fmols}$

$$E_a \Rightarrow \frac{E_p}{2}$$

"Mean resistance mo  
space mo  
C P is constant"

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→ BET apparatus → specific surface of a porous catalyst

→ Sequence of reaction in 2<sup>nd</sup> order

→ 15, 10, 5

$$\rightarrow -\gamma_A = k P_A \cdot P_B \cdot P_C$$

$$1 + k_A \cdot P_A + k_C \cdot P_C$$

→ rate controlling step for this reaction.

→ A and B in gas phase (surface reactor)

→ Unreacting core model → Routing of sulphidic acids

→ Half life period  $\rightarrow \frac{1}{2}$  of initial concn. of reacting sub.

Participation of electrons → chemical reaction

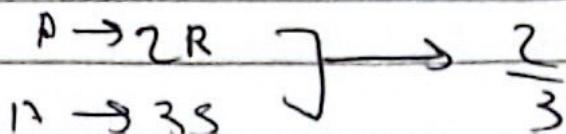
Tomp  $\downarrow$  → Endothermic reaction conversion  $\downarrow$

Eff of catalyst increases

→ Catalyst size  $\downarrow$  and catalyst diffusivity  $\uparrow$

$\rightarrow \frac{R}{8}$  doesn't take part in chemical reaction

Shift reaction  $\rightarrow \text{CO} \rightarrow \text{CO}_2 + \text{H}_2\text{O}$



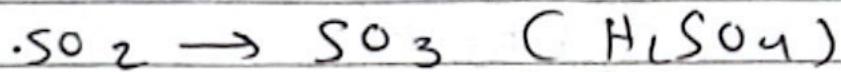
(A ↓, C<sub>B</sub> ↑)

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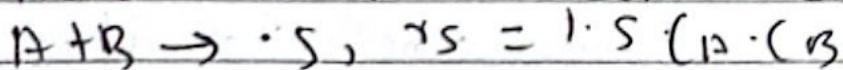
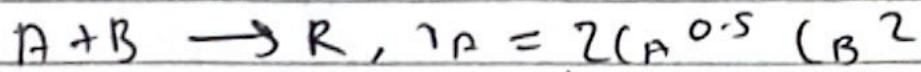
$$\frac{E-F}{L} = \frac{1}{V+k/D}$$

Performance equation on similar → P constant  
(PFR and batch reactor)



→ Yield will increase if (T ↓ and P ↑)

→ RTD of an ideal CSTR reactor is  $e^{-\frac{t}{\tau}}$



→ Low C<sub>P</sub>, high C<sub>B</sub>

## Chemical Process

- $N_2H_4$  → Rocket fuel (Hydrazine)
- Sugar content in sugarcane → 5 - 10 %
- Paper grade bamboo contains → 5 % cellulose
- Production of 1 ton cement → 1 - 2 tons of limestone
- Blotting paper → No requirement of fiber
- Phenolic antiseptic → Medicated soaps
- Lead chromate → Yellow Pigment
- Sweetest sugar → Fructose
- Flotation → Conc' of sulphate or
- $H_2SO_4$  → (furnace → converter → absorber)
- Margarine → is a fat
- Cumene (raw material) for → Phenol and acetone
- Molasses (starting raw material) → Alcohol
- flexible form → (Polyurethanes)
- $N_2$  is an essential component → Rockets



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→  $\text{SO}_2 \rightarrow \text{SO}_3$  (Low T, high P)

→ Liquid nitrogen → (Rapidly or slow cooling)

→  $\text{Na}_2\text{SO}_3 \rightarrow$  (Soda ash)→ Washing soda → ( $\text{Na}_2(\text{O}_2 \cdot 10\text{H}_2\text{O})$ )→ Baking soda → ( $\text{NaHCO}_3$ )

→ Dehydration of isopropanol → Acetone

→ Kraft pulp → Alkaline process

→ Ethylene  $\xrightarrow[\text{produced from}]{\text{Hydrocracking}}$  Naptha→ Neoprene  $\rightarrow$  (Synthetic rubber)  
(Polychloroprene)→ H<sub>2</sub>S is absorbed by using → Ethylamine→ Boiling of water → CO<sub>2</sub> as temporary hardness

→ Purpose of tanning → Stiffen leather

Mylon - 6 → Polyamide → C (Caprolactam)

(Hexamethylene diimide and Adipic acid) → Nylon 66

(CO + H<sub>2</sub>) → [Producing gas, Water gas, Hydrogen gas]Teflon → C<sub>2</sub>F<sub>4</sub> (PTFE)

HU → Muriatic acid

↳ Average Mol. wt → Saponification number  
Number of oil / fats

→ Oleum produces fumes of  $\rightarrow \text{SO}_3$

Unsaturated oil  $\leftrightarrow$  Saturated oil.

→ Melting point low, high reactivity to oxygen.

→ Wrought iron → Purest form of iron.

→ Thinner in paints → Suspends pigments and dissolves film forming materials.

→ Bosch process →  $\text{H}_2$  produced from  $(\text{CO} + \text{H}_2\text{O})$

→ Linoleic acid → Main constituent of seed oil

→ Cellulose → Main constituent of cotton fibre

→ Yellow phosphorus → most reactive allotrope.

→ Flint glass → Lead oxide

Bromine → Molar liquor

→ Penicillin operating condition  $\rightarrow 25^\circ\text{C}, 2\text{ atm}$

→ Absorption of  $\text{SO}_3$  in  $97\% \text{ H}_2\text{SO}_4$   
 $(\rightarrow$  Exothermic process  $)$

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## Environment Engineering in CE

→ Noise limit (WHO) → 75 dB

→ 5 major → CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, ...

→ Dose of chlorine → 1 mg (ppm)

→ Higher conc' of N<sub>2</sub> → Bronchitis

→ CO → CTUV limit < 50 ppm

↳ Automobile exhaust → Asphylation

→ Major constituents of air pollution  
(SO<sub>2</sub>)

→ Chlorammonium ions → disinfection in water treatment plant

CH<sup>+</sup> ion in distilled water → 10<sup>-7</sup>)

→ Alum → chemical coagulant

→ Lagooning process → sludge disposal

→ Temporary hardness removed by → lime-soda process

Composting → Biological decomposition

pH value of portable water  $\rightarrow$  6.5 - 8

Chlorination  $\rightarrow$  Remove algae growth.

(catalytic converter .C platinum as catalyst)  
 $\rightarrow \text{CO} \rightarrow \text{CO}_2$   
 $\text{NO}_2 \rightarrow \text{N}_2, \text{NH}_3$

$\rightarrow \text{Ozone} \rightarrow$  secondary pollutant  
 $\rightarrow$  Impervious to UV rays

$\rightarrow \text{SO}_2 \rightarrow 4 \text{ ppm}$  (Pungent smell)

$\rightarrow$  Salt content in sea water  $\rightarrow 3.5\%$

$\rightarrow \text{BOD} \rightarrow$  characteristic of liquid effluents.

Smoko  $\rightarrow$  ( $< 1 \mu\text{m}$ )

[Smoko + fog  $\rightarrow$  Smog]

$\rightarrow$  TLV of mercury in portable water  $\Rightarrow$  ~~0.001 ppm~~

Average thickness of Ozone layer  $\rightarrow 230 \text{ DU}$

$\rightarrow$  Dissolved Oxygen in water  $\Rightarrow 5 \text{ ppm}$

$\rightarrow \text{SO}_3 \rightarrow$  (not a green house gases)

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## Mechanical Operations

→ Unit of cake resistance  $\rightarrow \text{cm} / \text{cm}^2$

→ Shape factor  $\alpha$

sphericity

→ For sphere volume shape factor  $\Rightarrow \frac{\pi}{6} \left( \frac{V}{D^3} \right)$

→ Classifiers  $\rightarrow$  Coarse particle from

slurry fine particles.

→ Straight line  $\rightarrow$  Incompressible cake and laminar

Shape factor  $\Rightarrow \frac{AD}{V}$  (for spheres)

⇒ sphericity  $\Rightarrow \frac{\text{Surface area of same volume}}{\text{Surface area of the particle}}$

→ Ultrafine grinders  $\Rightarrow$  Attrition principle

Filter aid is added

→ Added to the food slurry

→ Precoated to the filter medium prior to filtration

$$\sqrt{\left(\frac{S}{V}\right)}_p, TQ \approx 3.6 V W D_r p$$

→ Hot, lumpy and fibrous material  $\rightarrow$  Attrition

→ Screen blinding  $\rightarrow$  Screen is plugged with solid particles

sphericity for washing nys  $\leq 1$

Food  $\rightarrow$  100 - 300 mm, Product  $\rightarrow$  10 - 50 mm (Secondary)

Taggart's  $\Rightarrow$  93 LS ( $\text{cm}^3/\text{hr}$ )

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$\rightarrow$  Porosity of compressible coke  
(Minimum at filter medium)

(jaw crusher, Ball mill, fluid energy mill)

$$\rightarrow \phi_s \Rightarrow \frac{6 \cdot V_p}{D_v S_p}$$

(Sphericity for non spherical particle.)

$\rightarrow$  Diatomaceous earth  $\rightarrow$  Most common filter aid

All resistances during washing of coke  $\rightarrow$  Roman constant

Lime stone  $\rightarrow$  Hammer crusher.

Pressure drop  $\Rightarrow \frac{1}{2} \cdot w^2 \cdot g \cdot pL (2k + \delta)$

$\rightarrow$  froth floatation  $\rightarrow$  sulphide ores

Pressure filter thickeners  $\rightarrow$  thick suspension from thin slurry

Cassiterite  $\rightarrow$  Not a non-metallic mineral

Gravity stamp mill  $\rightarrow$  fine crushing

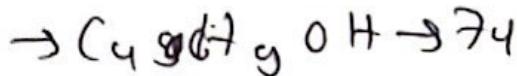
Hydrocyclone  $\rightarrow$  No gravity settling operations

Toothed roll  $\rightarrow$  iron and gypsum

Unit of Length (Parsoc, Fermi, Angstrom)  
↓  
(Barn X)

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## Stoichiometry

$$\rightarrow 1 \text{ bar} \rightarrow 1 \text{ atm} \quad (\text{BC})$$

$\rightarrow$  Baumé gravity scale  $\approx 148 - \frac{145}{C}$   
(liquids heavier than water)

$$\rightarrow (\text{B6} \Rightarrow \frac{140}{C} - 130)$$

(liquids lighter than water)

$$1 \text{ BTU} = 9.7 \text{ kJ}$$
$$f^3 \text{ m}^3$$

$\rightarrow$  Azeotropic soln  $\rightarrow$  "t vs" deviation from Raoult's law

$\rightarrow$  Unsteady chemical process

(Flow rates and composition both on time dependent)

$\rightarrow$  Eutectic point  $\rightarrow$  3 phases

$\rightarrow$  Endothermic reaction  $\rightarrow$  Value of AE is  $> \Delta H$

$$P \rightarrow 2P \quad \rightarrow \text{Boyle's law obey}$$

$$\text{Then } V = \frac{V_1}{2} \quad \rightarrow \text{boyle temp.}$$

$$\rightarrow 1 \text{ micron} \Rightarrow 10^{-4} \text{ cm}$$

$\rightarrow$  Kopp's rule  $\rightarrow$  Heat capacities of solid.

Hess law  $\rightarrow$  Change in heat of reaction

Molar heat  $\approx 3 \text{ kcal/kg mol} \cdot ^\circ \text{K}$   
Capacity at constant volume

30.6 Molar

Superheated vapor  $\rightarrow P \cdot P < E \cdot P \cdot p$

$\rightarrow$  At 0°C, the molecules have  $\rightarrow$  translational energy

$\rightarrow$  Colligative property

- Osmotic pressure  $\rightarrow$  depend on constituent of solids
- Depression of freezing point.
- Lowering of vapor pressure

3.1 P  $\rightarrow$  1 atm, 15.5°C.

1% sugar  $\Rightarrow$  1 brix (Molarity  $\downarrow \rightarrow T \uparrow$ )

$\rightarrow$  Saturated pressure  $\rightarrow$  liquid and vapor both exist

$\rightarrow$  20.1° H<sub>2</sub> in dry basis

$\rightarrow$  Osmotic pressure by 27.41 at 0°C  $\rightarrow$  1 atm

1 kg/m<sup>2</sup>  $\rightarrow$  1 mm water column

APP gravity of water at NTP  $\rightarrow$  1.0

$\rightarrow$  Kinematic viscosity

$$\hookrightarrow \frac{1 \text{ cm}^2}{\text{s}} \Rightarrow 10^4 \text{ stokes}$$

$\rightarrow$  Unit of mass velocity  $\rightarrow \frac{\text{kg}}{\text{m}^2 \cdot \text{hr}}$

$\rightarrow$  Neutral solution [H<sup>+</sup>] = [OH<sup>-</sup>], the value of [H<sup>+</sup>] [OH<sup>-</sup>]

$$\Rightarrow 1$$

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## Polymer Technology

→ Phenol and formaldehyde condensation → Bakelite  
→ Polythene → can be recycled and reused

→ Formaldehyde resin → Melamine resin  
→ Vinyl flooring → PVC sheets

PVC → emulsion polymerisation (Thermoplastic)  
→ Thermosetting polymers → have strongest inter particle forces.

Orion → polymerising vinyl chloride

→ Step growth polymerisation → Terylene

→ Polypropylene → Solution polymerisation

→ Phthalic anhydride → Plastics

Polycaprolactum → Nylon - 6

→ B-glucose → monomer of cellulose

Polymers are → Macromolecules.

Polythene → Addition polymerisation product

→ Polyvinyl alcohol → water soluble with osmotic pressure

→ Melamine → Unbreakable crockery

# PMMA (met condensation polymer)



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- Rain coats are made of → PVC.
- Rayon is → cellulosic fibro.
- Phosphates → plasticizers

SBR → Synthetic polymer (Emulsion polymerization)

Nylon 6 (6 represents carbon atom in linear polymer chain).

Linen of bugs → Polypropylene

Visco-elastic behavior → Solid and liquid of plastics

- Ziegler process → high density polymer
- Vulcanisation of rubber → Thickness decreases

Teflon → Non sticky coating on flying pan

Bakelite → Copolymer

SBR

Buna-S

Tyros → Rotational molding

Thermoplastic resins → less brittle than thermosetting plastic.

- Thermosetting materials → cross linked molecules
- Plastic tubes and pipes → Extrusion

Vulcanite or abonite → no elasticity