UNIT-V

MATERIAL OF CONSTRUCTION

- **Introduction**
- **General composition of material**
- **Corrosion**
- **Stainless steel**
- **Glass**

INDUSTRIAL HAZARD

- **Mechanical hazard**
- **Chemical hazard**
- **Electrical hazard**
- **Fire and Dust hazard**
- **Industrial dermatitis**
- **Accidental records**

Materials of Construction

- A wide variety of materials can be utilized for the construction of equipment.
- The selection of a material for the construction of equipment depends of the following properties.
    - ✓ Chemical resistance
    - ✓ Structure resistance
    - ✓ Resistance of physical shock i.e., operating pressure
    - ✓ Resistance of thermal shock i.e., operating temperature
    - ✓ Ease of fabrication
    - ✓ Cost
    - ✓ Maintenance

Factors Influencing Selection of Materials-Three type of factors.

- ✓ Chemical Factors
- ✓ Physical Factors
- ✓ Economics Factors

Chemical Factors

- Contamination of the product by material of plant lead to instability composition and physiological effect.
- E.g. presence of traces of heavy metal decompose penicillin, Stability of vitamins decrease in presence of metallic ions (Cu++, Co++, Ni++).
- The effect on the material of plant by drugs and chemicals. Acids, Alkalis and Oxidizing agent and tannins may affect the material of construction

Physical Factors

- ✓ Adequate Mechanical Strength.
- ✓ Erosion
- ✓ Weight
- ✓ Ease of fabrication
- ✓ Thermal Expansion
- ✓ Thermal Conductivity
- ✓ Cleansing
- ✓ Sterilization
- ✓ Transparency

- ✓ Economic factorsInitial costs and maintenance of the plant must be economical.
- ✓ Low wearing qualities and lower maintenance

Cast Iron

- Cast iron consist of iron with a proportion of carbon (beyond 1.5 %).
- The properties of iron depends on the amt of carbon present.
- Cast iron is abundantly available, inexpensive.

Advantages:

- It is cheap.
- It is resistant to concentrated sulphuric acid, nitric acid, dilute alkalis.
- It has low thermal conductivity so used for construction of outer surface of jackets.

Disadvantages:

- It is very hard & brittle so it is difficult to machine.
- It has low thermal conductivity so not used for heat transfer in stills.

Uses:

- Supports for plant.
- Jackets of steam pans.
- Linings with enamel, plastic or suitable protective material

Carbon Steel

- Carbon steel is an iron alloy, which contain small percentage of carbon.

Advantages:

- It is cheapest & weldable.
- It is frequently used in fabrication.

Disadvantages

- It has limited resistance to corrosion. This can be improved by preparing alloys.
- It reacts with caustic soda, brine &sea-water. Alloying it can reduce this reativity.

Uses:

- Used for construction of bars, pipes & plates.
- It is used to fabricate storage tanks for water & organic solvents.

Stainless Steel

- Stainless steel is an alloy of iron.
- It contains chromium & nickel, which make the steel corrosion resistant.
- It is stabilised by the addition of titanium, niobium or tantalum.

- Minor amounts of other elements such as copper, molybdenum & selenium are added.
- It has the advantage of ease in fabrication.

Properties of Stainless steel:

- Heat resistance.
- Corrosion resistance.
- Ease of fabrication.
- Cleaning & sterilization.
- Tensile strength.

Different Types of Stainless Steel

Composition	**Advantage**	**Disadvantage**	**Uses**
Martensitic			
Chromium:12-20%	Mildly corrosion	Ductility is	Sinks,bench tops,
Carbon:0.2-0.4%	resistant, atm &	poor	storage tanks,
Nickle upto 2.0%	organic exposures		bucket, etc .
Ferritic Better corrosion res- not good against Tower lining,			
Chromium:15-30%	stant, easy to machine reducing agents, baffles, separator		
Carbin:0.1%	resistant to oxidation	hydrochloric	heat exchanger,
Nickel:nil	& temperature	acid	pumps shafts,
Austenitic Highly corrosion Fermentors,			
Chromium:13-20%	resistant, sterilizable,	Not easy	storage vessels,
Nickel:6-22%	easy to weld, readily	to machine	

ALUMINIUM

- It is cheap, light in weight and offer good mechanical strength.
- Al. equipment can be easily fabricated.
- Al. can be strengthened by cold working.
- Number of modifications of Al are available.
- Al is non toxic to micro-organism

ADVANTAGE

- High resistant to atm conditions, industrial fumes, vapor and fresh or salt waters.
- Thermal conductivity of Al. is 60 % that of pure copper.

DISADVANTAGE

- Mechanical strength decrease above 150 ^{0} C.
- Al. can not be used with strong caustic solution.
- Many mineral acids attack Al.
- Oxide & hydro-oxide films form rapidly when exposed.

USES

- Preferred for food and pharmaceutical use.
- Used in heat transfer.
- Used as storage containers.
- Used in production of citric acid, laconic acid and streptomycin.
- Most useful for construction of drums, barrels, rail tankers

LEAD

- It has the lowest cost.
- Used as collapsible tube material particularly for non-food products such as adhesives, inks, paints and lubricants.
- Lead tubes with internal linings are used for fluoride tooth-paste.
- Lead chamber process is used in the manufacture of sulphuric acid.

ADVANTAGE

- It has the lowest cost.

DISADVANTAGE

- Lead has low melting point and hence posses poor structural qualities.
- It has a high coefficient of expansion. So temp strain result in permanent deformation

USES

- Used as collapsible tube material particularly for non-food products such as adhesives, inks, paints and lubricants.
- Lead tubes with internal linings are used for fluoride tooth-paste.

RUBBER

- Used as such as a lining material for the construction of plants.

Type of rubber

- ✓ Natural Rubber
- ✓ Soft rubber.
- ✓ Hard Rubber
- ✓ Synthetic Rubber.

PLASTIC

- Light in wt so transportation is easy and cheap.
- Available in variety of shape and easily fabricated.
- Used for storing number of materials.
- In machines, plastic material is preferred wherever moving parts are present indicating that it offers less resistant.
- Plastics are synthetic resins containing long chains of atoms linked to form giant or macromolecules (polymer).
- They have high molecular weight

ADVANTAGES:-

- ✓ Low thermal and electrical resistance.

DISADVANTAGE:-

- Low mechanical strength.
- High expansion rates.

TYPES OF PLASTIC

THERMOSETTING PLASTIC

- Thermosetting plastics can be formed under heat and pressure. But this cannot be softened or remolded, once hardened.
- Some are made of phenol and urea.

THERMOPLASTIC PLASTICS

- They are formed by the application of heat and pressure can be softened and remolded.

- e.g. of thermoplastic material and their use
- Polyethene: cables, buckets, pipes.
- Polypropylene: milk, cartons, ropes.
- Polyvinyl chloride: gloves, water proof garments.
- Teflon: gaskets, coatings.

Glass:

Composition

Sand : Silica pure (SiO_2) : Base material

Soda Ash : Na_2CO_3 : Improves the properties.

Lime stone : $CaCO_3$: Improves the properties.

Cullet : Broken glass : Fusion agent

Advantages

- Superior protective qualities, attractive and low cost.
- Chemically inert to large extent and available in variety of sizes, shapes and colors.
- Offer excellent barrier against many elements except light.

Disadvantages

- UV rays and sunlight are harmful to certain ingredients and cause deterioration.
- Protection against light can be obtained by amber colored bottle and against IR rays by green color glass.
- Fragility and weight.

Uses

- Mostly used in pharmaceutical industries as a containers

Types of Glass used in Pharmaceutical Industry

Types General description	Properties	Uses
Highly resistant borosilicate.(Alkali & earth cations are replaced by boron .	Resistant to alkali leaching, less brittle, low thermal expansion, easy to clean & sterilize	Containers for buffered 7 unbuffered, aqueous solution & injectables.
2 Treated soda lime glass	Surface alkali is neutralized by sulphur dioxide vapors. Glass surface is resistant to water.	Containers for buffered, aqueous solution with pH below 7.0, dry powders, oleaginous solution.

3 Soda-lime glass	It release comparatively more alkali. It offers moderate hydrolytic resistance	Dry powders, ologenous solutions.
General purpose soda-lime glass		Not for parenterals, used as containers for tablets, oral solutions, suspensions, ointments &liq. For external use.

Corrosion

- Corrosion is defined as the reaction of a metallic material environment, which causes a measurable change to the material and can result in a functional failure of a metallic component or of a complete system.
- Exposure of the surface to air, water & caustic chemicals are responsible for corrosion.
- Corrosion can be either dry or wet type-

Dry corrosion: It involves the direct attack of dry gases(air & oxygen) on the metal through chemical reaction.

Wet corrosion: It involves the direct attack of aqueous media(strong or dilute, acidic or alkaline) on the metal through electrochemical reaction.

Effects of corrosion

- Losses are economic and safety:
- Reduced Strength
- Downtime of equipment
- Escape of fluids
- Lost surface properties
- Reduced value of goods

Corrosion" of plastics

Not only metals suffer "corrosion" effects. This dished end of a vessel is made of glass fibre reinforced PVC. Due to internal stresses and an aggressive environment it has suffered "environmental stress cracking".

GALVANIC CORROSION

- This rainwater guttering is made of aluminium and would normally resist corrosion well.
- The tubing, shown here was part of an aircraft's hydraulic system. The material is an aluminium alloy and to prevent bimetallic galvanic corrosion due to contact with the copper alloy retaining nut this was cadmium plated. The plating was not applied to an adequate thickness and pitting corrosion resulted.
- Galvanic corrosion can be even worse underneath the tyre in bicycles used all winter. Here the corrosion is so advanced it has penetrated the rim thickness.
- This polished Aluminium rim was left over Christmas with road salt and mud on the rim. Galvanic corrosion has started between the chromium plated brass spoke nipple and the aluminium rim

PREVENTION OF CORROSION

Industrial hazards

Types of Industrial Hazards

- ✓ MECHANICAL HAZARDS
- ✓ ELECTRICAL HAZARDS
- ✓ CHEMICAL HAZARDS
- ✓ FIRE HAZARD

MECHANICAL HAZARDS

CAUSES___

- ✓ Failure of components of mechanical system due to faulty design or assembly, OR material and delay of maintenance.
- ✓ Inadequate safeguards on the machine or equipment.
- ✓ Negligence in the use of personal protection equipments.
- ✓ Inadvertence and complacency on the part of workers at the points of operation.

SAFETY MEASURMENT AGAINST HAZARDS

- ✓ Provision of interlock guard.
- ✓ Enclose dangerous parts with suitable casing.
- ✓ Dangerous parts should be out of reach during operation.

ELECTRICAL HAZARDS

CAUSES__

- ✓ Sub-standard material and equipment used.
- ✓ Electrical equipment not as per required regulation and standards.
- ✓ Over loading of equipment.
- ✓ No preventive maintenance.
- ✓ Insulation failure.
- ✓ Improper earthling.
- ✓ Static electricity not controlled

INSTRUCTION

- ➢ To avoid from industrial electrical hazards .
- ➢ The following instruction should be followed by carefully.
- ➢ Under normal circumstances the rate of current flow in amperes of the order of 20mA to 25mA can cause electrical shock.
- ➢ A fatal shock can be caused by 50mA of current. For this type of electrical supply a better method would be to use (MCB5)---miniature circuit breakers,
- ➢ (ACBs)—Air circuit breakers.
- ➢ (DCBs)—Oil circuit breakers to protect electrical installation from hazards fir big industrial units the circuit breakers types are ---
- ➢ MCCBs—Molded cases circuit breakers .
- ➢ ELCBs—Earth leakage circuit breakers.
- ➢ These circuit breakers can cut off the supply immediately i.e. within friction of second in case of current exceeds or short circuit or leakage etc.

CHEMICAL HAZARDS

- Storage
- Handling
- For safety point of view in chemical industries the care should be taken in:--
- Manufacture(operation and processes)
- Use of chemicals.
- Must be strict surveillance on the part of each worker i.e. managers, supervisors and workmen

FIRE HAZARDS

- Some of the common terms used in the context of fire hazards are as follows-
- Fire escapes-It means external stairs are meant for being used by the occupants in case of fire, for their safe evacuation.
- Fire Towers-Fire towers are safe escape routes for multi-storey end buildings in which there is access from the various floors through corridors, passages etc.
- Travel Distance-It is the distance which the worker/occupant has to cover during a fire to arrive at an exit.

CAUSES OF FIRE HAZARDS

- Smoking.
- Heating devices e.g. electric heaters, soldering irons etc..
- Electrical installation.
- Welding and cutting operation.
- Spray painting.
- Industrial ovens and dryers.
- Improper storage of flammable material.
- Poor machinery maintenance.
- Poor house keeping.

Industrial Dermatitis

- Industrial Dermatitis is an inflammatory reaction of the skin caused by regular contact with irritant substances in the course of employment.

They are two types-

Irritant Contact Dermatitis (ICD):

- ICD is normally the result of skin coming into contact with one or more substance causing cell damage.
- Prolong exposure to even weak irritants can give rise to chronic ICD; strong irritants can give rise to acute ICD.

Allergic Contact Dermatitis(ACD):

- This normally arises due to the sensitization of individual to the relevant substance/allergen which may occur after only exposure or repeated exposure spanning a number of years

Symptoms

- Common symptoms of dermatitis are irritants of skin disease in the category of skin such as psoriasis or scabies, which often difficult to distinguish.

Causes:

- Construction workers
- A film laboratory worker
- Manufacturing work in contact with pharmaceutical agents
- A hospital worker in contact with detergent/soaps
- A metal machining worker in contact with mineral oils
- An electronics worker in contact with soldering fluxes