

INDUSTRIAL CHEMISTRY



WHAT IS INDUSTRIAL CHEMISTRY

Industrial chemistry is the branch of chemistry that focuses on the large scale production and processing of chemical materials and products used in various industries. It applies chemical principles and techniques to develop, optimize and manage industrial processes for manufacturing goods like fertilizers, plastic, pharmaceuticals, foodstuffs, metals and more.



CARL BOSCH (1874-1940)



FRITZ HABER (1868-1934)

BATTERY

A battery is a device that stores chemical energy and converts it into electrical energy. It consists of one or more electrochemical cells, each with two electrodes (anode and cathode) and an electrolyte. When a device is connected to the battery, a chemical reaction occurs, generating an electric current that flows from the anode to the cathode through the external circuit.

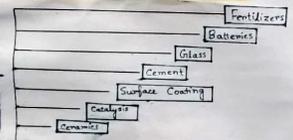
There are two main types of batteries -

1) **Primary Batteries**
A primary battery is one that cannot easily be recharged after use, and are discarded following discharge.
Ex - Lithium batteries



2) **Secondary Batteries**
A secondary battery is one that can be electrically recharged after use to reuse original pre-discharge condition, by passing current through the circuit in the opposite direction to the current during discharge, for lead-acid batteries.

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE



FERTILIZERS

After sequential cultivation, a range of bioactive molecules which will become less bioactive, or ability of the above nutrients which is not favorable. Thus, in order to make up this deficiency, certain elements in the form of their compounds have to be added to the soil to make it reproductive. These substances are known as fertilizers. These fertilizers are substances which must be added to the soil in order to increase the availability of essential elements required for plant growth. The need of fertilizing a land is therefore not only to supplement what has been taken up by the plants but to maintain the pH of the soil in the range of 7-8 and thereby facilitate nitrogen fixation and carbon.



- Remember: Here are a few examples of common fertilizers -
- 1) Urea (A highly concentrated nitrogen used in agriculture)
 - 2) Triple superphosphate (A phosphorus-rich fertilizer that promotes root growth)

GLASS

Glass is an amorphous solid material that is highly transparent or translucent and hard, brittle, and electrically inert. It is commonly made by melting sand, soda ash, and limestone at high temperatures and then cooling it quickly to prevent the formation of crystals. This process creates a non-crystalline structure, which is what gives glass its unique properties -

- 1) Glass is completely unreactive product.
- 2) They are insulator of heat and electricity.
- 3) Glass is not attacked by air and oxidizing agents.
- 4) Combining glass is readily changed by soluble, but very resistant to acids, except hydrofluoric acid.

CEMENT

Cement is a material with adhesive and cohesive properties which make it capable of bonding numerous fragments into a composite mass.

- 1) **Composition** - Cement is primarily composed of CaO, SiO₂, Al₂O₃, Fe₂O₃, MgO, Na₂O, K₂O.
- 2) **Properties** - 1) When mixed with water, cement undergoes a chemical reaction called hydration, which forms a strong, water-resistant matrix of crystalline hydrates, including silicates, sulfates, and oxides, resulting in a durable building material.

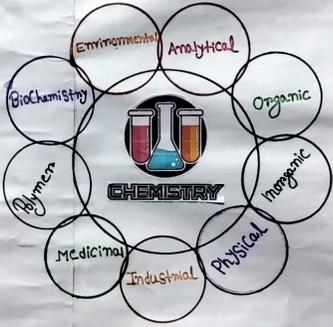
2) Uses of Cement as concrete is an essential component in numerous construction applications such as concrete, mortar, plaster, brick, road, precast concrete.



SURFACE COATING

Surface coating is a broad term that refers to the application of a layer of material to the surface of another material to the surface of another material to the surface of another material, known as the substrate. The purpose of surface coating can be decorative, functional, or both. There are many types of surface coatings -

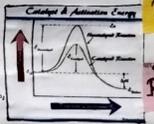
- 1) **Paints** (They are used to add color and protect surfaces from the elements. Paints can be water-based or solvent-based)
- 2) **Varnishes** (Varnishes are clear coatings that are used to protect surfaces from scratches and wear)
- 3) **Anodizing** (Anodizing is a process that uses an electric current to create a thin, protective layer of oxide on the surface of a metal)
- 4) **Uses** - Surface coatings are used to improve aesthetic, safety, and equipment from the weather and wear and tear.



CATALYSIS

Catalysis is the process of speeding up a chemical reaction by adding a substance called a catalyst. Catalysts work by lowering the activation energy of a reaction, making it easier for the reaction to occur. There are two types of catalysts -

- 1) **Heterogeneous Catalysis**: The catalyst is in one phase (solid, liquid, or gas) as the reactants. For example, nickel acts as a catalyst in the production of H₂.
- 2) **Homogeneous Catalysis**: The catalyst is in the same phase as the reactants. For example, permanganate and sulfuric acid act as a catalyst.



CERAMICS

Ceramics are non-metallic, inorganic materials that are typically made by shaping and heating material (clay or other material-based substances) at high temperatures. This process hardens the material, making it strong, heat-resistant, and durable.

- 1) **Properties** - 1) Ceramics are generally very hard and strong, especially in compression.
- 2) Ceramics are often chemically unreactive, making them resistant to corrosion and degradation.
- 3) **Applications** - 1) Traditional uses: Pottery and tableware, bricks and tiles etc.
- 2) Modern uses: Tiles made for spacecraft, incubators etc.



ADVANTAGES AND DISADVANTAGES OF INDUSTRIAL CHEMISTRY

Advantages -

- 1) **Economic Growth** - Boosts industries like pharmaceuticals, agriculture, and manufacturing, creating jobs and revenue.
- 2) **Technological Advancements** - Industrial chemistry has led to the development of numerous products that have improved our quality of life.
- 3) **Sustainable Solutions** - Help develop eco-friendly alternatives like biodegradable plastics and green energy solutions.

Disadvantages -

- 1) **Environmental Pollution** - The chemical industry is a major source of pollution, releasing harmful chemicals into the air, water, and soil.
- 2) **Health Concerns** - Exposure to certain chemicals can cause a variety of health problems, including respiratory issues, cancer, and reproductive issues.

CONCLUSION

Industrial chemistry plays a vital role in modern society by driving economic growth, technological advancement, and improving our quality of life through mass production of essential goods. However, it also poses significant environmental and health challenges, including pollution, resource depletion, and waste management issues. To maximize the benefits while minimizing the drawbacks, industries must adopt sustainable practices, invest in green technologies, and enforce strict regulations. With responsible management, industrial chemistry can continue to support human progress while protecting the environment for future generations, ensuring a balance between industrial development and sustainability. Industrial chemistry can remain a driving force for progress while safeguarding our planet.

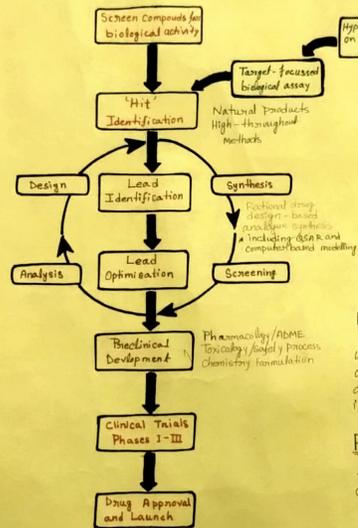


PHARMACEUTICAL CHEMISTRY



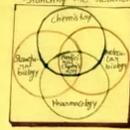
INTRODUCTION :-

Pharmaceutical chemistry is a branch of chemistry that focuses on the discovery, design, synthesis, and development of pharmaceutical drugs. It integrates concepts from Organic Chemistry, Biochemistry, Pharmacology, and Molecular Biology to understand the properties and effects of drugs on a biological system. The field plays a crucial role in drug development by creating new compounds with therapeutic potential, improving the efficacy of existing drugs, and minimizing adverse side effects. Pharmaceutical chemistry also involves the study of how drugs are absorbed, distributed, metabolized, and excreted by the body (Pharmacokinetics), as well as their biological effects (Pharmacodynamics). It ensures the safety, quality, and effectiveness of pharmaceutical products, making it essential for the development of new treatments for various diseases and health conditions.



MEDICINAL CHEMISTRY :-

Medicinal chemistry is an interdisciplinary field that combines principles from chemistry, biology, and pharmacology to design, develop, and synthesize new therapeutic agents. It focuses on understanding the relationship between a drug's chemical structure and its biological activity, aiming to optimize efficacy and minimize toxicity.



RETROSYNTHETIC APPROACH :-

Retro-synthesis is a strategy used in organic chemistry to plan synthesis by mentally breaking down a target molecule into simpler precursors. This process involves identifying key disconnections, functional groups, and reaction conditions, working backward step-by-step readily available reagents.

HERE ARE SOME KEY CONCEPTS IN PHARMACEUTICAL CHEMISTRY :-

• DRUG DISCOVERY :-

Drug discovery involves approaches like random screening, rational extraction, molecular modification, and target-based design. Random screening tests large numbers of compounds for biological activity, while rational extraction isolates bioactive compounds from plants, microbes, and marine organisms, leading to the discovery of drugs like penicillin and natural molecular modification improves the efficacy and bioavailability of existing compounds and target-based design focuses on identifying biological targets to create drugs that specifically interact with them.

• DRUG DESIGN :-

Drug design involves identifying a biological target, discovering a lead compound that interacts with it, modifying the compound through Structure-Activity Relationship (SAR) studies to improve its efficacy and testing the drug in clinical trials to ensure its safety and effectiveness before approval.

• DRUG DEVELOPMENT :-

Drug development is the process of bringing a new drug from discovery to market. It includes preclinical testing, clinical trials, and regulatory approval to ensure the drug is safe and effective. This process helps provide new treatments for various diseases.

• CLINICAL TRIALS :-

A clinical trial is a research study conducted with human participants to evaluate the effects of one or more interventions - such as drugs, vaccines, surgical procedures, or behavioral treatments.

• PHASE - 1 :-

Tests safety and dosage on a small group of healthy volunteers.

• PHASE - 2 :-

Assesses effectiveness and side effects on a larger patient group.

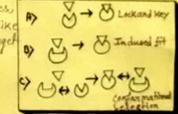
• PHASE - 3 :-

Confirms efficacy, monitors adverse reactions in a large population.

Outline of the typical drug discovery sequence

MOR :-

Mechanism of Action (MOA) describes how the drug interacts with specific targets in the body, such as receptors, enzymes, or ion channels, to produce a biological response. Think of it like a key fitting into a lock - the drug is the key and the target is the lock.

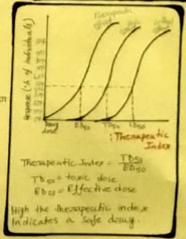


PARACETAMOL :-

USES: Paracetamol is used as a pain reliever (analgesic) and fever reducer (antipyretic) for conditions like headache, muscle pain, colds, and fever.

PHARMACOLOGICAL PROPERTIES

It is rapidly absorbed in the gastrointestinal tract, metabolized in the liver and excreted through the kidneys, with minimal side effects when taken at recommended doses.



SYNTHESIS :-

