# INDUSTRY

## Importance of Chemical Industry

- The chemical industry is the practical outcome of chemical research.
- It provides **useful materials** directly to consumers and to other industries.
- Plays a vital role in **large-scale production** of:
  - Plastics
  - Synthetic fibres
  - Elastomers
- Industrial chemists develop **new and improved processes** focusing on:
  - Energy efficiency
  - Fewer production steps
  - Reduced environmental impact

## Major Contributions

- **Fertilizers & pesticides**: Increased agricultural yield manifold.
- **Food chemistry**: New methods to improve food quantity and quality.
- **Synthetic fibres**: Widely used in textiles and insulation.
- **Pharmaceutical industry**:
  - Development of medicines and drugs
  - Medicinal chemists design safer and more effective drugs.
- **Personal care products**:
  - Soaps, shampoos, cosmetics, skin and hair care products.
- Other important chemical industries:
  - Sulphuric acid
  - Paints and varnishes
  - Cement, glass, metallurgy
  - Petrochemicals
  - Ammonia and fertilizers
  - Food materials



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## Green Chemistry

- Focuses on **environment-friendly chemical processes**.
- Aims to:
  - Reduce pollution
  - Develop waste management and recycling methods
  - Produce biodegradable synthetic fibres
- Helps minimize the **environmental footprint** of chemical industries.

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# Raw Materials and Their Resources for Chemical Industry

Raw materials are obtained from different parts of the **environment**:

## 1. Atmosphere

Main components:

- Nitrogen
- Oxygen
- Hydrogen
- Carbon dioxide
- Noble gases

Uses:

- Nitrogen + Hydrogen → Ammonia → Urea fertilizer
- Nitrogen & Oxygen → Nitrogen oxides and nitric acid
- Oxygen → Steel industry and medical use

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## 2. Hydrosphere

- Ocean water contains dissolved minerals such as:
  - Sodium
  - Potassium
  - Magnesium
  - Calcium
  - Sulphates
  - Chlorides
  - Bromides
- These are extracted for manufacturing various chemicals.



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## 3. Biosphere

- **Plants** produce:
  - Cellulose (paper)
  - Starch and oils (food and chemical precursors)
  - Alkaloids, terpenes, resins
- **Biomass**:
  - Used to produce biogas, bioplastics and biochemicals
- **Microorganisms**:
  - Produce enzymes used as biocatalysts

- Important in fermentation and biotechnology
- Plant and animal materials are widely used in **medicinal chemistry**.

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## 4. Lithosphere

- Largest source of chemical raw materials.
- Resources vary by geographical region.
- Provides elements such as:
  - Oxygen, silicon, aluminium, iron, titanium, carbon
- Major raw materials:
  - Fossil fuels: petroleum, coal, natural gas
  - Mineral ores: iron, aluminium, sulphur, gold, chromium, uranium

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### Chemical Raw Materials in Pakistan

### Metallic and Mineral Resources

- **Iron ore**: ~1.427 billion tonnes
- **Chromite**: Pakistan is an exporter
- **Gold & copper**:
  - Large reserves in Baluchistan
  - Explored but mostly unexploited
- **Natural gas & coal**:
  - Found in Sui and Sandak
  - Coal reserves: ~185 billion tonnes (high sulphur content)
- **Gypsum**:
  - 5.5 billion tonnes
  - Mainly used in cement industry
- Other minerals:
  - Limestone
  - Rock salt
  - Marble
  - Granite

### Gemstones

- Northern and northeastern regions are rich in gemstones:
  - Aquamarine
  - Tourmaline
  - Peridot
  - Emerald
  - Ruby

  - Topaz
  - Zircon
  - Rhodochrosite
- Some gemstones serve as ores for precious metals.

## Important Chemical Processes

Chemical processes are large-scale methods used in industries to convert raw materials into useful products.

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### 1. Polymerization

- A modern chemical process.
- Small molecules called **monomers** join together to form long-chain molecules called **polymers**.
- Examples:
  - Ethene → Polyethene
  - Vinyl chloride → PVC
- Used in the manufacture of plastics, synthetic fibres, rubbers, etc.

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### 2. Calcination

- Process in which **limestone ($CaCO_3$)** is strongly heated.
- It decomposes into:
  - **Calcium oxide (CaO)** and
  - **Carbon dioxide ($CO_2$)**
- Reaction:
  $CaCO_3 \rightarrow CaO + CO_2$
- Used in cement and lime industries.

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### 3. Reforming

- Petroleum fractions are converted into more useful products.
- **Steam reforming**:
  - Produces hydrogen, ammonia and methanol.
- **Catalytic reforming**:
  - Hydrocarbons are heated with a catalyst.
  - Produces **high octane gasoline**.

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### 4. Smelting

- Metallic oxides are heated with **coke (carbon)**.
- Metal is obtained from its oxide.
- Example:
  - Iron extracted from iron oxide.
- Used in metallurgical industries.

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### 5. Hall–Héroult Process

- Industrial method for the extraction of **aluminium**.
- Aluminium oxide is electrolyzed in molten state.
- Produces pure aluminium metal.

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### 6. Bessemer Process

- Major process for the **manufacture of steel**.
- Impurities are removed from molten iron by blowing air.
- Produces steel on a large scale.

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### 7. Haber Process

- Nitrogen and hydrogen gases combine under:
  - High pressure
  - High temperature
  - Presence of catalyst
- Produces **ammonia ($NH_3$)**.
- Ammonia is used to manufacture **urea fertilizer**.

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### 8. Bosch Process

- Industrial method for producing **hydrogen gas**.
- Steam is passed over **red hot coke**.
- Hydrogen obtained is used in many chemical industries.

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### 9. Frasch Process

- Used for extraction of **sulphur** from deep underground.
- Superheated water is pumped to melt sulphur.
- Molten sulphur is brought to the surface.

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### 10. Down's Method

- Used to obtain **sodium metal**.
- Electrolysis of **molten sodium chloride (halite)**.
- Produces sodium metal on industrial scale.

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### 11. Solvay's Process

- Used to manufacture **sodium carbonate (soda ash)**.
- Important raw material for glass, soap and paper industries.

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### 12. Bergius Process

- Coal is converted into:
  - **Synthetic fuels**
  - **Lubricating oils**
- Important for countries with large coal reserves.

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### 13. Contact Process

- Industrial method for manufacturing **sulphuric acid**.
- Sulphur dioxide ($SO_2$) is oxidized to sulphur trioxide ($SO_3$).
- $SO_3$ is then converted into sulphuric acid.

## For More Information:

## Online and physical tuition is available

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