

- **T.Y.B.Sc. CBCS COURSE IN CHEMISTRY CH: 504 Industrial Chemistry**
  - **Core Course- (Semester I)**
    - **Chapter 1: General Aspects of Industrial Chemistry (L: 9, M: 12)**
- **A POWERPOINT PRESENTATION FOR T. Y. B. Sc. CBCS COURSE IN INDUSTRIAL CHEMISTRY ON THE TOPIC**

**ENTITLED**

**“General Aspects In Industrial Chemistry”**

**Online lecture no. -1**

**BY**

**Dr. R. K. Chaudhari**

Associate Professor, S.V.S.'s Dadasaheb Rawal College, Dondaicha.

Dondaicha. Dist- Dhule. (M. S.)

----- August 2020 -----

# “General Aspects In Industrial Chemistry”

**Introduction:** - In industrial chemistry, the focus will be placed on a holistic understanding of the relationship between natural resources, chemical transformation and waste generation for a sustainable insights derived from green chemistry and environmental chemistry.

**Definition of Industrial Chemistry:** - “Industrial chemistry is the branch of chemistry, which applies physical and chemical processes towards the transformation of raw materials into products that are of beneficial to society.”

**Or** “Industrial chemistry is the development, optimization and monitoring of basic chemical processes applied in industry for changing raw materials and precursors into helpful commercial products for society.”

**Scope of Industrial Chemistry:** -

1) **Role as a applied science.**

2) Social problem solver

3) Synthesizes crop enhancing agricultural chemicals to ensure a constant and viable food supply.

4) Helps in the eradication of deadly diseases.

5) Developing life-saving pharmaceuticals

6) Develop innovative plastics and synthetic fibres

7) Provides economically good quality of Industrial and consumer products.

# “General Aspects In Industrial Chemistry”

**Introduction:** - In industrial chemistry, the focus will be placed on a holistic understanding of the relationship between natural resources, chemical transformation and waste generation for a sustainable insights derived from green chemistry and environmental chemistry.

**Definition of Industrial Chemistry:** - “Industrial chemistry is the branch of chemistry, which applies physical and chemical processes towards the transformation of raw materials into products that are of beneficial to society.”

**Or** “Industrial chemistry is the development, optimization and monitoring of basic chemical processes applied in industry for changing raw materials and precursors into helpful commercial products for society.”

**Scope of Industrial Chemistry:** - Industrial chemistry plays an important role as an applied science in different areas that affect the society from environmental, economic to political stability.

Chemical industry is considered as a social problem solver, it synthesizes crop enhancing agricultural chemicals to ensure a constant and viable food supply helped in the eradication of deadly diseases by developing life-saving pharmaceuticals and chemical pesticides, develop innovative plastics and synthetic fibres for use in both industrial and consumer products.

It covers all industries ranging from large scale production of bulk chemical commodities

- 1) Studies the current economic and environmental effects .
- 2) Ozone depletion
- 3) Acid rain
- 4) Global warming and endocrine disrupting chemicals.
- 5) It is focused on emerging chemical technologies, based on green chemistry principles, water recycling and alternative fuels.

**Basic requirements of chemical industries: -**

- 1) **Chemical process selection, Design and operation: -**
- 2) **Chemical process economics: -**
- 3) **Material Balance:-**
- 4) **Plant Location: -**
- 5) **Construction of Plant:-**
- 6) **Research and Development: -**

It covers all industries ranging from large scale production of bulk chemical commodities, industrial gases, fertilizers, explosives, petrochemicals and polymers. Industrial chemistry also studies the current economic and environmental effects of expanding industrial activity including ozone depletion, acid rain, global warming and endocrine disrupting chemicals. It is focused on emerging chemical technologies, based on green chemistry principles, water recycling and alternative fuels.

### **Basic requirements of chemical industries: -**

**1) Chemical process selection, Design and operation:** - Adequate and flexible initial design is essential for the promotion of a chemical plant.

Automatic and instrument control chemical processes are essential. Instruments should not be selected simply to record the parameters of a process, but their function is to give consistent quality by sensing controls, recording and maintaining desired operating conditions.

**2) Chemical process economics:** - An objective of this step is that should be to deliver safely the best product or most efficient service at lower cost to the public.

**3) Material Balance:** - Yield and conversion are the chemical characteristics which form the basis for the material balances and are useful for the cost determination.

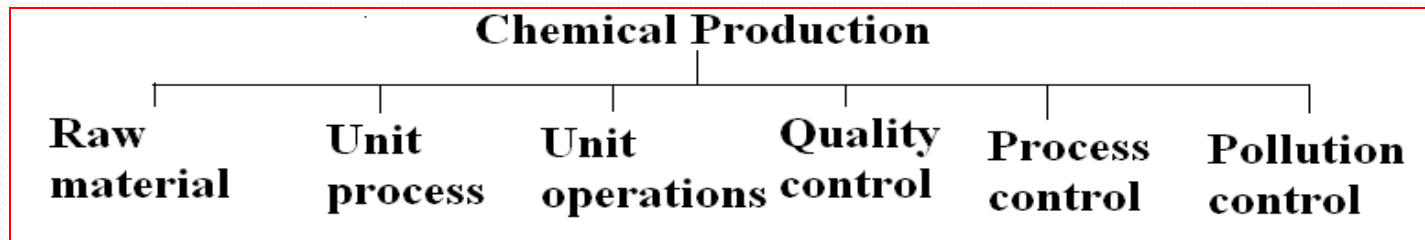
**4) Plant Location:** - The location of chemical plant is decided by the availability of raw materials, transportation, market and power (electricity). Now the environmental constituent's water supply, availability of efficient labor, cost of land and waste disposal facilities are also important criteria for the plant location.

**5) Construction of Plant:-** For small and large companies construction, engineering organizations are available that will build a plant and participate in its design.

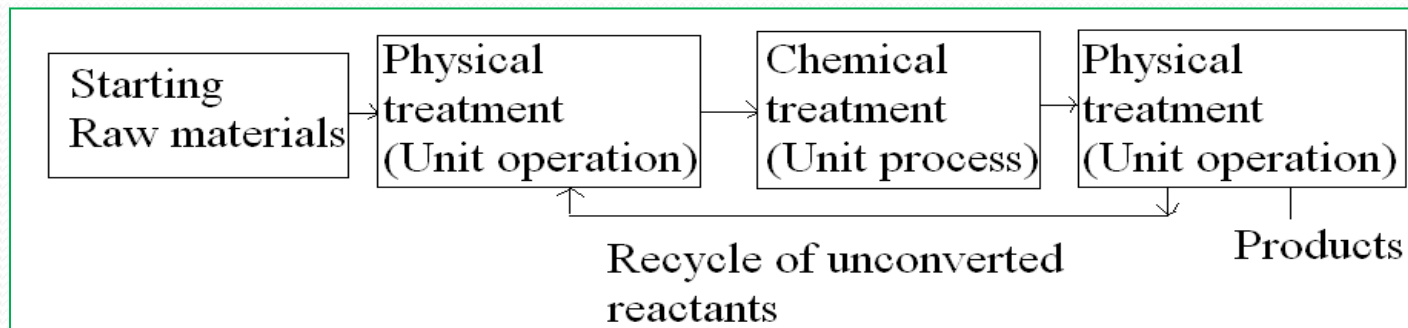
**6) Research and Development:** - Sufficient and skilled research with patent protection is necessary for future profits. One of the important challenges for industries is the rapidly changing processes, new raw materials and new markets. Research creates these changes and the factory will have a competitive progress. This research brings about development and the adoption of ideas, concepts; methodologies form the production of the industry. The results and benefits of research establish the developing country on the road of progress and raise the level of life of common man.

**Chemical production:** - A chemical process in which conversion of raw materials into finished products that passing through any single or combination of chemical and physical treatments is called chemical production. Manufacture of chemical products requires raw materials and it involves various operations and processes as follows:

**Chemical production:** - A chemical process in which conversion of raw materials into finished products that passing through any single or combination of chemical and physical treatments is called chemical production.



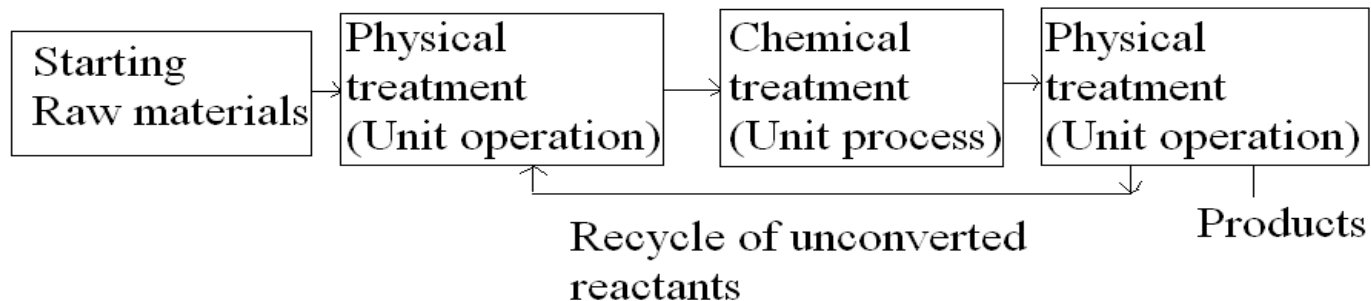
A typical chemical process is as follows:



## Chemical Production

**Raw material**      **Unit process**      **Unit operations**      **Quality control**      **Process control**      **Pollution control**

In order to get maximum yield, the chemical process is designed in a particular way. The raw materials are given physical treatment involving unit operations such as heat transfer, mixing, filtration, solvent extraction, etc. Then in a reactor, chemical treatment is given by which transformation occurs. The products are then further treated physically for the separation and purification in order to get a desired product. A typical chemical process is as follows:





**Raw Materials:** - “Raw materials are the basic materials from which goods and products are made.”

Or “It is the basic substance in its natural, modified or semi processed state, used as an input to a production process for subsequent modification or transformation into a finished good.”

There are two subcategories of raw materials; Direct and Indirect materials.

**Unit operations:** -“The operations which involve physical changes are known as unit operations.”

**Unit Process:** -“The processes which involve chemical changes are known as unit processes.”

**Raw Materials:** - “Raw materials are the basic materials from which goods and products are made.”

Or “It is the basic substance in its natural, modified or semi processed state, used as an input to a production process for subsequent modification or transformation into a finished good.”

Raw materials are generally natural resources such as oil, iron and wood.

There are two subcategories of raw materials; Direct and Indirect materials.

Direct raw materials are those which will be directly incorporated into the final product. E. g. The wood is used to build a table. While, Indirect raw materials are those which are consumed during the production process.

E. g. Crude oil is a feedstock raw material providing finished products in the fuel, plastic, chemical and pharmaceutical industries.

**Unit operations:** - “The operations which involve physical changes are known as unit operations.”

When raw materials are transformed into product, certain physical treatment is necessary before and after chemical process. The physical treatments may be distillation, fluid transformation, heat and mass transfer, evaporation, extraction, drying, crystallization, filtration, mixing, size separation, crushing and grinding, conveying, etc. i.e. Any chemical process cannot be effectively worked out without a suitable unit operations. Examples of unit operations are centrifuging, crushing, decanting, settling, pumping, etc.

Also during chemical processing, heating, cooling, stirring of reactants, transfer of reactants and intermediates to another reactor etc. are required. Even after completion of reaction, the product obtained is to be separated from byproducts or mother liquor.

**Unit Process:** - “The processes which involve chemical changes are known as unit processes.”

A unit process is one or more grouped operation in a manufacturing system that can be defined and separated from others. Such processes include



**Quality control:** - “It is a system of routine technical activities which measures and determines the quality level of products”.

Or “It is the integral part of the chemical production which involves the analysis or testing of the raw materials and the final products for their standard specifications.”

Quality control activities include use of approved standardized procedures for analysis to check the accuracy and quality. Different industries require different quality and purity of compounds. Terms such as technical grade, analytical grade, reagent grade, spectroscopic purity etc. are used to denote the degree of purity and quantity of the compounds. The use of sophisticated instruments, skilled labor and atomization can maintain the quality of the products. Melting point, boiling point, refractive index, colour, odour, tensile strength etc. are important properties use to check the quality.

**Quality Assurance:** - “Quality assurance is a complete system to assure the quality of products and services. It is not only a process, but a complete system including control also.” It is a way of management.

Quality assurance means an overall management plan to guarantee the integrity of data. Quality control unit check the quality of the product by using different analytical methods while quality assurance check the correct working of quality control unit. Overall quality control and quality assurance together is responsible for the quality and homogeneity of the product.

Quality assurance is the implementation of producers to ensure and document that the method continues to perform as required and is part of the responsibility of the quality assurance unit. It includes written documentation of validation of the method, procedure used etc. Method validation includes studies on selectivity, linearity, accuracy, precision, sensitivity, range, limit of detection and robustness of method an important aspect of applying it is to assure that it is working properly, once a method has been validated.

## Difference between Quality control and Quality assurance:

Quality control	Quality assurance
1) It is related to product.	1) It is related to process.
2) It is reactive	2) It is pro-active
3) It finds the defects.	3) It prevents the defects.
4) It is a line function	4) It is a staff function
5) Example: It walks through testing, Inspection, check point and review.	5) Example: Quality audit, defining process, selection of tools, trainings.

**Process control:** - “It refers to the methods that are used to control process variables during manufacturing of product.”

Manufacturers control the production process for three reasons: -

- 1) To reduce variability
- 2) To increase efficiency
- 3) To ensure safety.

The process control variables are temperature, pressure, flow rate, pH, humidity level, concentration, viscosity, conductivity, turbidity, redox potential, electrical behavior, flammability, etc.

e. g. Factors such as the proportion of one ingredient to another, the temperature of materials, how well the ingredients are mixed and the pressure under which the materials are held can significantly affect the quality of an end product.

The instruments used in chemical process should not be selected simply to record process variables but also their function is to assure consistent quality usually by sensing, controlling, recording and maintaining desired operating conditions in proper running order.

**Pollution control:** - “Pollution is the introduction of contaminants into the natural environment that causes adverse change.” Pollution control is a term used in environmental management. It means the control of emissions and effluents into air, water or soil.

Protection of environment is a serious problem today. Environment is affected by almost every chemical process industry. For protection of environment, two important laws have been made;

- 1) Water pollution law: -To ensure proper disposal of effluent by private industry, municipality and others.
- 2) Air pollution law: -To maintain the purity of air.

Pollution may be caused due to a) Natural reasons-e. g. Volcanic eruptions, forest fires, etc.

b) Man made reasons- e.g. Factors concerned with industrial, agricultural, commercial and domestic activities.



**Research and Development:** - “Discovering new knowledge about products, processes, services and then applying that knowledge and ideas to create new and improved products, processes and services that fit the market needs are called R and D.”

It is the systematic activity combining both basic and applied research which is aimed at discovering solutions to problems or creating new goods and knowledge. Research and development may result in ownership of intellectual property such as patents. Investing a good amount of capital into research and development often leads to future growth and improvement of processes.

Adequate and skilled research is necessary with patent protection for future profits. For industries, the outstanding characteristic is rapidly changing procedure with reference to raw materials and the research has to utilize these changes. Development is the adaption of research ideas to the reality of production. The benefits of research to the industries are;

- 1) New and improved processes are introduced.
- 2) It reduces the cost of products.
- 3) Stabilization of business and industrial employment.
- 4) Products of improved quality are obtained.
- 5) Freedom from domination by foreign control.
- 6) Change of rarities to common commercial supplies of practical usefulness.

**Human Resource:** - “It is the department within an organization that deals with the people who works for that organization.”

Or “It is the company department charged finding, screening, recruiting and training job applicants as well as administering employee benefit programmes.”

The human resource department of an industry may set strategies and development policies and standards for companies. Their role is-

- 1) Effective managing and utilizing people.
- 2) Trying performance appraisal and compensation to competencies.
- 3) Developing competencies that enhance individual and organizational performance.
- 4) Increasing the innovation, creativity and flexibility necessary to enhance competitiveness.
- 5) Applying new approaches to work process design, succession planning career development and liberty.
- 6) Managing the implementation and integration of technology through improved staffing, training and communication with employees.

**Safety Measures:** - “These are activities and precautions taken to improve safety i.e. reduce risk related to human health.”

Safety of industry people working in industry, environment around the industry are crucial things. Many chemical reactions are difficult to monitor. Loss of control over a chemical reaction may create explosion or hazardous situation. Carelessness many times leads to an accident, loss of human being, material, machinery and environment may occur under all such critical situations. Appropriate safety measures must be made and inspected from time to time.

Safety procedures are available across all industries and for all types of equipment and processes. Procedures that are easy to understand and easy to use can significantly help to manage the safety of workplace. Insurances are compulsory for workers in industries.

Chemical industries are always threatened by hazards like fire or production of toxic materials, etc. Following safety precautions must be taken:

- 1) While designing and erecting a chemical plant, adequate measures have to be taken.
- 2) Prevention of fire and maintaining fire fighting efficiently must be made compulsory.
- 3) The person have to educate about and made aware of the possible hazards and toxic chemicals.

4) Regular checkup and maintenance of equipments should be done to avoid leakages in pipes, vessels, etc.

5) Gas masks, gloves must be provided to the persons handling carcinogenic chemicals.

6) If waste products contain any toxic material, they must be properly treated before disposal.

**Classification of chemical reactions:** - Chemical reactions can be classified in number of ways:-

1) Depending on phase: - Homogeneous and heterogeneous.

2) Use of catalyst: -Catalytic and non-catalytic.

3) Depending on electron transfer: - Oxidation and reduction.

There are four major types of reactions:-

1) Combination or synthesis reactions:- Two or more reactants combine to form a single product.



e.g.  $C + O_2 \rightarrow CO_2$ , or  $S + O_2 \rightarrow SO_2$

2) Decomposition reactions: A single reactant is broken down into two or more products.



e. g.  $CaCO_3 \rightarrow CaO + CO_2$

3) Substitution or single replacement reactions:- A single free element replaces one of the element in a compound. The free element is more reactive than than the one it replaces.



e. g.  $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

4) Double displacement or Metathesis: - “Exchange of partners”



e.g.  $HCl + NaOH \rightarrow NaCl + H_2O$

## **Batch and Continuous process: -**

**Batch Process:** - It is a single or multistage process in which certain quantities of inputs are added into the chemical reaction unit under conditions suitable for obtaining the desired reaction. At the end of process, mixture is removed from reactor and then undergoes appropriate separation and different processing stages.

**Continuous Process:** - The process in which inputs are added into the system at a constant rate and in definite ratios and at the same time a constant extraction of outputs (products, byproducts, energy, etc.) is obtained.

## Distinguish between Batch and Continuous Process:-

- |  |   |
|--|---|
| <p>1) The raw materials are added in one lot and the products are removed after some time.</p> <p>2) The apparatus is idle during charging and discharging.</p> <p>3) Charging and discharging operations requires more manual labour.</p> <p>4) Temperature, pressure, concentration, etc. may not remain constant in all batches.</p> <p>5) The rate of reaction does not remain constant during entire process.</p> | <p>1) The raw materials are added continuously and the products are removed simultaneously.</p> <p>2) The apparatus is never idle.</p> <p>3) Charging and discharging operations are easier and requires less manual labour.</p> <p>4) These remains constant throughout the reaction process.</p> <p>5) Due to full automation, rate of reaction remains constant.</p> |
|--|---|

6) It requires more energy due to alternate heating and cooling.

7) Quality control is difficult.

8) Production cost is high.

9) Useful for small scale production.

10) They require much smaller and less expensive equipments.

11) It is less profitable.

12) Less product per man hour is obtained.

13) Quality of product is inferior, and may change from batch to batch.

6) It requires less energy as waste heat is immediately used for preheating the raw material.

7) High quality control is obtained.

8) Production cost is low.

9) Useful for large scale production.

10) They require good quality, bigger and more expensive equipments.

11) It is more profitable.

12) More products per man hour are obtained.

13) Quality of product is superior and uniform.

**Conversion, Selectivity and Yield:** - These are the important mathematical parameters for characterizing a chemical reaction.

**Conversion:** - “It is the amount of reactant chemically converted into the product.” It is expressed as a % conversion which can be differing by changing reaction conditions. Generally, all the variables are optimized to effect maximum conversion.

**Selectivity:** - “It indicates how much desired product was formed in ratio to the undesired product.” It indicates the formation of a particular product from the given reactant. Sometimes, reactants may interact with each other differently,

e. g.  $\text{NH}_3 + \text{O}_2 \rightarrow \text{NO}, \text{NO}_2, \text{or } \text{N}_2$

By applying proper reaction conditions any one of these products can be selectively obtained. Selectivity increases the yield of desired product.

**Yield:** - It refers to the amount of product formed in the reaction.” It is expressed in %. It is related to the conversion and selectivity. Greater is the % conversion, more is the yield of product. i. e.

**Yield = Conversion x Selectivity/100**

**Economic and Technical Feasibility:-** The primary objective of the engineers efforts should be to deliver safely the best products or the most efficient services at the lowest cost to the employer and the consuming public.

“The economic and technical feasibility study is an evaluation and analysis of the potential of a proposed project which is based on extensive investigation and research to support the process of decision making.”



**Copyright act:** - “It is a legal right created by the law of country that grants the creator of original work exclusive rights to its use and distribution, usually for a limited time with the intension of enabling the creator to receive compensation for their intellectual effort.”

Or “It is the ownership of an intellectual property within the limits, prescribed by a particular nations or international law.”

**Patent act:** - “A patent is a legal monopoly granted for a limited period of time to the owner of an invention.”

It empowers the owner of an invention to prevent others from manufacturing, using, importing or selling the patented invention.

Invention may either for a product or process. The rights enjoyed by owner of the patent are proprietary in nature and the patentee or his agent or licensees has the exclusive right to use and have the benefits of patented invention and prevent unauthorized use, during the period of patent protection. Period during which the owner enjoys the benefits is called term of the patent. Registration is essential for patent protection and the protection granted is territorial in nature. i. e. Patent granted in a country will give the owner of the patent right only within that country.

**Trade Marks:** - “It is a mark capable of being represented graphically and which is capable of distinguishing the goods or services of one person from others and may include shape of goods, their packing and combination of colours.”

Or “It is a recognizable sign, design or expression which identifies products or services from those of others.”

The trade mark owner can be an individual, business organization or any legal entity. A trade mark may be located on a package, a label, a voucher or on the product itself. The trade mark is designated by following symbols:- TM\_ is used an unregistered trade mark, while ® is used an registered trade mark. Similarly, ISI, TFM, FPO, Agmark, Eco mark, Hall mark, Dark green circle and dark red circle in black square, etc.

**Barcodes:-** A **barcode** is a method of representing data in a visual, machine-readable form. Initially, barcodes represented data by varying the widths and spacing’s of parallel lines. These barcodes, now commonly referred to as linear or one-dimensional (1D), can be scanned by special optical scanners, called barcode readers. Later, two-dimensional (2D) variants were developed, using rectangles, dots, hexagons and other geometric patterns, called *matrix codes* or *2D barcodes*, although they do not use bars as such. 2D barcodes can be read or deconstructed using application software on mobile devices with inbuilt cameras, such as smartphones. These barcodes are in the UPC-A code format. It is 12 digit long and the UPC number itself is reflected to as the GTIN (Global trade item number). The GTIN is made up of two parts. The UPC company prefix and the number that you have assigned to that unique product. The first 6-10 digits identify the company. The last two digits identify

**Thank You.**

**STAY HOME,  
STAY SAFE**



<https://classroom.google.com/c/MTI2NDE5NTYxODA1?cjc=4kcw2nk>