Introduction to Chemical Engineering

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Objectives

- Understand the background of chemical engineering field;
- Grasping the impact of chemical engineering in industrial development;
- Explaining the concept of unit operations;
- Familiarization of the role of chemical engineers;
- Appreciate the ten major achievements in chemical engineering .

What is chemical engineering

"Chemical engineers" use math, physical sciences (physics, chemistry), life sciences (biology, microbiology and bio-chemistry), and economics to solve practical problems (convert raw materials into useful products). The difference between chemical engineers and other types of engineers is that they apply a knowledge of chemistry in addition to other engineering disciplines. Chemical engineers may be called "universal engineers" because their scientific and technical mastery is so extensive.

Chemical engineering focusing on transport and transformation of materials at molecular level, often accompanied with, and sometimes for the purpose of energy transport and transformation.

What chemical engineering can make?











What chemical engineering can build?

Basis of Chemical Engineering

The foundation of Chemical engineering is based on

- Physical, Organic, and Inorganic chemistry
- Thermodynamics
- Chemical kinetics
- Momentum, heat & mass transfer

Just like an electrician is not an electrical engineer, a chemist is not a chemical engineer.

Field of operation

History of Chemical Engineering

ChE Principles:

1805 **-** John Dalton published Atomic Weights, allowing chemical equations to be balanced and the basis for chemical engineering ***mass balances***.

1824 **-** Sadi Carnot was the first to study the ***thermodynamics*** of combustion reactions.

1850 **-** Rudolf Clausius applied the principles developed by Carnot to ***chemical systems*** at the atomic to molecular scale.

History of Chemical Engineering

ChE Principles:

1873 to 1876 **-** Josiah Willard Gibbs developed a ***mathematical-based***, graphical methodology, for the study of chemical systems using the thermodynamics of Clausius.

1882 **-** Hermann von Helmholtz showed that measure of chemical affinity is determined by the measure of the free energy of the ***reaction process***.

1883 **-** Osborne Reynolds defines the dimensionless group for ***fluid flow***, leading to practical scale-up and understanding of flow, ***heat and mass transfer***

History of Chemical Engineering

ChE Education:

1882 – a course in "Chemical Technology" is offered at University College London.

1885 –a course in "chemical engineering" is offered at Central College (later Imperial College), London.

1888 –a new curriculum at Massachusetts Institute of Technology (MIT) started: Course X, Chemical Engineering.

History of Chemical Engineering

ChE Institutes:

1908 – the American Institute of Chemical Engineers (AIChE) is founded.

1922 – the UK Institution of Chemical Engineers (IChemE) is founded.

1996 – the Thailand Institute of Chemical Engineering and Applied Chemistry (TiChE) is founded.

Chemical process industry

An industry in which the raw materials undergo chemical conversion during their processing into finished products, as well as (or instead of) the physical conversions

Systematic analysis of chemical process-

- Mass and energy balances
- Thermodynamics and kinetics
- Unit operations and chemical reactors
- Instrumentation and control
- Economics

Unit processes & Unit operations

- **Unit processes** are the chemical transformations or conversions that are performed in a process. For example; smelting, reduction, calcination, dehydrogenation, electrolysis etc.
- **Unit operation** is defined as a process which does not involve any chemical reaction i.e.,. separation, crystallization, evaporation, filtration, polymerization, isomerization etc. Unit operations only deal with physical changes of the materials involved in the process.

What does chemical engineer do?

- **Research**
  - Fundamental, exploratory, and process research
- **Process development**
  - Planning the development program
  - Designing and building the pilot plant
  - Operation of the pilot plant
  - Correlation, presentation, and evaluation of the data from the pilot plant.

What does chemical engineer do?

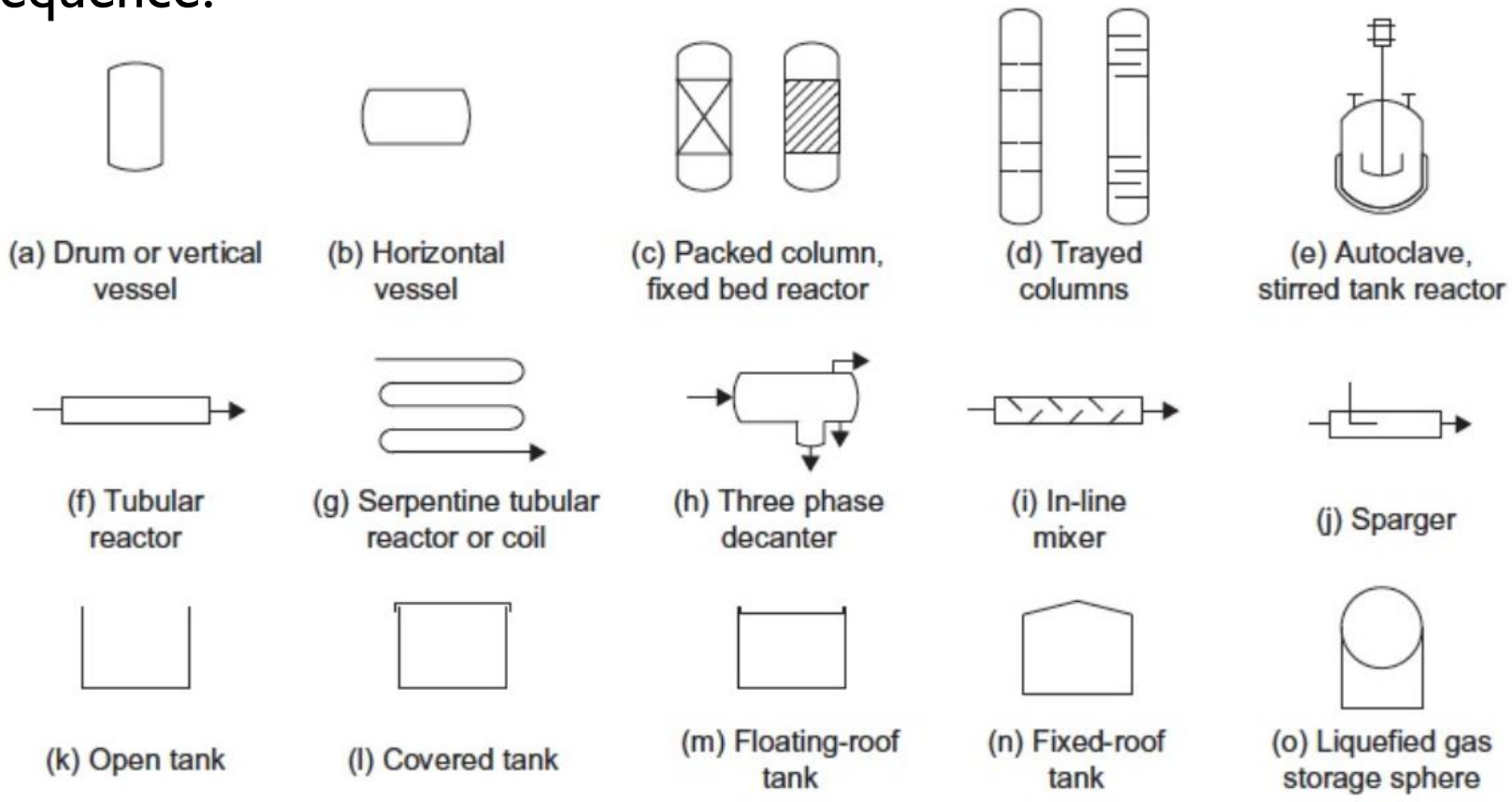
- **Process design and evaluation (major steps)**
  - Process flow sheet showing all pieces of equipment, instrumentation, and control and the operating pressures, temperatures, and flow rates.
  - Mass balances on the overall process and on each unit in the process showing yields of the products and purity of all stream in the process
  - Energy balances for all units in the process, including heat-exchanger requirements.
  - Specification of pump capacities, flow, and pressure requirements.
  - Specification of size and configuration of chemical reactors and storage tanks.
  - Determination of optimum operating conditions for the mass transfer operations required for the separation and purification of the raw materials and products.
  - Estimation of utility requirements, such as steam, water, electricity, and fuel.
  - Economic evaluation with an estimate of capital investment and operating costs.

What does chemical engineer do?

- Plant design
  - Include chemical, mechanical, electrical, and civil engineers.
- Construction
- Product supervision
- Plant technical service
- Product sales

Process flow diagram

A Flow Chart (also known as a Process Flow Diagram or Process Map) is a diagram of the steps in a process and their sequence.



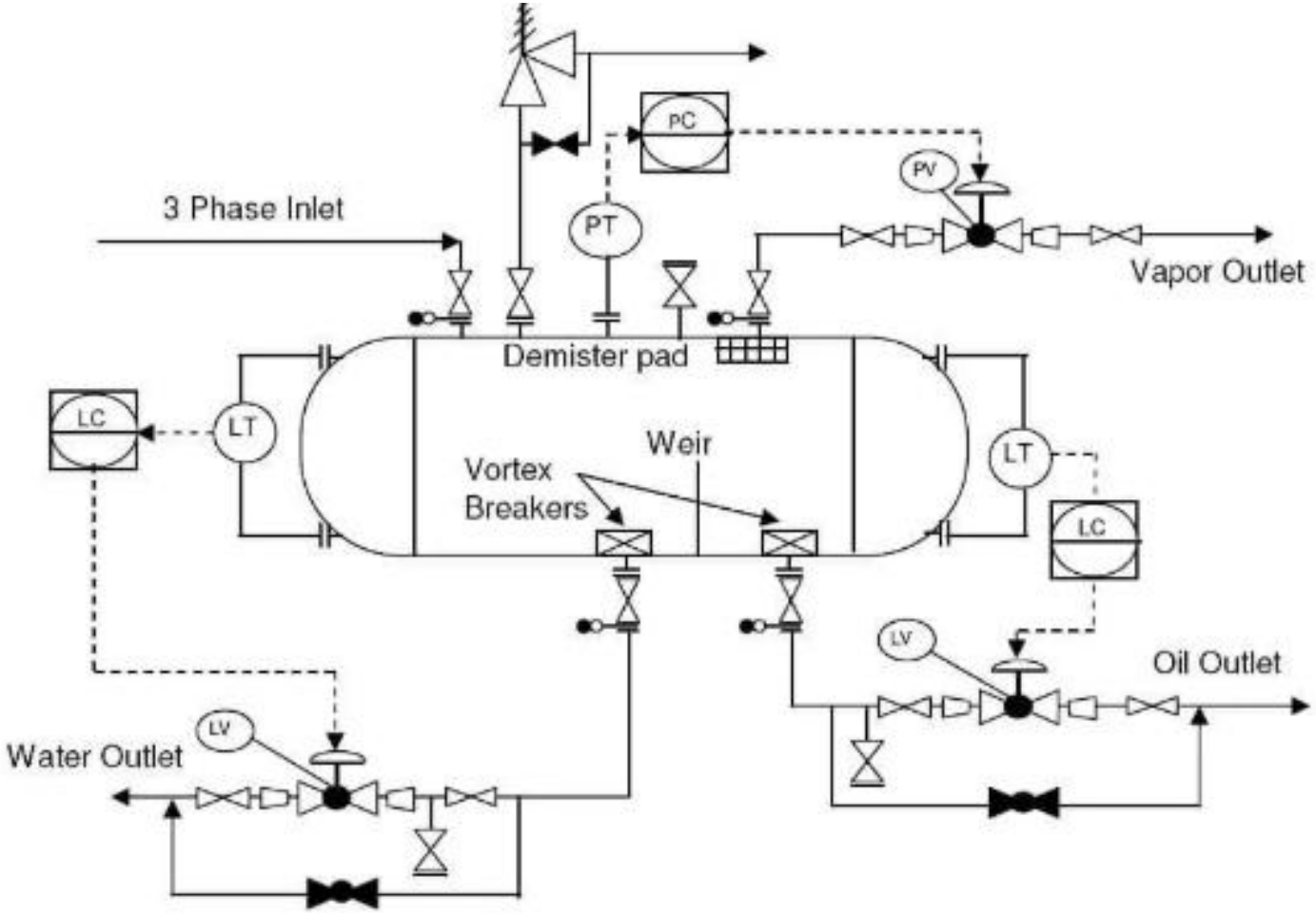
Various symbols for reactors, vessels and tanks

Diagrams Used

A diagram is a simple drawing or visual representation that explains how something works or the relationships between parts of a whole. Diagrams are used as visual aids to make complex ideas easier to understand, showing concepts, processes, or structures through lines, shapes, and symbols.

A Piping and Instrumentation Diagram (P&ID) is a detailed schematic that illustrates the functional relationship between all the piping, equipment, and instrumentation in a process plant. It serves as a critical tool for engineers and operators during the design, operation, and maintenance of industrial facilities, showing how the system's components are interconnected and controlled.

Piping and instrumentation diagram



Symbols for P& I diagram

Symbols for pipelines

01. 1.4 mm
Main process lines

02. 0.7 mm
Feed & Final product line

03. 0,35 mm
Utility line

04. 0,25 mm
Auxiliary line

05.
Jacketed pipe

06.
Flow direction

07.
Insulated pipe

08.
Hose pipe

09.
Pipeline crossing

10.
Pipeline junction

11.
Flanged & bolted connection

12.
Line blind

13.
Concentric reducer

Symbols for valves & fittings

01.
Gate valve
(Normally open)

02.
Gate valve
(Normally closed)

03. 
Hand control valve

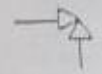
04. 
Safety valve

21. 
Swage reducer

05. 
Glove valve

06. 
Ball valve

22. 
Eccentric reducer

07. 
Angle valve

08. 
Butterfly valve

23. 
Concentric reduc

09. 
Diaphragm valve

10. 
Check valve

24. 
90° Elbow

11. 
Solenoid valve

12. 

three-way valve

25. 
45° Elbow / Bend

13. 
Four-way valve

14. 
Steam trap

15. 
Liquid separator

16. 
Strainer

26. 
Tee

17. 
Open funnel

18. 
Vent

27. 
Cross

19. 
sight glass

20. 
Level gauge

28. 

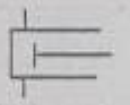
Symbols for equipment

01. 

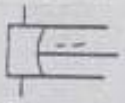
Pump (General)

02. 

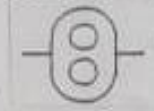
Centrifugal pump

03. 

Reciprocating pump (Plunger pump)

04. 

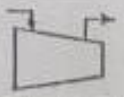
Diaphragm pump

05. 

Gear pump

06. 

Screw pump

07. 

Centrifugal compressor

08. 

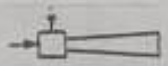
Turbine

09. 

Reciprocating compressor

10. 

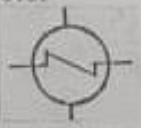
Fan

11. 

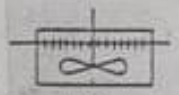
Ejector

12. 

Agitator

13. 

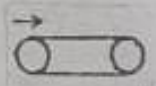
Heat exchanger (General)

14. 

Air cooler

15. 

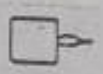
Bucket elevator

16. 

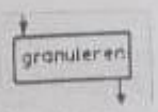
Conveyor belt

17. 

Rotary drum drier

18. 

Burner

19. 

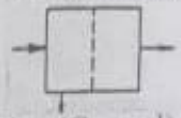
Granulator

20.

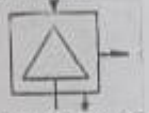
Furnace with burner

21. 

Separator

22. 

Filter (General)

23. 

Centrifuge (General)

24. 

Cyclone

25. 

Screen

26. 

Vessel

27. 

Tank

28. 

Column with packing

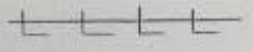
Symbols for Instruments

01. 

Pneumatic signal line

02.

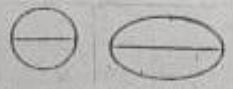
Electric signal line

03. 

Hydraulic signal line

04. 

Locally mounted

05. 

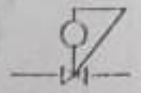
Instrument mounted on main board

06. 

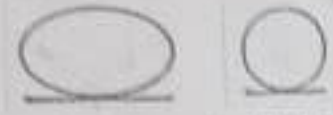
Instrument mounted on auxilia

07. 

Pneumatic control valve

08. 

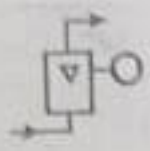
Pressure regulator

09. 

Instrument mounted behind main board

10. 

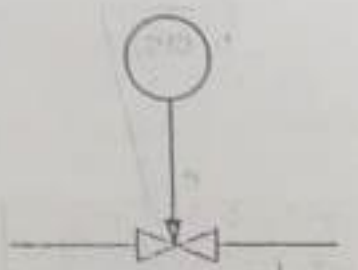
Flowmeter (General)

11. 

Float-operated flpwmeter

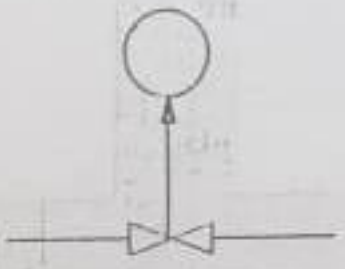
12. 

Orifice plate

13. 

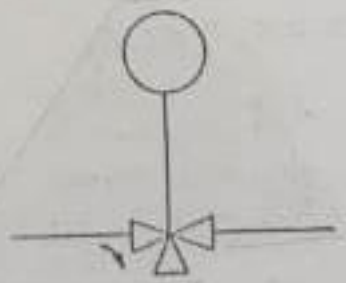
Two-way control valve

closed on failure of actuating energy

14. 

Two-way control valve

opens on failure of actuating energy

15. 

Three-way control valve.

Arrow indicates direction in which it opens on failure of actuating energy

General aspects of chemical engineering

- Communications
- Human relations
- Professional activities
- Technical reading

TOP 10 Chemical Engineering Contribution to Society

- Fueling the world's economies
- Creating cleaner energy
- Products for growing populations
- Removing harmful sulfur from fuels
- Better living through chemistry
- Stretching natural resources
- Large scale production engineering
- Convenient & abundant food
- Healing diseases & extending life
- Powering the personal computer

Jobs Opportunity for ChE