

Computer Aided Process Plant Design

Introduction

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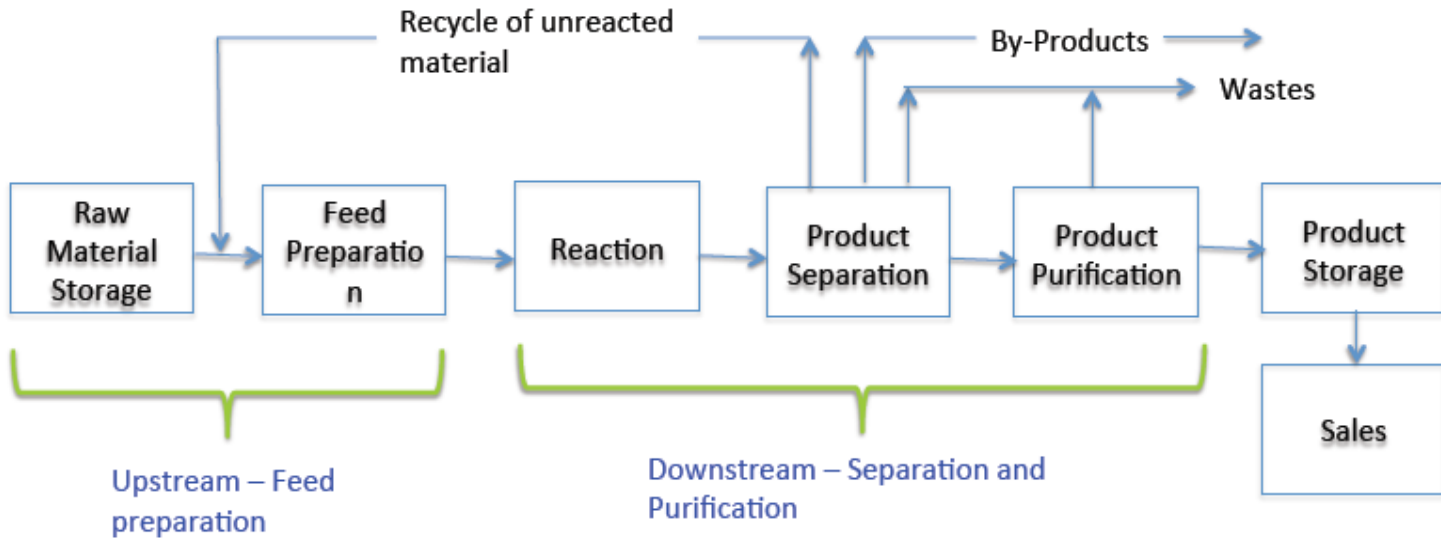


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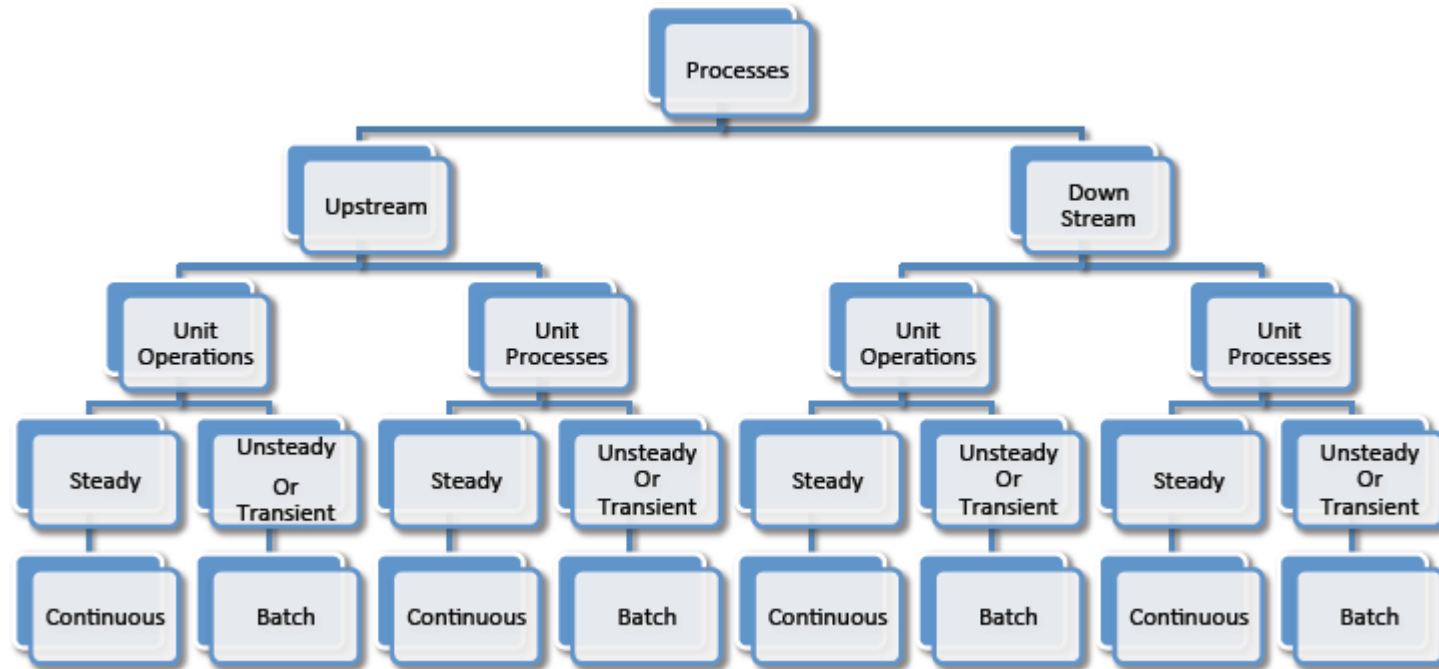
- 1 Anatomy of Chemical Production
- 2 Classification of Processes
- 3 Flow Diagrams
- 4 Professional Competency

1. Anatomy of Chemical Production Process

Schematic representation



2. Process Classification



Process

Dictionary meaning

A process is one or **series of actions** or operations or **treatments** that results in an end [Product].

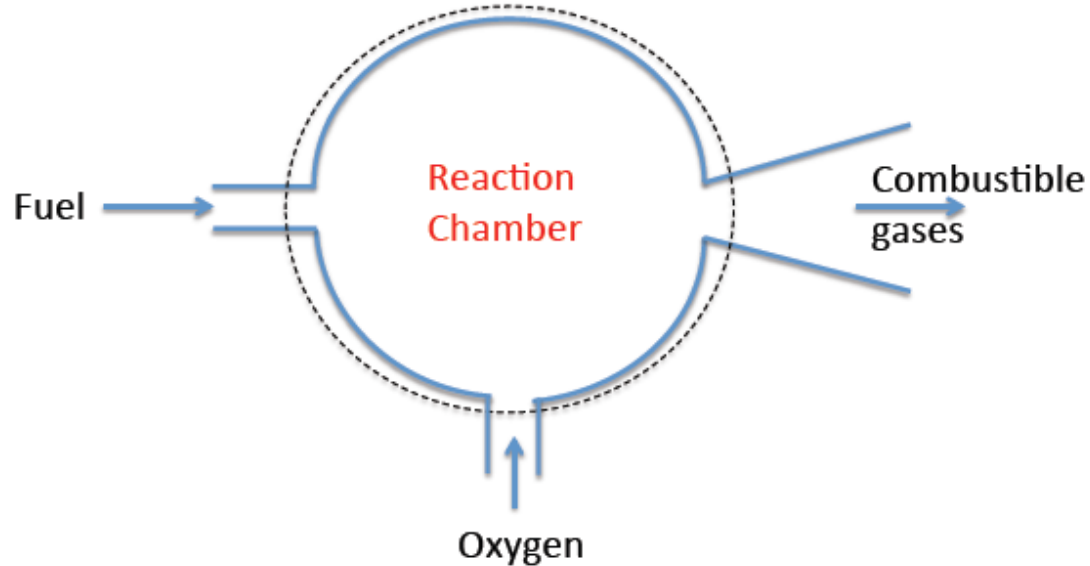
Working definition

In Chemical Engineering , the term process focus on operations such as chemical reactions, fluid transport, size reduction and enlargement, heat generation and transport, distillation, gas absorption, bioreactors and so on that cause **physical and chemical change** in materials.

System

Any **arbitrary portion** or whole of process **set out specifically for analysis**.

In other words, the system is the one where **we focus our attention**.



Upstream Process

The process that are employed in petrochemical, chemical and biochemical industries where the raw materials are processed.

The various process that are covered till the separation and purification of raw materials are called upstream process or **feed preparation** process in the above mention process industries.

Downstream Process

The process by which **separation and purification** of products from raw materials takes place.

Unit Operations

Unit operations is the one or series of operations in which only **physical changes** are studied with the combination of science and engineering principles. e.g **Distillation, Evaporation, Drying and so on.**

Unit Processes

Unit process is the one or series of operations in which **chemical changes** are studied with the combination of science and engineering principles. e.g. **Alkylation, Hydrogenation, Esterification and so on.**

Batch Process

Batch processes are designed to operate **intermittently (or periodically)**.
Some or all, the process units being frequently **shut down and start up**.

Batch processes are used where **some flexibility** is wanted in production rate or product specification.

Continuous Process

Continuous process are designed to operate 24 hours a day, 7 days a week, throughout the year. Some downtime (Shut down and Start up) will be allowed for maintenance and for some processes, catalyst regeneration.

The plant attainment, that is, the percentage of available hours in a year that the plant operates, will be usually 90 to 95%.

$$\text{Attainment, \%} = (\text{hours operated}) / (8720 \text{ days}) \times 100$$

Continuous processes will be more economical for large scale production.

Steady-state process

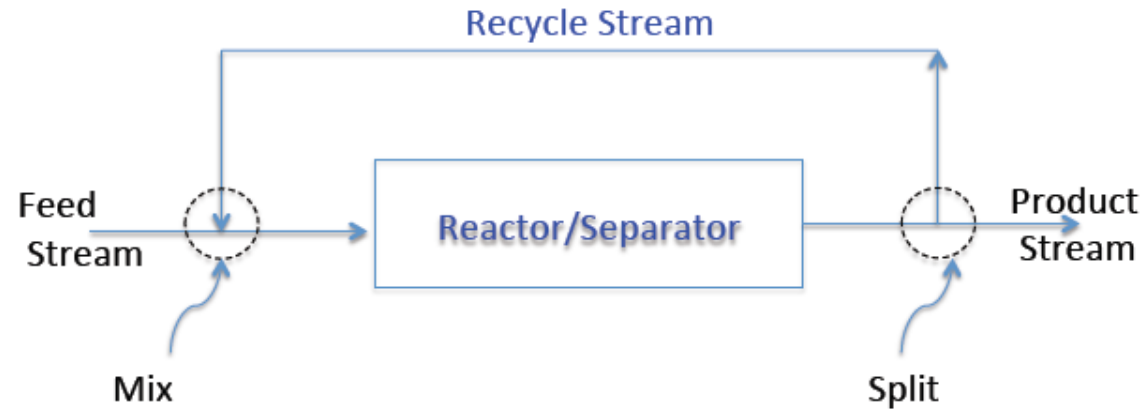
Steady-state process is one, where the **parameters** such as temperature, pressure, and concentration remains **unchanged with time**.

Unsteady-state (or transient) process

Unsteady-state process is one, where the **parameters** such as temperature, pressure, and concentration **changes with time**.

Recycle stream

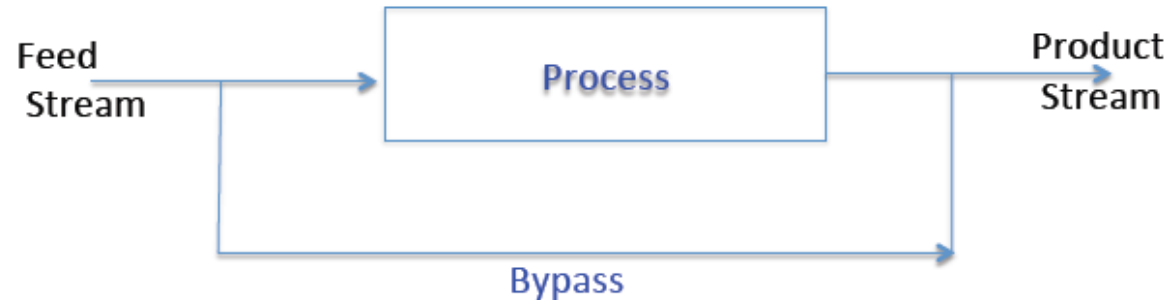
A common recycle stream structure is the reactor/separators, which is used to recover unreacted material.



By pass stream

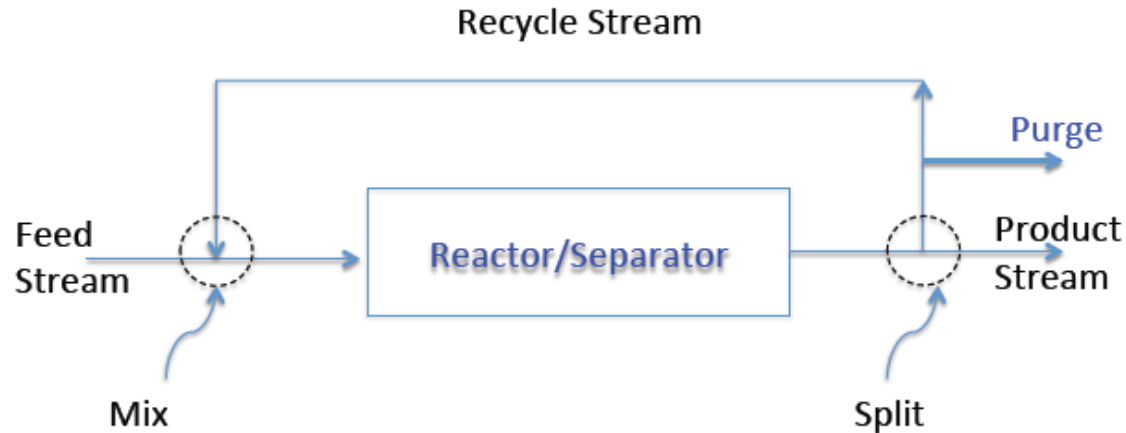
By pass operation is the one in which one or more steps in the production process is skipped off.

Most often this kind of streams are used for maintenance and or service of equipment in continuous production process.



Purge

When a process uses a recycled loop, there often can be **build up of some undesired material** inside the system. By using a purge a fraction of the recycle loop material or **accumulated undesired materials** can be removed.



Process Diagram

Representation of flow of various streams in the production processes and they are grouped as follows,

1. Block Diagram
2. Process Flow Diagram (PFD)
3. Process and Instrumentation Diagram (P and I D's)

1. Block Diagram

A block diagram is the **simplest form of presentation**.

Each block can represent a **single piece of equipment** or complete stage in process.

Block diagrams are useful for representing a process in a simplified form in reports and text books, but only have **limited use in as engineering documents**.

2. Process Flow Diagram (PFD)

A process flow diagram is one in which all incoming and out going materials and utilities are shown .

Process flow diagrams includes ,

- a. **Arrangement** of major pieces of equipment's and their interconnections.
- b. **Operating conditions** of each streams, such as temperature pressure and composition.
- c. **Heat added or removed** in a particular equipment .
- d. **Any specific information** which is useful in understanding the process.

3. Piping and Instrumentation Diagram (P & I D's)

Piping and instrumentation diagram shows the engineering details of the equipment, instruments, piping, valves and fittings; and their arrangement.

P & I diagram also shows the arrangement of the process equipment, piping, pumps, instruments, valves, control loop and other fittings.

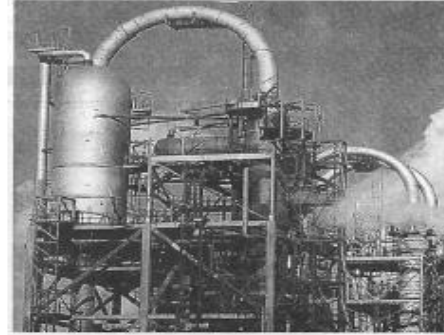
For simple process, the utility (service) lines can be shown on the P & I diagram. For Complete process, separate diagrams should be used to show the service line.

3. Flow Diagram

Schematic representation of equipment that are used in flow diagrams



Polyethylene reactor; this 16-in inner-diameter reactor is designed to operate at 35,000 psi and 600°F; in operation, this reactor is in a vertical configuration. Courtesy of Autoclave Engineers, Division of Snap-lite, Inc.



Schematic representation of equipment that are used in flow diagrams

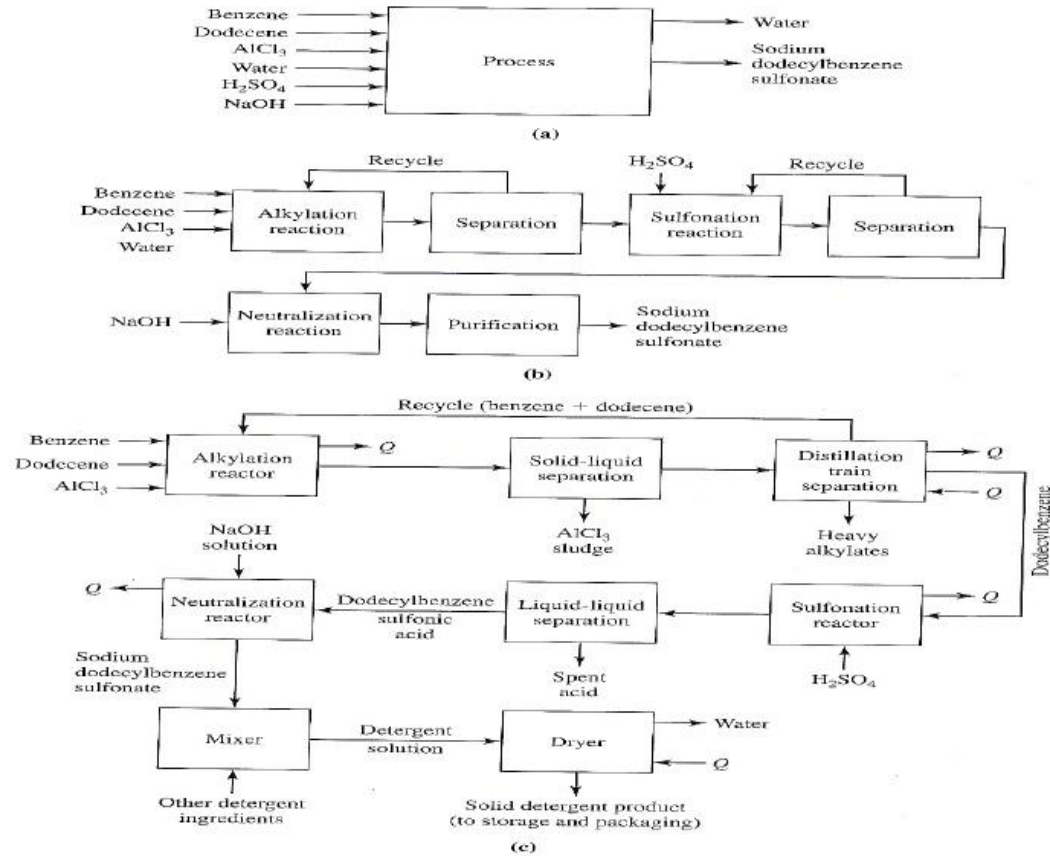
British Standard, [BS1553](#) “Graphical symbols for general engineering”

American National Standard Institute, [ANSI](#)

German Standard, [DIN 28004](#)

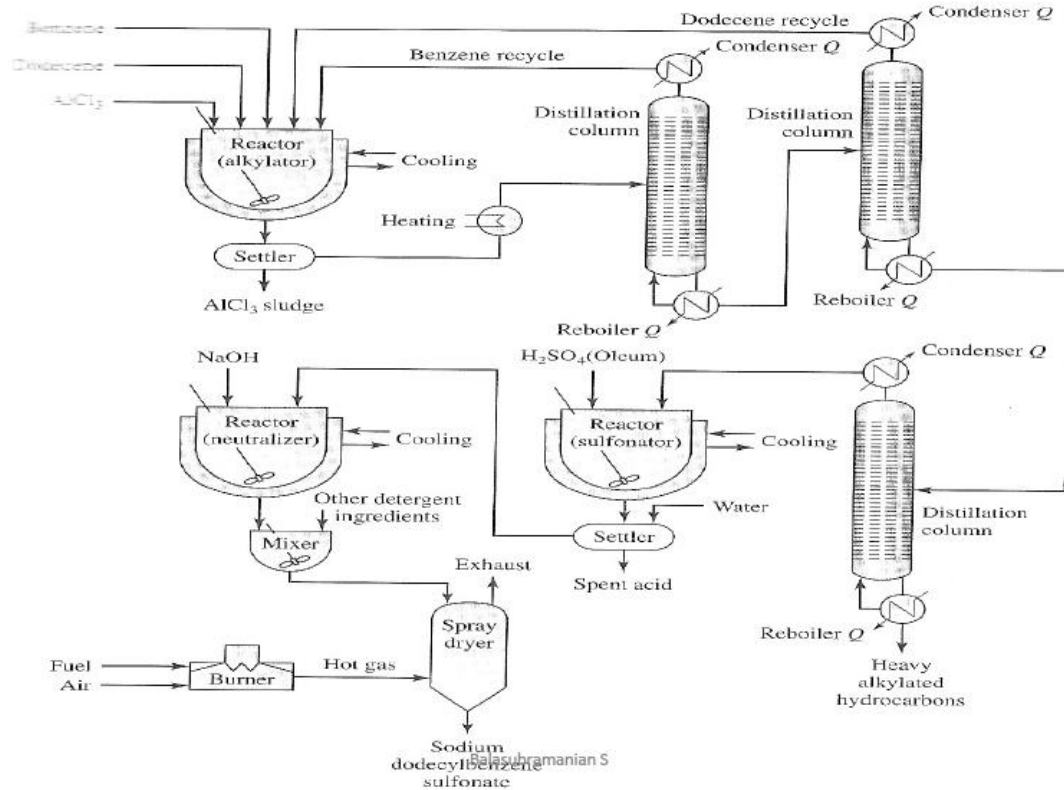
Block diagram - Sodium dodecyl benzene

3. Flow Diagram

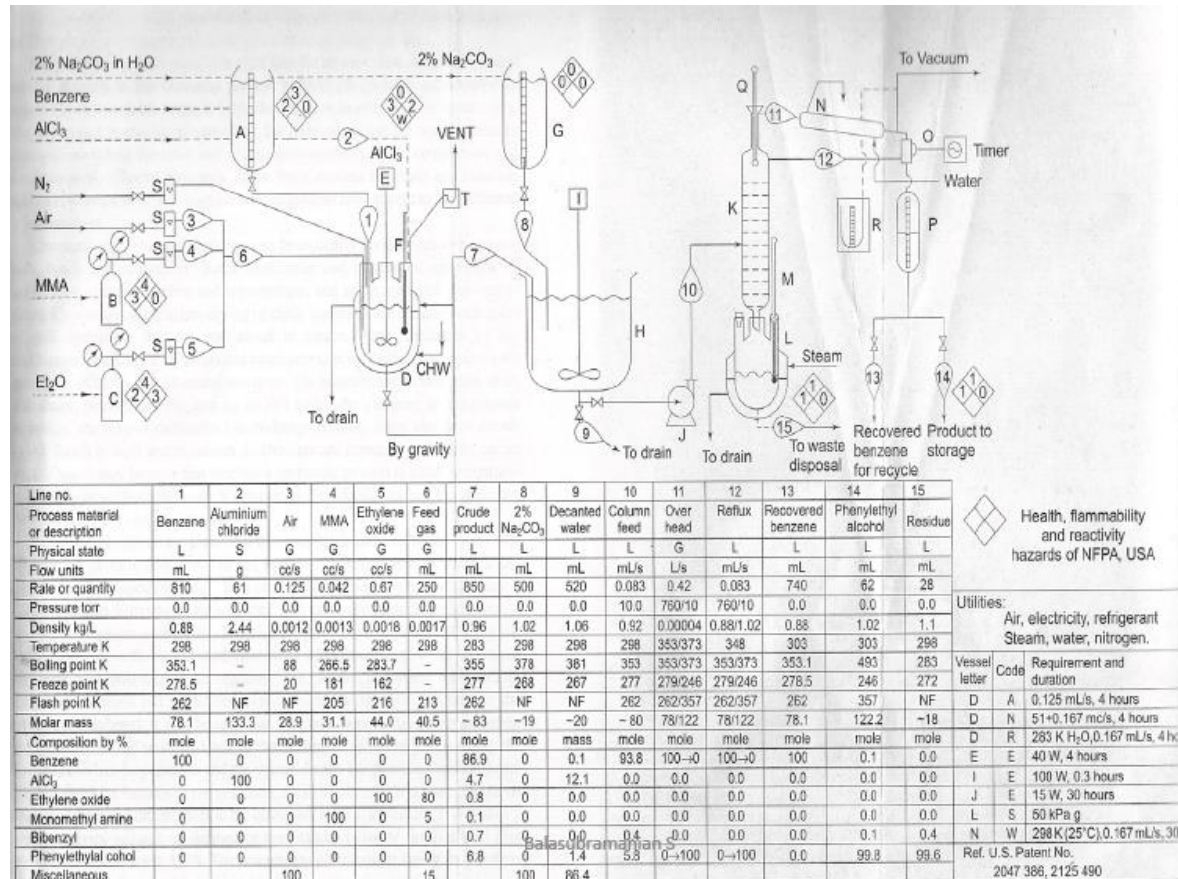


Process flow diagram - Sodium dodecyl benzene

3. Flow Diagram

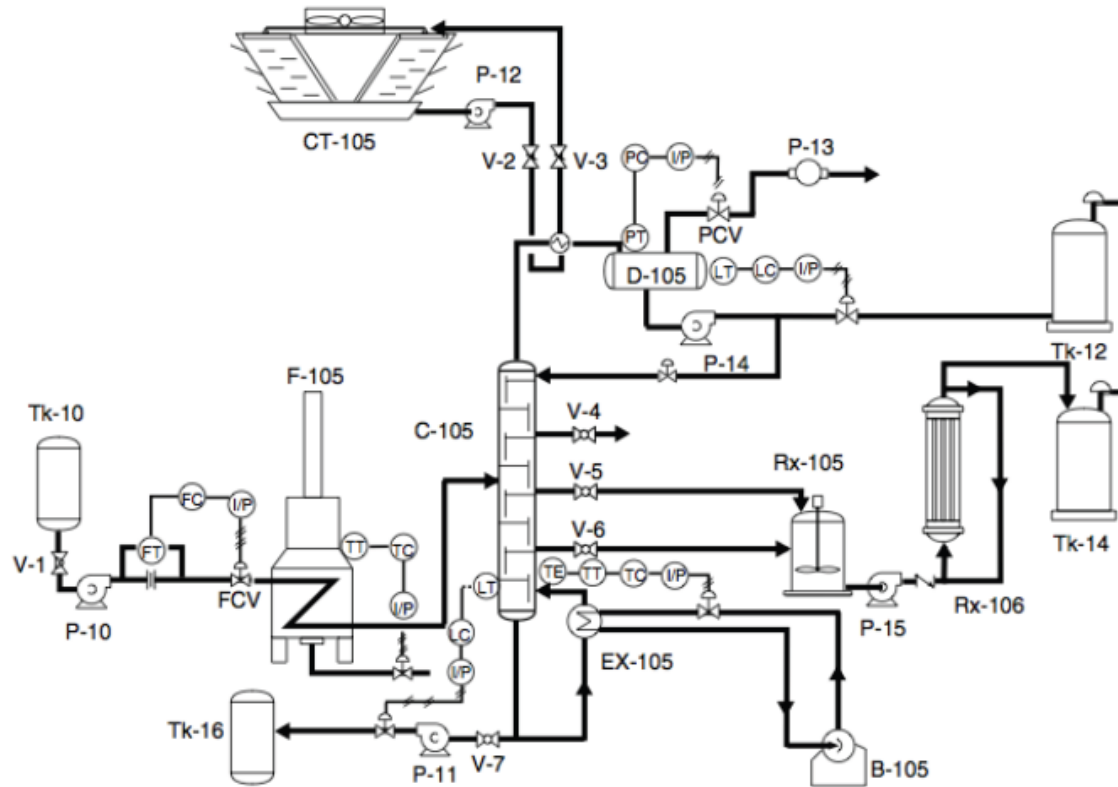


3. Flow Diagram



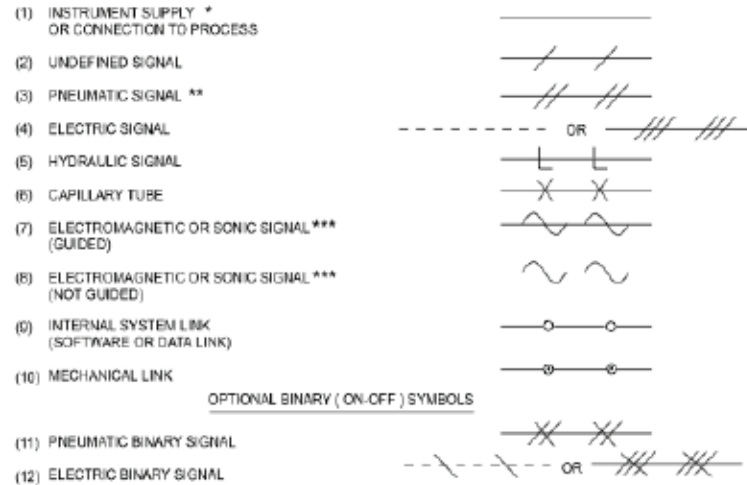
Piping and Instrumentation Diagram (P & I D's)

3. Flow Diagram





3. Flow Diagram



NOTE: *OR* means user's choice. Consistency is recommended.

* The following abbreviations are suggested to denote the types of power supply. These designations may also be applied to purge fluid supplies.

AS - Air Supply	} Options	HS - Hydraulic Supply
IA - Instrument Air		NS - Nitrogen Supply
PA - Plant Air		SS - Steam Supply
ES - Electric Supply		WS - Water Supply
GS - Gas Supply		

The supply level may be added to the instrument supply line, e.g., AS-100, a 100-psig air supply, ES-24DC, a 24-volt direct current power supply

** The pneumatic signal symbol applies to a signal using any gas as the signal medium. If a gas other than air is used, the gas may be identified by a note on the signal symbol or otherwise.

*** Electromagnetic phenomena include heat, radio waves, nuclear radiation, and light.

3. Flow Diagram – Software's Used

Some of the software used for process design

Acronym	Source
Aspen Plus	www.aspentech.com
ChemCad	www.chemstations.com
DesignII	www.winsim.com
Pro/II	iom.invensys.com

The professional stature of an engineer depends on skill in utilizing all sources of information to reach **practical solutions to processing problems.**

An engineer becomes competent in his or her profession by **mastering the techniques developed by ones predecessors – thereafter the time comes to pioneer new ones.**

References

