

SPD0015ERN
PROCESS DESIGN MANUAL

PROCESS FLOW DIAGRAM

REV. : [3](#)

DATE: [18 OCT 2013](#)



SAMSUNG
ENGINEERING

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1. GENERAL

1.1. [Purpose](#)

This manual outlines general requirements for the contents of the process flow diagram (hereinafter called PFD). In a process plant construction project, the process engineering is comprised of basic design and detailed design design. PFDs are a product of the first stage of basic design and form the basis for the subsequent basic design and for the detailed design.

1.2. [Use Limitation](#)

[This manual is applicable to all engineering projects if there are no special requirements from the Customer and / or Licensor.](#)

1.3. [References](#)

[SPD0019ERN Design Condition](#)

2. [Purpose of PFDs](#)

[The purpose of PFDs is to graphically show the following:](#)

(1) [Plant Design Basis](#)

[The PFDs show the plant design basis indicating the flow streams of the feedstocks and the products.](#)

(2) [Configuration of the Process](#)

[The PFDs serve to identify the configuration of the process](#)

(3) [Equipment Configuration](#)

[The PFDs show graphically the arrangement of major equipment, process lines, and some instrumentation.](#)

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(4) [Required Utilities](#)

[The PFDs show the utilities which are typically used continuously in the plant.](#)

[PFDs present information pertaining to major operating conditions. The PFDs are the Road-map of the process, and serve to identify and focus the scope of the process for all associated functions of the project.](#)

[A good PFD graphically identifies the process steps in proper sequence. This is done in such a manner and with sufficient information to present a proper interpretation of the process requirements.](#)

[A PFD shows where the feeds enter, the process flows through the major equipment and the products. It also shows liquid waste streams and hydrocarbon and non-hydrocarbon vent gas systems](#)

3. CONTENTS OF PFD

3.1. [Required](#) Items

This manual specifies the design philosophy and basic design procedures for a construction project. Accordingly, PFD usually comprises the following eight(8) items.

- (1) Process flow lines of raw materials, products, and by-products within the battery limits.
- (2) Utility flow lines which are used continuously within the battery limits.
- (3) Equipment diagrams to be arranged according to process flow, designation, and equipment number.
- (4) [Major process](#) control instrumentation to be involved in process flows.
- (5) Major Process analyzers.

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- (6) Operating condition, such as temperature and pressure, around major equipment.
- (7) Operating duty for all heat exchangers and fired heaters.
- (8) Information concerning individual process flow lines and conditions, such as flow rates, operating pressure & temperature, etc.

3.2. Typically Omitted Items

The following items (to be developed during the subsequent design phases) should not be described in PFD except in special cases.

- (1) Minor process lines which are not usually used in normal operation and minor equipment, such as block valves, safety /relief valves, etc.
- (2) The elevation of equipment
- (3) Spare equipment
- (4) Heat exchangers, pumps, compressor, etc., operated in parallel or in series shall be shown as one unit.
- (5) Piping information such as size, orifice plates, strainers, and classification into hot or cold insulated or jacket piping.
- (6) Pressure conditions which must be determined by hydraulic calculations, such as discharge pressure of pump and compressor. This item, however, is not applicable to cases where such pressure conditions are considered to be particularly important from the process point of view.
- (7) Instrumentation not related to major automatic process control
- (8) Instrumentation of safety trip system, (because it usually cannot be decided at the PFD preparation stage)

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(9) Drivers of rotating machinery except where they are important for controlling the process conditions.

[\(10\) Detailed dimensional information of equipment](#)

4. GENERAL DRAFTING INSTRUCTIONS

(1) Papers

As a rule, SECL Forms are recommended for the preparation of PFDs unless otherwise specified.

(2) Scale

PFDs should not be drafted to scale. However, their size should be compatible with that of equipment drawings.

(3) Flow direction

As a rule, PFDs should be drawn from the left to the right in accordance with process flows.

(4) Division of PFD

Where a PFD must be divided into two or more sheets, it should be divided at portions [where the division is best understood](#) from the process standpoint. Each divided section should be drawn on a separate sheet of paper.

(5) [Parallel](#) trains

Where there are two or more identical trains of process flows, one representative train may be given in the PFD and the others omitted, [as long as](#) annotations pointing out such omissions are clearly indicated [on all relevant PFDs](#).

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(6) Base line

As a rule, base lines should not be drawn. Similar items of equipment, however, should be aligned at the same level as far as possible.

(7) Title

The title should be given in the title block at the lower right-hand corner of the PFD, according to the SECL Form. [The terminology should be consistent on all PFDs.](#)

(8) Legend

The legend should be given, as a rule, at the upper right-hand corner [of each PFD, if it is not a separate PFD. Otherwise, a note should designate where the legend is located \(i.e. on another PFD\).](#)

(9) [Type](#) of lines

As a rule, Process lines, utility lines, and Loop lines for instrument should be described as follows:

(a) Main process lines (Dark)

(b) Secondary process lines and utility lines (Light)

(c) Loop lines for instruments (Dotted)

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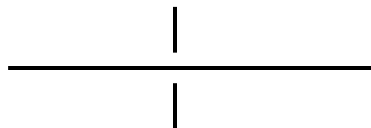
There should be no distinction in thickness between the main line and the secondary line in denoting process lines.

There should be no distinction in the PFD as to whether a loop line for an instrument is an electrical or a pneumatic one.

(10) Line crossover

Where two lines cross each other, the horizontal line should be drawn as a continuous line in all cases. This shall not apply to loop lines for instruments.

(a) where two main lines cross



(b) Where one main line crosses one secondary (utility) line



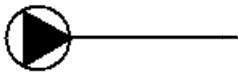
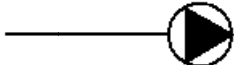
(c) Where one main line crosses one loop line for an instrument:



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(11) Notation of lines at battery limit tie-in points

(a) Process Lines

From Item No. And/or Dwg. No	To Item No. And/or Dwg. No.
	

Where a PFD consists of two or more divided sheets, drawing numbers should be indicated for each sheet.

(b) Utility Lines



Names of fluids should be given in parentheses above the utility lines.

Names of these fluids should be abbreviations defined for each job, such as CW for cooling water.

(12) Direction of flow

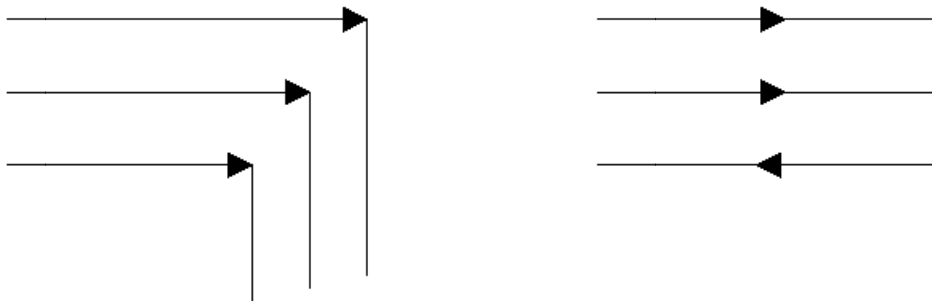
The direction of flow should be indicated by arrows.

In principle all flow lines should have arrows located at the inlet of equipment, at merging points, and at the corners of the lines. Where a process lines is long, however, the process flow may be denoted by arrows located at intermediate points.

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The number of arrows used to show process flow [direction is subject to PFD clarity](#). However, care should be taken not to clutter the drawing with excessive arrows.

Arrows at corners may be suitably omitted.



5. IDENTIFICATION AND NUMBERING

5.1. Process Equipment

(1) Each item of equipment shall be assigned with an identifying number and a corresponding sequence number in accordance with [the equipment list and](#) the numbering system of the Basic Engineering Design Data.

- The equipment number and name should be given in the PFD, as a rule, at the upper or the lower part of the sheet, preferably in a space close to the center line of the equipment which is to be denoted. However, depending upon the space, either the number or the name can be omitted.
- Installed spare equipment, such as pumps, shall be indicated by a suffix letter like A or B .
- Equipment drivers shall carry the same designation as the driven equipment [plus one additional letter, such as T, to denote a turbine drive.](#)

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5.2. Instrumentation

It is not necessary to assign an identifying number for instrumentation on the PFD.
(see Section 7)

6. DESCRIPTION OF EQUIPMENT

6.1. Equipment Symbols

Equipment types that are common to an individual process should be displayed with uniformly consistent symbols. Symbols to denote specific or unique equipment items are optional, but shcu symbols should be drawn as simply as possible.

6.2. Operating Conditions Symbols

Arabic numerals should be used inside the symbols mentioned in Fig. 6-1 to denote operating conditions. The position of the operating condition denotation should be as close as possible to the point requiring indication. Where it is difficult to find space for such denotation, however, an auxiliary line should be used to indicate it.

6.3. Minimum Information Requirements for Equipment

(1) Designated pipelines

Stream numbers should be Arabic numerals in series inside a diamond symbol

- Fluid name
- Total flow rate
- Density and/or molecular weight if required
- Operating pressure and temperature if required

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(2) Heat exchangers

- Identification number and service name
- Operating heat duty
- Inlet and outlet temperatures on both shell and tube sides

(3) Furnaces

- Identification number and service name
- Operating absorbed heat duty
- Inlet and outlet operating temperatures on tube side.

(4) Reactors

- Identification number and service name
- Inlet and outlet operation temperature.
- Inlet and/or outlet pressure

(5) Columns

- Identification number and service name
- Top and bottom operating temperatures
- Top and/or bottom operating pressures
- Tray numbers for top, bottom, feed, draw-off, etc.

(6) Drums

- Identification number and service name
- Operating temperature
- Operating pressure

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(7) Pumps

- Identification number and service name

(8) Compressors and blowers

- Identification number and service name

(9) Ejectors

- Identification number and service name
- Inlet and outlet operating pressure for ejector system

(10) Tanks

- Identification number and service name
- Operating temperature
- Operating pressure

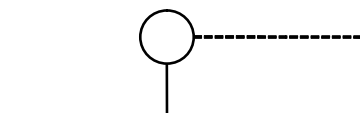
7. DESCRIPTION OF INSTRUMENTATION

Instrumentation to be [shown on PFDs](#) are instruments, measuring devices and control valves.

7.1. Instruments

(1) Symbols for instrument

- The symbol for an instrument is a circle which shall be connected to the line which is nearest the point of measurement.



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- Where the instrument is a controller, a dotted line representing the control impulse shall connect the instrument circle to the controller valve.
- The denotation of such functional symbols as R for recorder, I for indicator, and A for alarm, etc. should be omitted except for the functional symbol C for control.
- There should be no distinction as to whether instruments should be locally installed or mounted on the main instrument panel.
- No distinction is made either between pneumatic, electric or hydraulic transmission line.

(2) Functional symbols for control

The following symbols are shown inside the circle representing the instrument.

Flow Controlling	FC
Flow Ratio Controlling	FrC
Level Controlling	LC
Pressure Controlling	PC
Pressure Difference Controlling	PdC
Temperature Controlling	TC
Temperature Difference Controlling	TdC
Speed Controlling	SC
Quality Controlling	QC
Movement, Displacement Controlling	UC
Weight Controlling	WC
Any Other Property Controlling	XC

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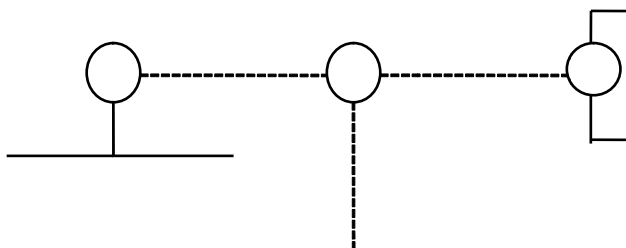
(3) Cascade control

Where one controller [influences the](#) value of one or more other controllers, the instruments circles shall be connected by a dotted line.



(4) Compound control

Where the control actions of two or more controllers combine to operate one or more control valves, the instrument circles representing the controllers shall be joined by dotted lines to the instrument circle representing the combining device.



7.2. Measuring Devices

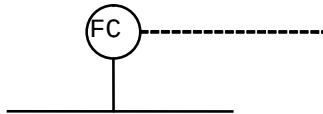
The connecting line between the circle representing the instrument and the stream line represents the measuring device such as for temperature measurement, pressure measurement, flow rate measurement, etc.

(1) Flow rate measuring

- Regarding flow rate measurement, definitions of apparatus type such as rotor meter, pitot tube, turbine meter, orifice, etc., need not be shown.

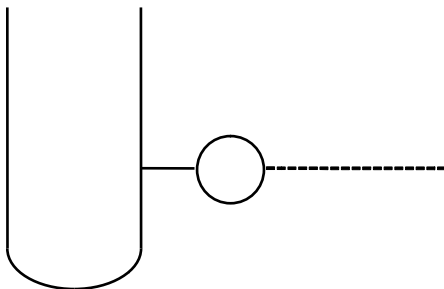
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- Orifice flanges and orifice plate need not be shown.
- Valves associated with the device need not be shown.



(2) Level measuring

- definitions of apparatus type such as ball float, displacement, difference pressure, etc. need not be shown.
- A distinction should not be made as to whether the apparatus is an internal or external type.
- Valves associated with the device need not be shown.



(3) Measurement of pressure, temperature, etc.

- No distinction should be made regarding measuring type.
- Valves associated with measuring devices need not be shown.

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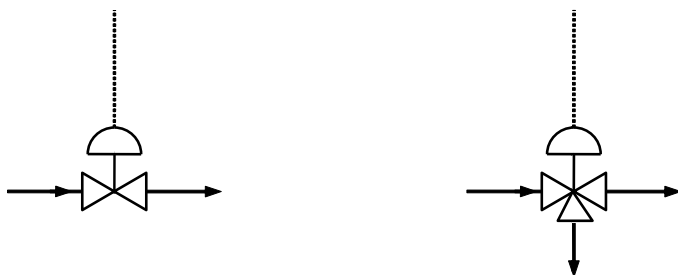
7.3. Control Valves

(1) Actuator

- The symbol for an actuator is a half circle which half circle shall be connected with a dotted line representing the control impulse.
- There should be no distinction made as to whether the actuator is a diaphragm type, electric motor type or oil cylinder type, etc.

(2) Control valves

Control valves operated by instruments are shown as following.



- There should be no distinction made as to whether the valve type is power failure open or close.
- By-pass and block valves around control valve need not be shown.

8. MATERIAL BALANCE SHEETS

In the case where the material and heat balance sheet is to be prepared as an item of basic design work separately from the preparation of the PFD, refer to SECL Form entitled Project Specification Heat and Material Balance.

Here, provisions are described for the case where the material balance is represented in the form of a balance sheet in the PFD.

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8.1. Contents of Material Balance Sheet

A material balance sheet literally describes the balance between materials and, in many cases, includes further information. A common material balance sheet will consist of the following information.

(1) Stream information

Stream No. name of stream, flow rate, composition

(2) Operating conditions

Operating temperature and pressure

(3) Basic physical properties

Molecular weight, API gravity, Sp.Gr, etc..

(4) Data concerning hydraulic calculation

Density, viscosity, etc. if required

8.2. Denotation of Material Balance Sheet

As a rule, no requirements will be made regarding the form of the material balance sheet.

However, the following points should be considered.

(1) Position

As a rule, the material balance sheet can be inserted at the lower part of the PFD , at its right-hand side, [or in a material balance table separate from the PFD.](#)

(2) Unit

The unit of flow rate should be expressed by [weight \(mass/time\) or mole \(moles/time\).](#)

(3) Number of digits of numerals and denotation of small quantities

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As a rule, percentages should be expressed down to 0.01. Where traces of components are concerned, special units, such as PPM, should be used.

8.3. Examples

A typical material balance sheet is shown in Table 8-1. The following comments should be noted prior to preparation of the sheet, however.

- Operating pressure and temperature may be omitted because the operating conditions are indicated on the equipment as stated in Minimum Information Requirements for Equipment
- The total flow rate is sometimes described as kg/hr or BPSD for liquid flow and as Nm³/hr or SCFD for gas flow. [These depend on the units of measurements as required by the project.](#)
- The molecular weight and/or boiling point and/or API of each component are often inserted near each component mentioned in Table 8-1.
- Flow density and viscosity are often omitted from a PFD.

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9. REVISION HISTORY

Rev. No.	Rev. Date	Rev. Page	Reason for Revision
1	25 OCT 2004	All	First Issue Written at Proces & System Eng'g Dept. -Prepared by: W.J.Lee -Checked by: J.C.Ro, Y.Y.Koo, J.H. Park -Approved by: C.S.Jung
2	25 NOV 2010		Document Number change due to new numbering system Written at Proces & System Eng'g Dept. -Prepared by: C.H.Yun -Checked by: J.H.Park -Approved by: Y.Y.Koo
3	18 OCT 2013		Written at Proces & System Eng'g Dept. -Prepared by: S.H.Kim -Checked by: J.H.Park, I.H.Hwang -Approved by: S.B.Lee

APPENDIX A: Table and Figures

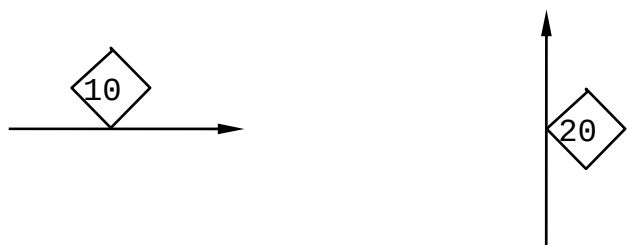
Table 8-1. Typical Material Balance

Stream No.		101	102
Fluid Name			
Components (mole/hr or mole%) or (wt/hr or wt%)	MW and/or BP and/or MP		
A			
B			
C			
D			
E			
Total Flow Rate (mole/hr)			
Total Flow Rate (wt/hr)			
Total Flow Rate (volume/hr)			
Operating Pressure (kg/cm2G)			
Operating Temperature (°C)			
Molecular weight			
Specific Gravity			
Others			
Remarks			

Fig. 6-1. Equipment Symbols

- (1) Pipe Line Symbols
- (2) Shell and Tube Type Heat Exchanger Symbols
- (3) Reboiler Symbols
- (4) Air Fin Cooler Symbols
- (5) Plate Heat Exchanger Symbol
- (6) Furnace Symbol
- (7) Reactor Symbols
- (8) Column Symbols
- (9) Drum Symbols
- (10) Pump Symbols
- (11) Compressor, Expander and Blower Symbols
- (12) Ejector Symbol
- (13) Tank Symbols
- (14) Filter Symbols
- (15) Other Equipment Symbols

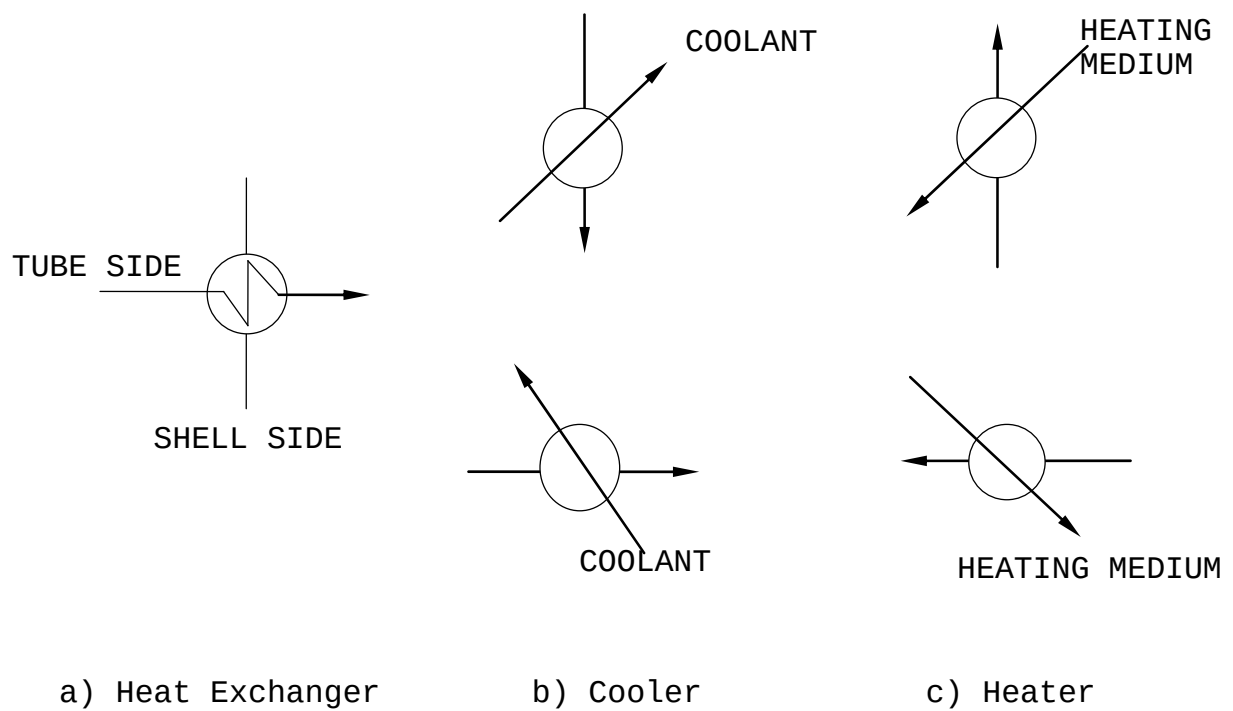
Fig. 6-1 (1) Pipeline Symbols



Note

Stream numbers should be serially denoted by Arabic numerals which are given, as a rule, above a horizontal line or on the right-hand side of a vertical line.

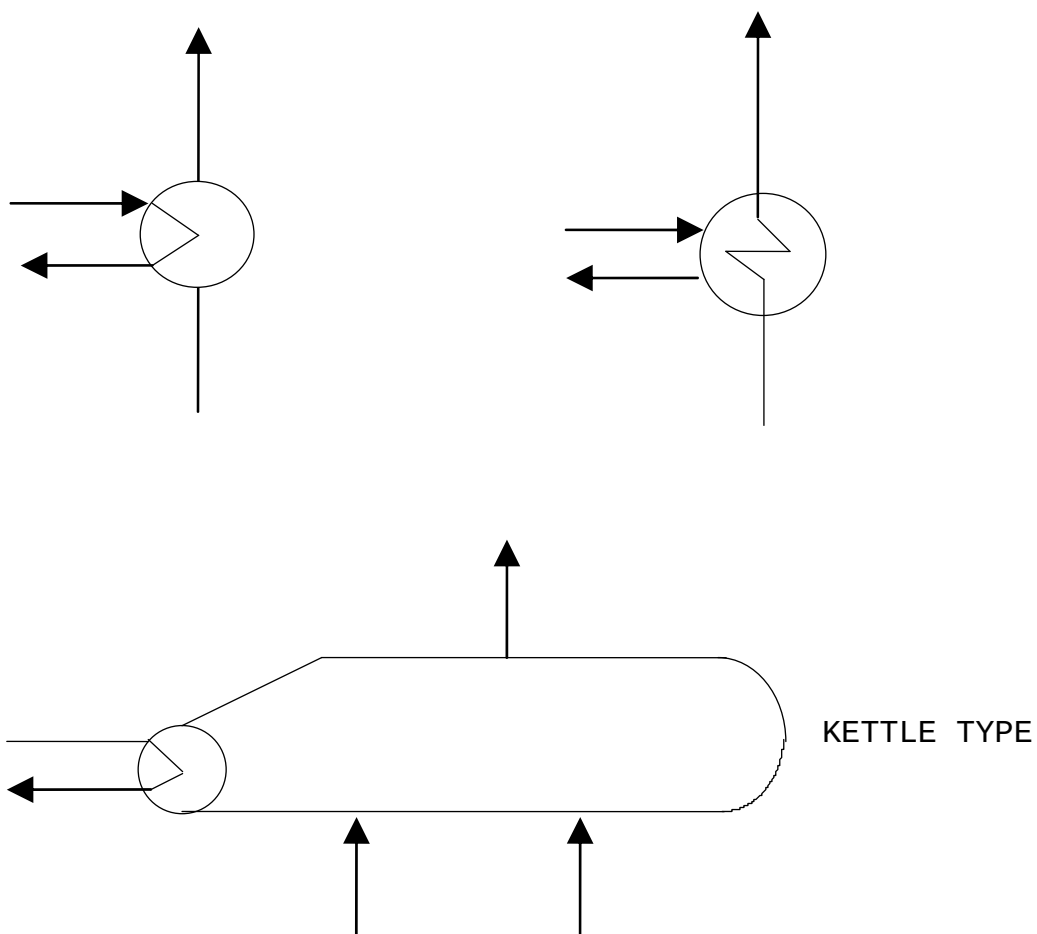
Fig. 6-1 (2) Shell and Tube Type Heat Exchanger Symbols



Note

- Distinction to be made between shell and tube side
- Flow direction of heating medium should be downward
- Flow direction of cooling medium should be upward

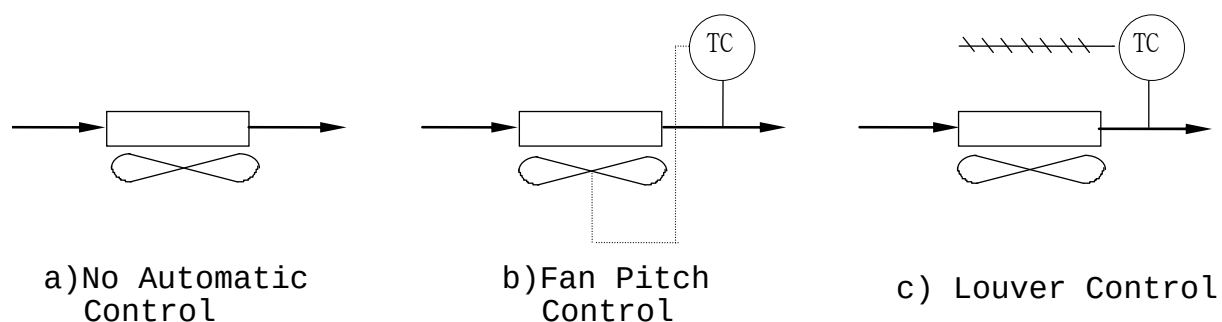
Fig. 6-1 (3) Reboiler Symbols



Note

- The direction of lines is optional, but the lines denoting the shell and tube side respectively, should cross each other at 90 or 45.

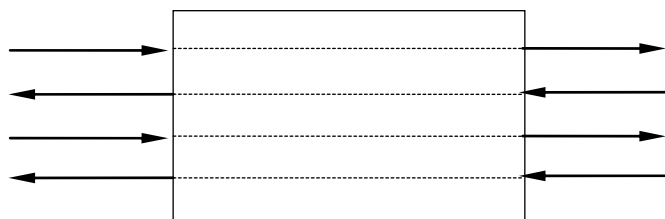
Fig. 6-1 (4) AIR FIN COOLER SYMBOLS



Note

- Where temperature controls must be selected in consideration of various factors, the process engineer will show the control types on the PFD.
- There is no distinction between Forced and Induced AFC.

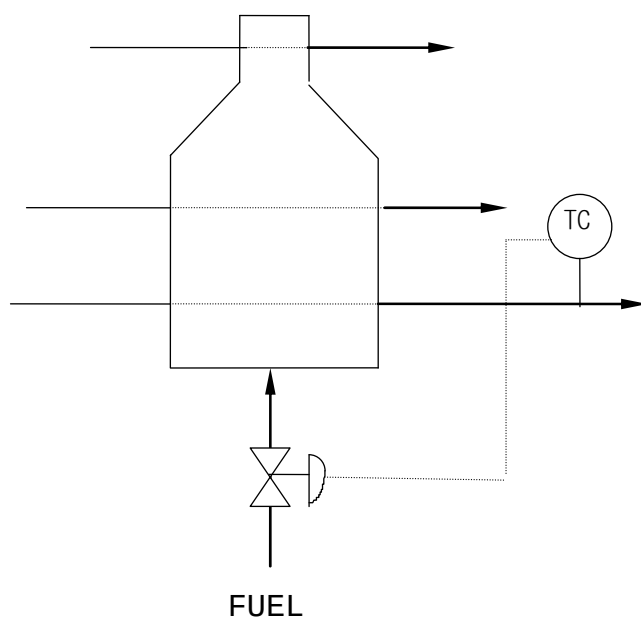
Fig. 6-1 (5) Plate Heat Exchanger Symbol



Note

- All arriving and departing process streams should be shown.
- The arrival point and departure point of a given process stream should be tied by a dotted line.

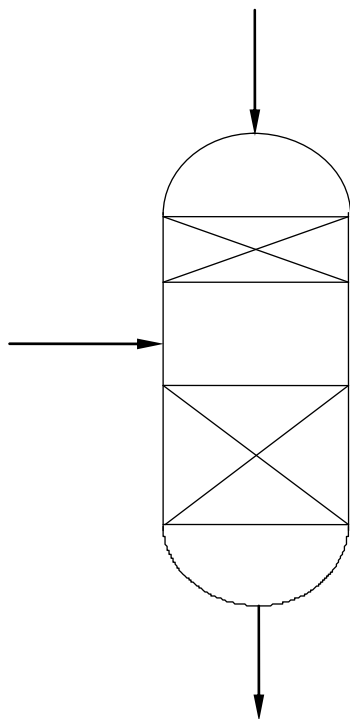
Fig. 6-1 (6) Furnace Symbol



Note

- All arriving and departing process streams should be shown.
- The arrival point and departure point of a given process stream should be tied by a dotted line.
- There is no distinction between a Forced Draft and Induced Draft type.

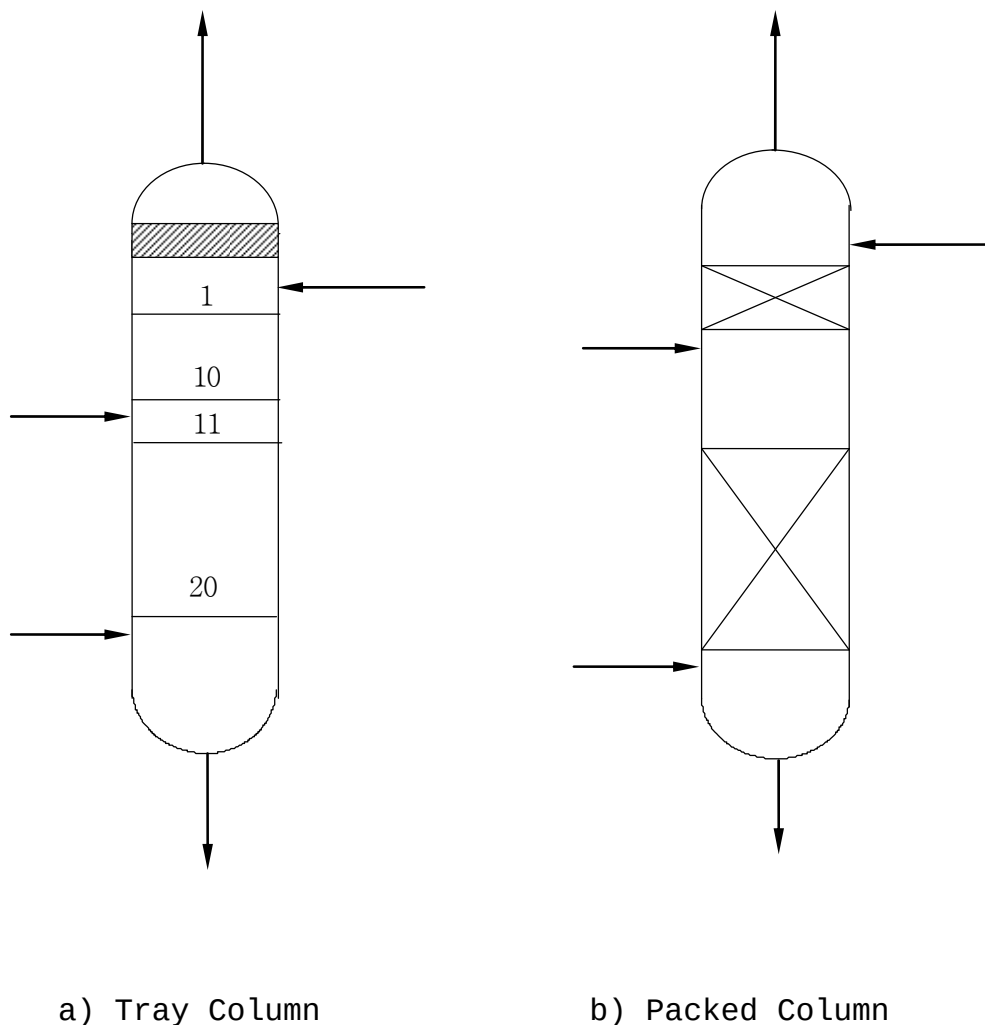
Fig. 6-1 (7) Reactor Symbol



Note

- All process streams should be shown
- The catalyst beds should be shown pictorially in such a way that their number can be readily determined.
- It is not necessary to show any internals such as fluid distributors

Fig. 6-1 (8) Column Symbols

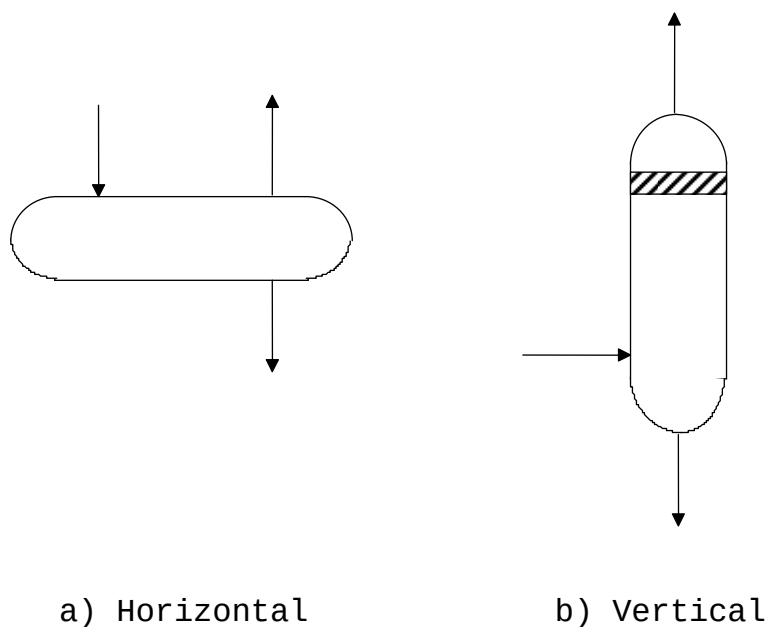


Note

- Skirts and supports need not be shown
- The trays should be shown pictorially in such a way that their number can be readily determined. Actual numbers should be inserted only in parts which are important from the process point of view.
- Packed beds should be shown pictorially in such a way that their number can be readily determined.

- Demister mats should be shown pictorially.
- It is not necessary to show internals such as distributors, spray nozzles, chimneys, cyclones, partition plates, vortex breakers, etc., except in special cases.
- It is not necessary to show tray type such as valve, bubble cap, sieve, grid, etc.
- It is not necessary to show the path number in a tray column.

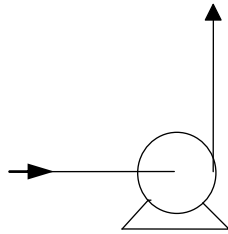
Fig. 6-1 (9) Drum Symbols



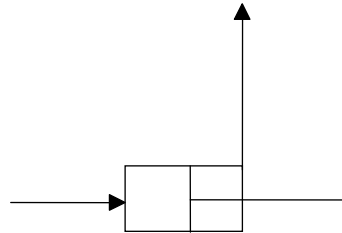
Note

- Skirts and supports need not be shown
- Demister mat should be shown pictorially.
- it is not necessary to show internals such as distributors, vortex breakers, etc., except in special cases.

Fig. 6-1 (10) Pump Symbols



a) Centrifugal Pump

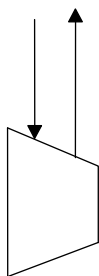


b) Reciprocating Pump

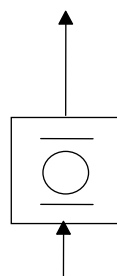
Note

- There is no distinction between Single or Multiple stage.
- Drivers need not be shown. Driver type must be determined depending on possible power failure, economic choice and power balance. It cannot therefore be decided at the PFDpreparation stage.

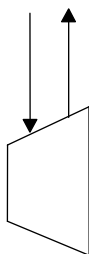
Fig. 6-1 (11) Compressor, Expander and Blower Symbols



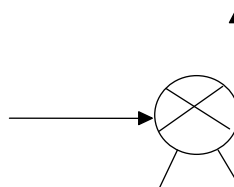
a) Centrifugal Compressor



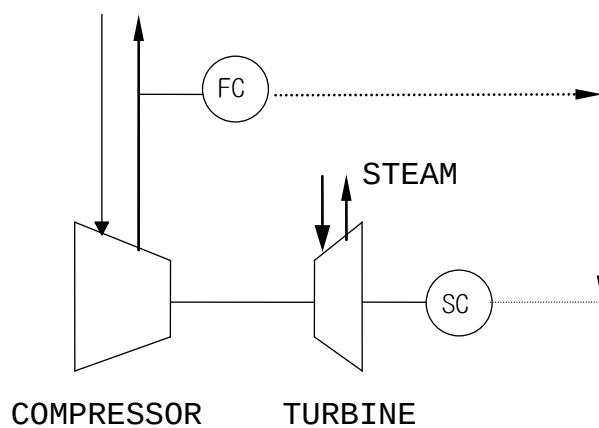
b) Reciprocating Compressor



c) Expander



d) Blower

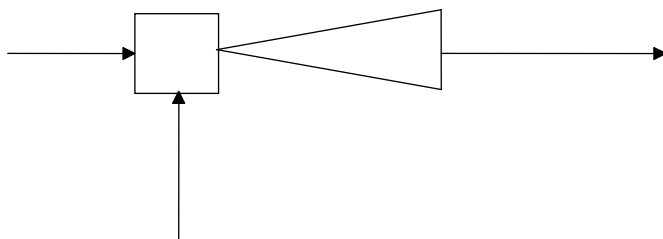


e) Driver Control

Note

- There is no distinction between Single or Multiple stage
- The intercooler need not be shown.
- The driver need not normally be shown. The driver type must be determined depending on possible power failure, economic choice and power balance.
- In the case where the process gas pressure or flow rate is controlled by a driver (speed), it is necessary to show the driver and control system as mentioned above.

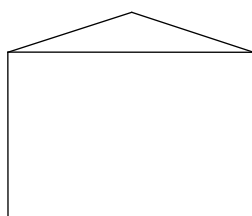
Fig. 6-1 (12) Ejector Symbol



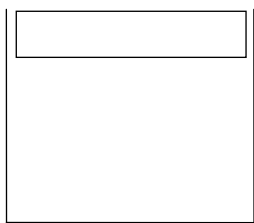
Note

- There is no distinction between Single or Multiple" stage.

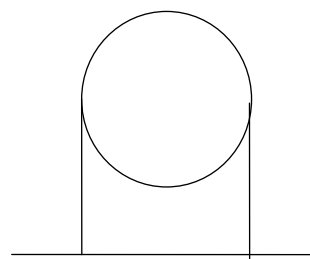
Fig. 6-1 (13) Tank Symbols



a) Cone Roof



b) Floating Roof

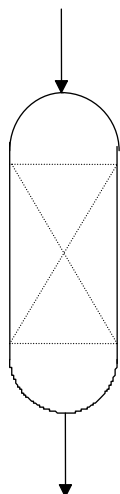


c) Spherical

Note

- The pressure relieving and vacuum breaking system need not be shown.

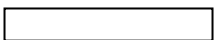
Fig.6-1 (14) Filter Symbols



Note

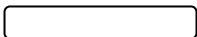
- Distributors need not be shown
- There is no distinction between Packed Bed Type or Leaf Type

Fig. 6-2 Symbols of Operating Conditions

Temperature : 

Pressure : 

Flow rate : 

Heat duty : 

Arabic numerals should be inserted inside the symbols