Process Flow Diagrams

Process Flow Diagram
Conveys the major processing steps represented by the equipment

- Useful for conveying the heat and material balances
- Useful for conveying major pieces of equipment
- Useful for conveying processing conditions
- Useful for conveying utilities

There are no hard and fast rules but Howat Standards include
- essentially every major piece of equipment
- every flow
- every temperature
- every pressure
- auxiliary services (utility flows)
- equipment sizes
- process control
Standard symbols
BS 8888 ; BS 1553
Material Flow Sheet

- Is drawn with standard symbols and labeled and include all data obtained
  If no space available to label equipment, a equipment key can be drawn at the bottom of the flow sheet
  Following data should be shown on the flow sheet in deferent ways
    - flow rate of each component
    - total stream flow rate
    - percentage composition

Simplest method suitable for simple processes with few equipments,
  tabulate the data in blocks alongside the process stream  
Better method applicable for all complex processes,
  stream line is numbered and the data tabulated at the top or bottom of the sheet (above and below the equipment layout)  

Process Flow Diagram

The following diagrams are examples of class and commercial process flow diagrams (PFD’s). The content depends on the goals for the communication.

Unless there are reasons to the contrary, the standard is:

- All major equipment
- All major process lines
- All major utility lines involving material flow
- All stream numbers, temperatures, pressures, flows
- All major process controls and valves
- All equipment sizes with relevant MEB information as required
- All equipment names and numbers
The goal is to present the most amount of information with the least amount of effort on the part of the reader.

- The flowsheet should generally flow from left to right.
- The flowsheet should not be cluttered - use multiple sheets.
- The flowsheet should be in landscape with the bound edge at top.
- The equipment should be drawn in approximately relative size, e.g. towers larger than drums, exchangers larger than pumps etc.
- The major towers and reactors are generally on one, or nearly one, level.
- The reader should be able to follow it with his or her eye.
- The streams should have the minimum of direction changes.
- The streams that enter across the battery limits should be on the left.
- The streams that leave across the battery limits should be on the right.
- The streams that move to the next sheet should leave on the right.
- The streams that recycle to earlier sheets should leave on the left.

Flowsheeting

The process flowsheet shown below is one possible expansion of the block flow for T-104. When this PFD was drawn, the process was not complete as is evident by the missing equipment sizes, pump discharge pressures etc. In this case, the process control scheme was not included. It generally is, however.
The following process flow is an approximate rendition of a refinery alkylation unit. This is however not as complete as it is required in industry practice.

Note that equipment sizing is not included.

The material balance grid is included. Many companies require the material balance to be imposed on the diagram. In those cases, the stream numbering may not be as extensive as we typically use in design. Or, only a limited number of streams are included in the material balance grid.
Another example from design. This includes the equipment sizing and material balance block. Note the symbol key is included. This is frequently necessary when client standards differ.

Process Flow Diagram

The following two sheets are examples of a commercial PFD developed prior to construction. Note that the content is, yet again, different. In this case, the control scheme is included as is the legend key. There are some differences. Note that there are three different feed points shown on the diagram. It is typical to have multiple feed points for a column but unusual to show them on the PFD. They were shown here because it was critical for discussing different feedstocks in the process design report. The process description which accompanied the PFD described the reason for the multiple feeds. On the second diagram, you will note the pressure control. This is a split range controller with the primary control being a flooded condenser and the secondary control being a vent. Note that the pumps show operating and design conditions.
The process description will sometimes dictate the content of the process flow diagram. For most purposes, the process control scheme will be included in our work. Multiple feed points or side stream points will not be shown unless it is critical to the process. We will typically not be showing the future equipment such as the reboiler shown on the left of the column.

When you examine the flowsheet, you should be able to deduce the type of equipment.

*Tower type?*
*Reboiler type?*
*Pump type?*

This is the other part of the previous flowsheet. Because of scan limitations, I’ve broken the flowsheet into two parts. However, the original is all one flowsheet drawn in landscape.

In this flowsheet, you will not the original reboiler is on flow control reset by temperature. The primary measured variable is steam flow, the manipulated variable is steam flow and the controlled variable is temperature. The secondary measured variable is temperature. What is the temperature indicative of? Why above the bottom?
This process flow diagram is another commercial example. This client standard had two PFD’s per page, each shown in landscape, one on top of the other on the same page. I have taken the top PFD and split in two. (This is the basis for the following EFD’s.)

This was a revamp. Shaded equipment is new, unshaded equipment is existing. Note that the control scheme is included. There are additional symbols which indicate that the controls are connected to a digital distributed control system. The tags at the edge of the page indicate connections to other PFD’s.

This is an extractive distillation tower. There are additional reboilers here (type?) that are in place for heat recovery. The shaded equipment is new. The unshaded equipment was existing. The equipment might be in a new service, however. We will generally not show instrument connections to the DCS (distributed control system). The instruments will be shown but the connection will be implied.
This is the overhead system for the extractive distillation column. Note that there is a vent condenser from F-204. Why might we add a vent condenser? What is the purpose? Note that the F-204 Reflux Drum has a ‘boot’. What might that be for? The circle symbol in the center bottom is a professional stamp of a licensed engineer. He/she is signifying that the engineering integrity of the process.

Process Flow Diagram

Unless stated otherwise, the target content for PFD’s is:

- All major process equipment
- All major process and utility streams – all numbered
- All major process controls necessary to operate the process
- All operating temperatures
- All operating pressures
- All operating flows
- All equipment sizes