1.3 Process & Instrumentation Diagram

An important means for engineering communication in the process industry is the so called Process & Instrumentation (P&I) diagram. Figure 1.5 shows the P&I diagram of a typical industrial heat exchanger. Heat exchanger is a process unit in which steam is used to heat up a liquid material. The material (called feedstock) is pumped at a specific flow rate into the pipes passing through the heat exchanger chamber where heat is transferred from steam to the material in the pipe. It is usually desired to regulate the temperature of the outlet flow irrespective of the change in the demand (flow rate) of the feedstock or change in the inlet temperature of the feedstock. The regulation of the outlet temperature is achieved by automatic control of the steam flow rate to the heat exchanger. The P&I diagram utilizes certain standard symbols to represent the process units, the instrumentation, and the process flow.

A Process & Instrumentation diagram consists of:

1- A pictorial representation of the major pieces of equipment required with major lines of flow to and from each piece.

2- All other equipment items with design temperatures, pressures, flow, etc..

3- All interconnecting piping with size, material and fabrication specifications indicated.

4. All major instrument devices.

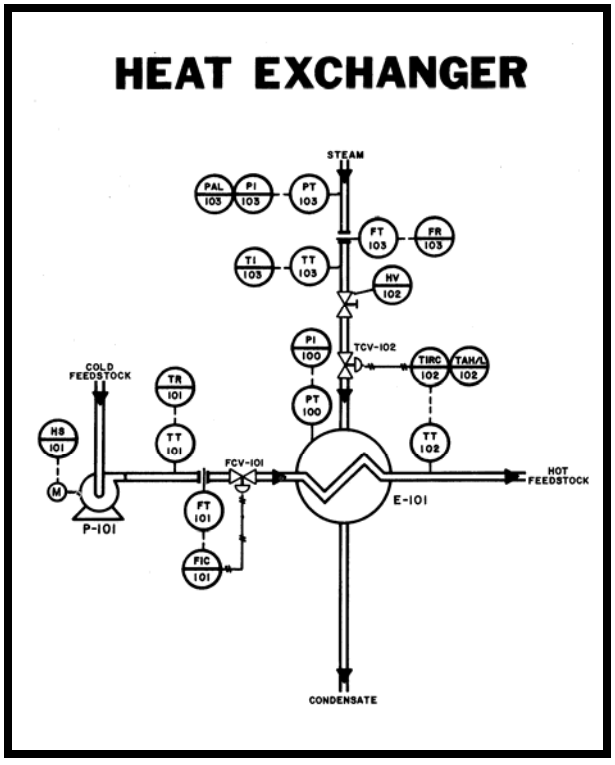


FIGURE 1.5
P&I Diagram of a Heat Exchanger

A partial list of the symbols and abbreviations are given in the tables in Appendix 1.A at the end of this chapter. A comprehensive coverage may be found in the ISA standard in reference [1]. Instruments are shown on the P&I diagram by circles, usually called "balloons". The balloons contain alphanumeric which reflect the function of the instrument and its tag number. For example, TT102 means Temperature Transmitter number 2 in the process unit (or area) number 1. The number 102 is called tag number. Each Temperature Transmitter (TT) must have a unique tag number in the plant. Tag numbering may be different from one user to the other. P&I diagrams provide a valuable reference for proper project installation. The instrument engineer uses it as a source for many documents which must be prepared.

Another type of diagrams is known as ***Process flow Sheet.*** Process flow sheets consist also of a pictorial representation of the major pieces of equipment required with major lines of flow to and from each piece. However, additional information often given includes operating conditions at various stages of the process (flows, pressures, temperatures, viscosity, etc.), material balance, equipment size and configuration and, in some cases, utility requirements. On the other hand, instrumentation on process flow sheets may or may not be essentially complete.

A third type of diagrams is called ***Loop Wiring Diagrams.*** Electrical loop wiring diagrams are electrical schematic drawings which are prepared for individual (or typical) electrical loops. The simplest loop is one that contains only a transmitter and a receiver. Other loops may contain many items such as; transmitters. recorders. controllers, alarm units, control valves, transducers, integrators, and perhaps other items. Loop wiring Diagrams are intended to show the location of the instruments, their identification numbers and termination of interconnecting wiring. Cable routing, wire size intermediate terminal points and other pertinent information are necessarily shown in other drawings.

However, knowledge of these diagrams is not required to understand the material of this book. Understanding the basic P& I examples shown in this book can easily be achieved following the heat exchanger example. The reader should consult Appendix 1.A to verify and understand the following instruments list of the heat exchanger P&I diagram.

Instrument	Description
FIC-101	Flow Indicator and Controller.0 to 50 m3/Hr, (normal reading 30 T/Hr). This instrument controls the flow of cold feedstock entering the tube side of the heat exchanger by positioning a valve on the cold feedstock flow path.
FR-103	Flow Recorder, 0 to 10 Ton/Hr, (2.14 T/Hr). This instrument records the steam flow rate.

HS-101	Hand Switch, ON/OFF (ON). This switch turns on/off cold feedstock pump P-101. When the switch is in the ON condition, the pump is running. When the switch is in the OFF condition, the pump is not running.
HV-102	Hand Valve, OPEN/CLOSED, (OPEN). This switch opens/closes the steam block valve through which steam is routed from the header to the shell side of the heat exchanger. When the switch is in the OPEN condition the block valve is open. When the switch is in the CLOSED condition, the block valve is closed.
PAL-103	Pressure Alarm Low, (Normal). This alarm fires should the steam header pressure be less than 6 kg/cm.sqr.
PI-100	Pressure Indicator, 0 to 15 kg/cm.sqr , (3.18 Kg/cm2). This instrument displays the steam pressure at the shell side of the heat exchanger.
PI-103	Pressure Indicator, 0 to 15 kg/cm.sqr, (10.55 Kg/cm2). This instrument displays the steam header pressure.
TAH/L-102	Temperature Alarm High/Low, (Normal). This alarm fires should the temperature of the feedstock at the exchanger outlet exceed 85 °C or be less than 71°C.
TI-103	Temperature Indicator, 0 to 200°C, (186 °C). This instrument displays the temperature of the steam entering the shell side of the heat exchanger.
TIRC-102	Temperature Indicator, Recorder, and Controller, 0 to 200°C, (80 °C). This instrument controls the temperature of the feedstock at the exchanger outlet by positioning the valve that regulates the steam flow to the exchanger.
TR-101	Temperature Recorder, 0 to 200°C, (38 °C). This instrument displays the temperature of the feedstock entering the exchanger.

APPENDIX 1.A

Process & Instrumentation Diagram

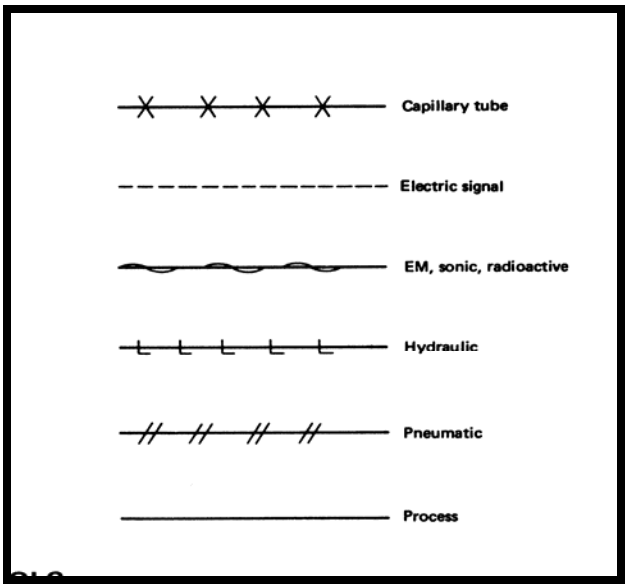


FIGURE 1.A-1
Line Symbols of the P&I Diagrams.

Table 1.A-1. Meanings of Identification Letters

First Letter	Succeeding letters	
A	Analysis	Alarm
B	Burner flame	
C	Conductivity	Control
D	Density or specific gravity	
E	Voltage	Primary element
F	Flow rate	
H	Hand (manually initiated)	High
	Current	Indicate
	Power	
K	Time or time schedule	Control station

L	Level	Light or low
M	Moisture or humidity	Middle or intermediate
O		Orifice
P	Pressure or vacuum	Point
Q	Quantity or event	
R	Radioactivity or ratio	Record or print
S	Speed or frequency	Switch
T	Temperature	Transmit
V	Viscosity	Valve, damper, or louver
W	Weight or force	Well
Y		Relay or compute
Z	Position	Drive

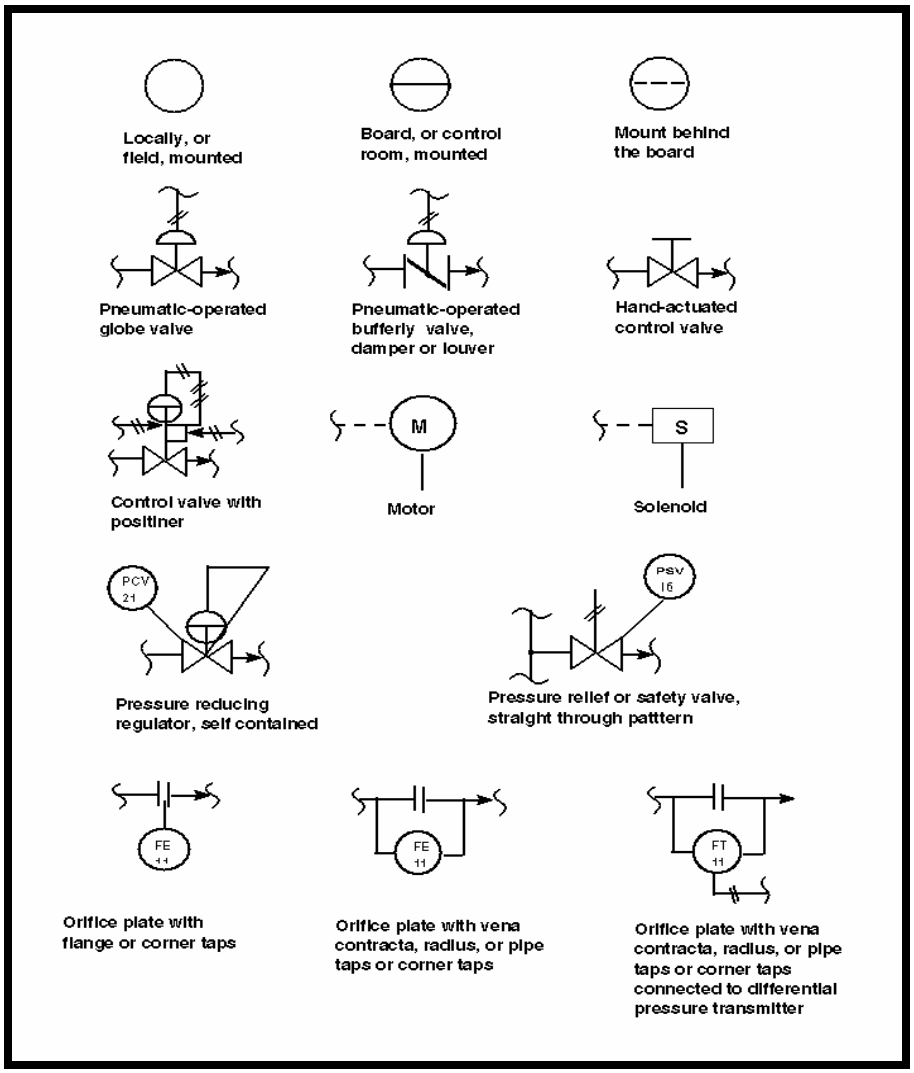
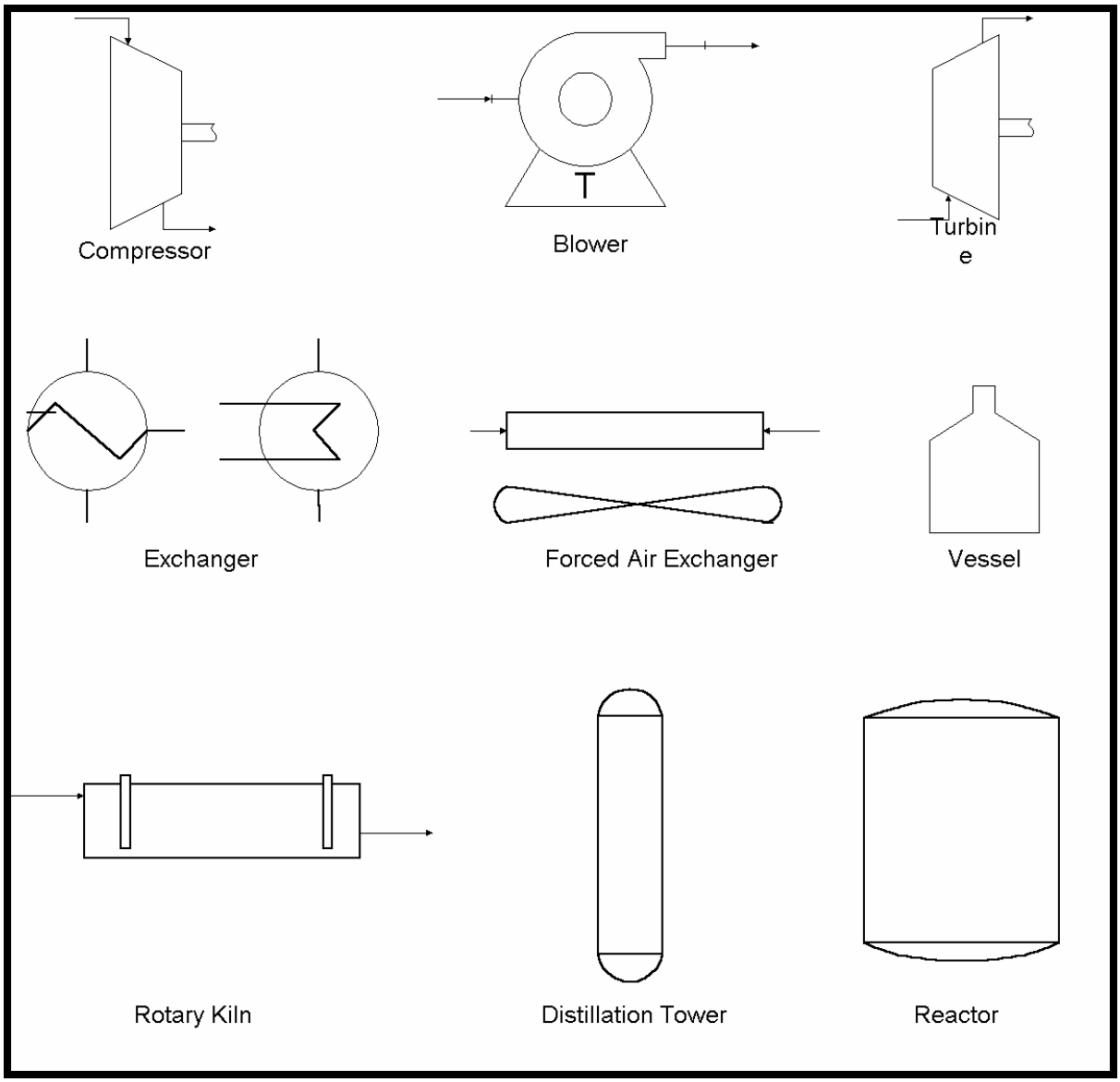


FIGURE 1.A-2
Summary of common symbols used in P&I diagrams.


Compressor
T
Blower
Turbin
e
Exchanger
Forced Air Exchanger
Vessel
Rotary Kiln
Distillation Tower
Reactor