Design and Evaluation of Piping and Instrumentation Diagram

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Abstract: Piping and instrumentation diagrams belong to a family of flowsheets that include block flow diagrams and process flow diagrams. Technology advancement has transformed these resources into intelligent documents, capable of storing layers of digital information. Piping and Instrumentation diagram (P&ID) is a detailed diagram in the process industry which shows the piping and vessels in the process flow, together with the instrumentation and control devices. Again, the super ordinate of the Piping and Instrumentation flow sheet is the process flow diagram (PFD) which indicates the more general flow of plant processes and equipment and gives relationship between major equipment of a plant facility.

Keywords: **P&ID diagram, Process Flow Diagram, Piping and Instrumentation Flow Sheet, Process Industry, Computer Added System.**

I. Introduction:

A P&ID shows information on piping, fittings, equipments, instruments and process plant in a representative and sequential arrangement on the basis of product flow paths. The P&ID layout does not necessarily reflect physical arrangements and also a P&ID is not drawn to scale. The appearance and form of piping and instrumentation diagrams (P&IDs) have changed little over time, despite decades of technology improvements .A P&ID that was created 60 years ago on the drawing board using ink pens on linen sheets, describes a process the same way as one created today using modern computer-aided design (CAD) software. P&IDs continue to be fundamental references for any process facility. This article discusses what makes a good P&ID, and how technology can improve its quality, usability and effectiveness.

II. Piping and Instrument Diagram:

The piping and instrumentation diagram (P&ID), also known as process flow diagram (PFD), provides information which is needed to engineers to begin planning for the construction of the plant.

2.1 P&ID Tag Number and Identification:

Process instruments contain individual tag number and identification

- Location of the device: It mounted on the process flow or in the control room or near the process.
- Type of instrument: Flow, Pressure, Temperature, Level etc.
- Tag number of instrument: Area number, Equipment type code, Unique sequence number.

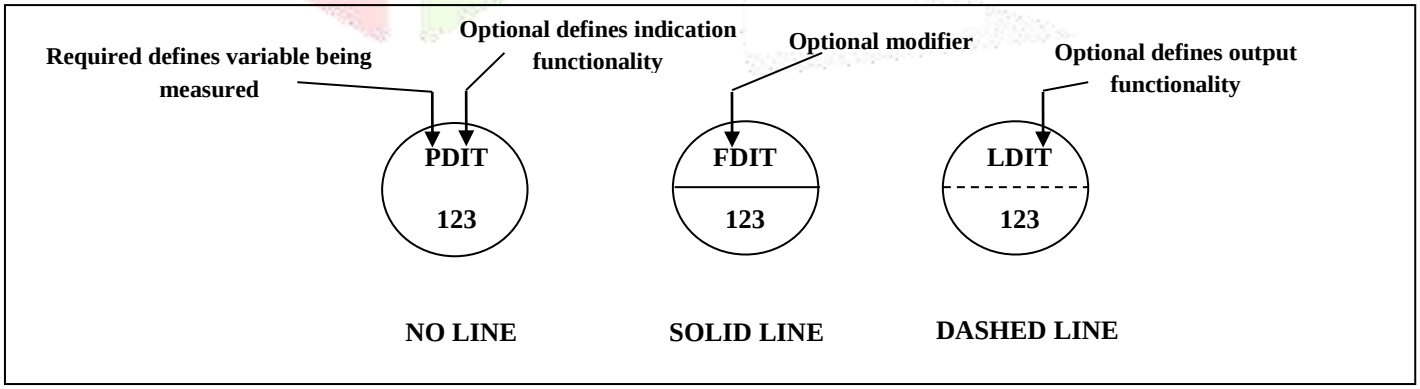


Fig: 1 P&ID Tag Number and Identification

- No Line: This instrument is mounted in the field near the process (close to the operator).
- Solid Line: This instrument is mounted in the control room (accessible to the operator).
- Dashed Line: This instrument is mounted out of sight (not accessible to the operator).

2.2 Instruments symbol:

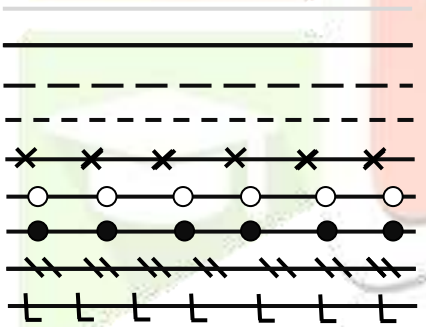
Analyzer	Level	Temperature	Pressure	Working
AI 123	LI 123	TI 123	PI 123	Indicates
AT 123	LT 123	TT 123	PT 123	Transmits
AIT 123	LIT 123	TIT 123	PIT 123	Indicates and Transmits
ADIT 123	LDIT 123	TDIT 123	PDIT 123	Indicates and Transmits (D indicates for differential)

Table: 1 Instruments symbols with their working

2.3 Instruments Signal Lines:

2.3.1 Piping Designation and Signal Characteristic: Similar nomenclature apply to process utility lines which are accompanied by an identification number such as 00"-XX-00000-0X0-X0". In this example first line says about the size of the pipe (eg. -53"). This is the following two latter indicate the commodity in the line such as (VA=vent, CU=condensate). The third field is of five digit numbers, first two denote gas system code (30=Process Gas, 60=Fuel Gas), last three digit from 001 to 999 are sequential identifier. The next section is alphanumeric code type of pipe specification (eg. – A1, B1B). The last segment indicates insulation information, with a letter indication (eg. - P=Personal Protection, H=Heat Conservation) followed by number thickness (eg. - 2").

- Major Signal
- Minor/Instrument Signal
- Existing Piping Signal
- Electrical Signal
- Capillary Signal
- Software Signal
- Mechanical Link
- Pneumatic Signal
- Hydraulic Signal



2.3.2 Terminal Points: In process control industry, the new work that begins ties with the existing works at the termination points for contracts is designated with the Termination Point (TP) symbol. Where more than one termination point is used, then it will be designated with a unique identification number.

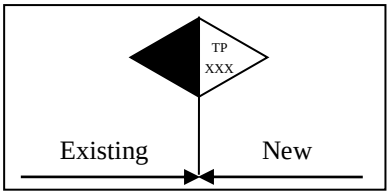


Fig: 2 Terminal Point Symbol

2.4 Instrumentation Designation:

In process industries, every instruments have its own number which allows identification of equipment by its unique number. An instrument identifier may consist of one letter and five number as “X-00000” The letter designates the type of equipment, such as [V = vessel, E = heat exchanger, HE = heater (electrical), P = pump and T = tank]. The first two numerals could be the system code, as [30 = process gas, 60 = fuel gas, and 33 = gas dehydration] and the final three numerals are a sequential identification number, from 001 to 999.

2.4.1 Instrumentation Designation for Acceptance:

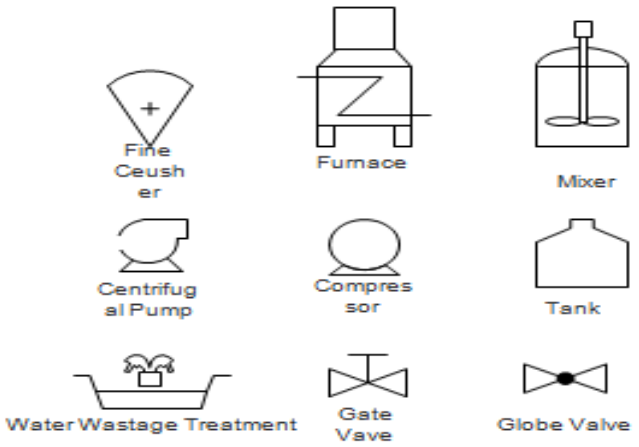


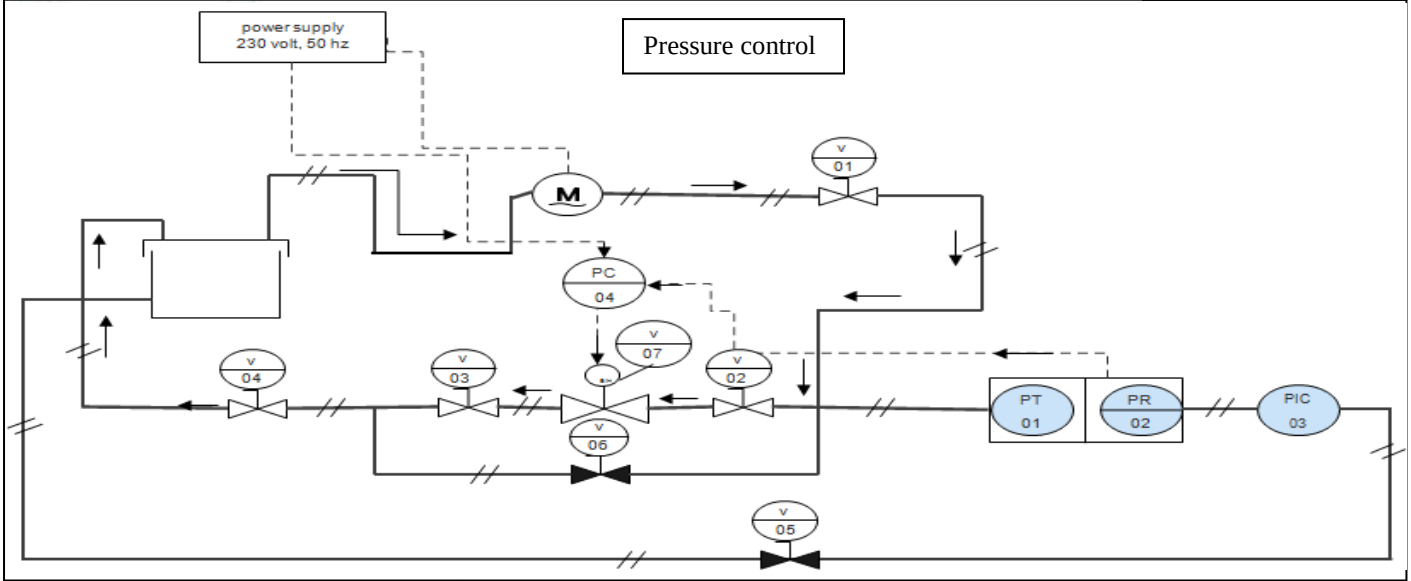
Fig: 3 Equipment Symbol Universally Accepted

2.5 Piping and Instrumentation Drawing Sheet:

Piping and Instrument drawing(P&ID) sheet consists of every instrument's description and is reserved for all equipment's technical information such as process equipment titles, equipment descriptors, number and size, capacity, duty arrangement, power and energy ratings. These drawing sheets are universally accepted and understand by any process engineer.

Instruments	ID	Description	Line Size	Valve Class	Manufacturer	Model	Machine Type	Qualifier	Connection Size	Service
Plug or cock valve	166									
Motor	105						Motor	AC		
Pressure Transmitter	125	pressure transmeter			abc	pt/01/13			01	tansmit pressure
Pressure Recorder	128	pressure recorder			abc	pr/02/13			02	record the reading from indicator
Pressure Controller	131	pressure controller			abc	pc/04/13			04	control pressure signal
Pressure Indicating	134	pressure indicator			abc	pi/03/13			03	indicate pressure
Plug or cock valve	152									
Plug or cock valve	153									
Plug or cock valve	154									
Plug or cock valve	155									
Indicator	215									
Indicator	220									
Indicator	223									
Indicator	226									
Indicator	229									
Plug or cock valve	232									
Indicator	233									

Equipment Label



No	Revision	Date	by	APR

Eng. Record	Date	Process Instrument Diagram Pressure Control	
Drawn by			
Creaked by		Job no.	
Approved by		Drawing no.	Rev. 0

Fig: 4 P&ID Designer Sheet

2.6 Standard and Rules of P&I Diagram:

P&IDs are prepared according to a set of rules established to maximize the document's usefulness. Standard symbols that are easily recognized must be used to represent the items on a P&ID. They must be labeled using specific conventions of nomenclature.

P&IDs take the conceptual aspects of the PFD which are included more information like

- Detailed symbols.
- Detailed equipment information.
- Equipment order and process sequence.
- Process and utility piping.
- Process flow direction.
- Major and minor bypass lines.
- Line numbers, pipe specifications, and pipe sizes.
- Isolation and shutoff valves.
- Maintenance vents and drains.

III. Process Flow Diagram:

A process flow diagram (PFD) is a diagram commonly used in chemical and process engineering to indicate the general flow of plant processes and equipment. The PFD displays the relationship between major equipment of a plant facility and does not show minor details such as piping details and designations.

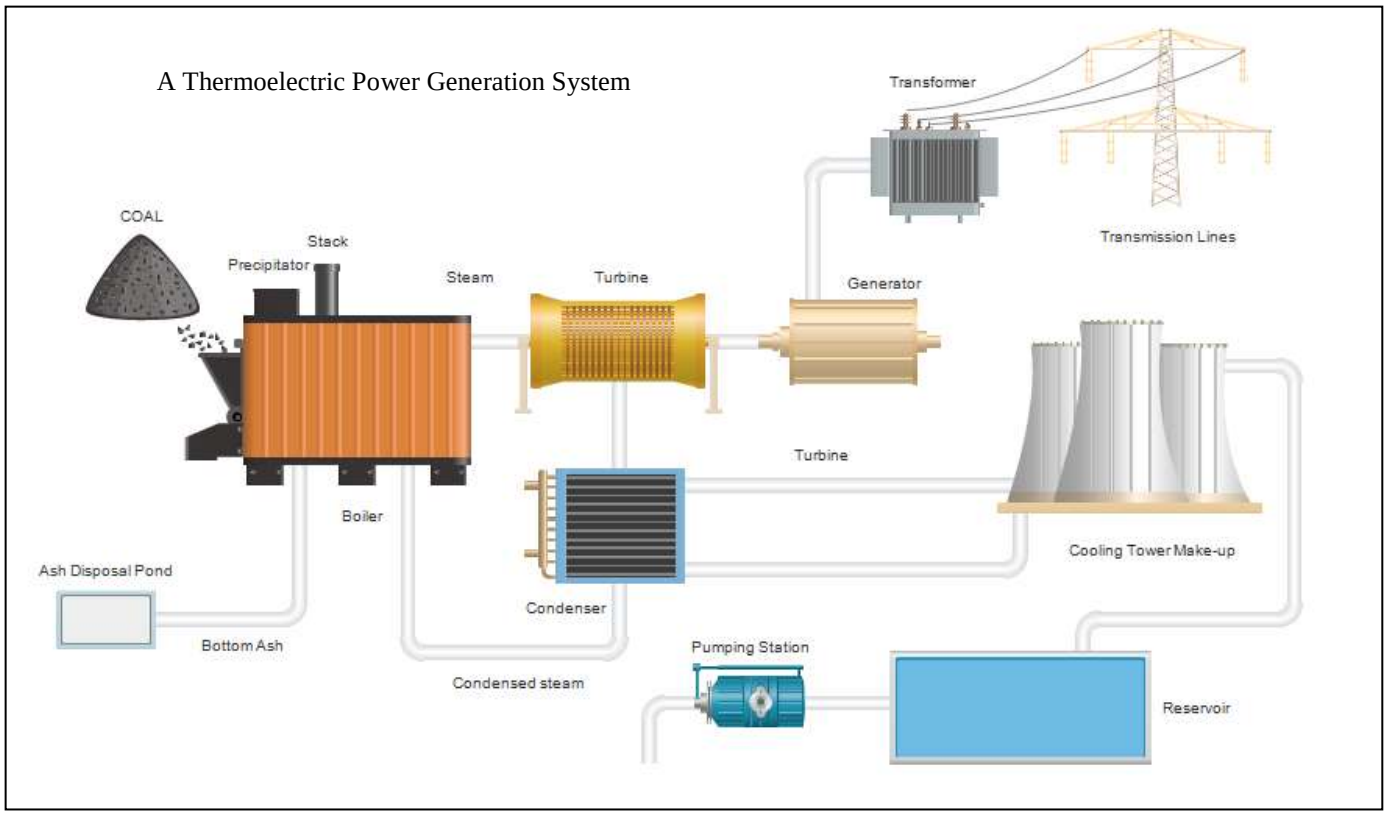
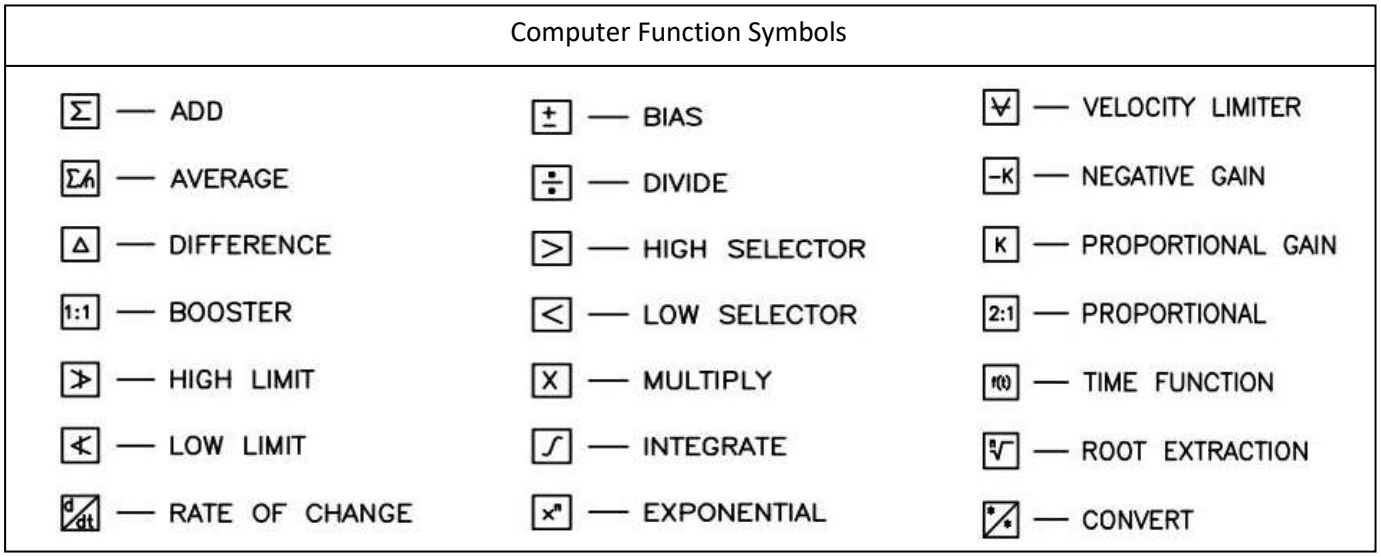


Fig: 4 Process Flow Diagrams

2.7 Computer Added P&ID Design:

Computer-aided design (CAD) is the use of computer systems to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. P&ID are mainly consisting of pipes arcs and instruments CAD systems are ideal for designing them. CAD produced P&IDs are far more legible than their hand-drawn counterparts, with the added benefit of being easier to update and maintain.



IV. CONCLUSION

P&IDs have always been very valuable and useful tools and it is now being widely used in modern technology. As P&IDs furnishes extra information for each component which makes it invaluable for engineers and designers. Nowadays, since CAD system used to design P&IDs, it is now being easier to update and maintain the system online. P&IDs are no longer limited to holding information that only skilled CAD operators can access. Thus, P&IDs provides its full potential to a design engineer to design the process just by looking at P&ID systems.

V. ACKNOWLEDGMENT

I hereby express my sincere gratitude to the Assistant prof. A.K.Kashyap, Dept. of Instrumentation and Control Engineering for providing us with the necessary arrangement for the completion of my project. Without his valuable guidance and support the project would not have been a success. I thank him for the good will and encouragement extended to us.

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