# Instrumentasi Industri

## Sensor Terminology

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# Sensor Terminology

- Span
- Zero
- Accuracy
- Repeatability
- Process measurement dynamics
- Calibration

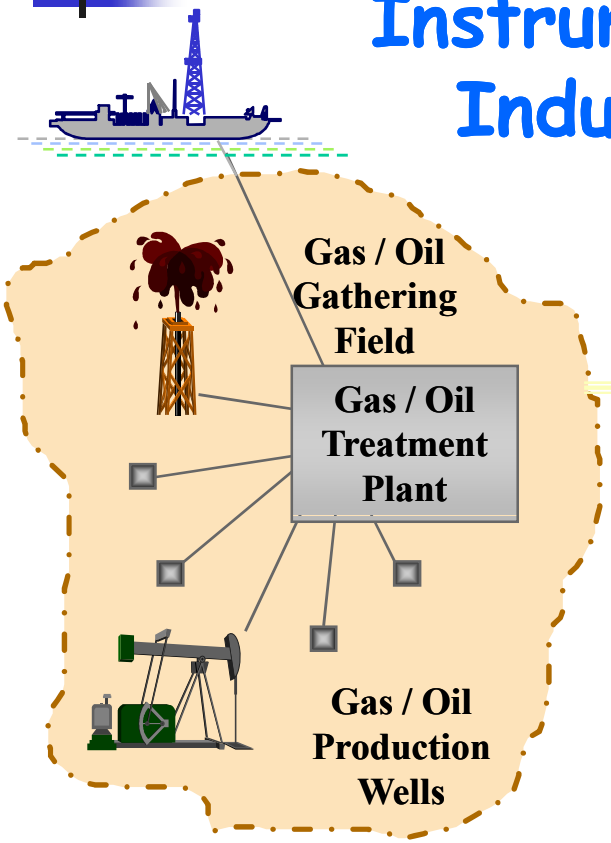
# Span and Zero Example

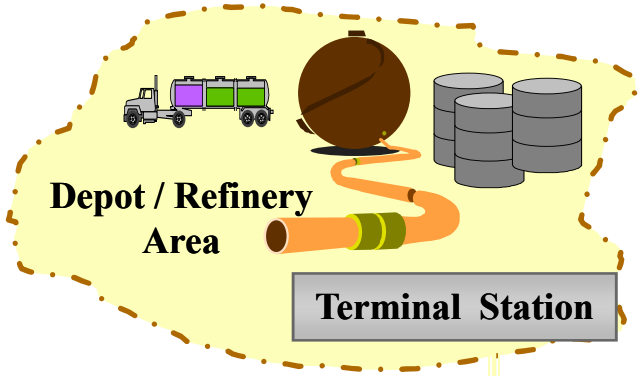
- Consider a case in which the maximum temperature that is to be measured is 350ºF and the minimum temperature is 100ºF.
- Then the zero is 100ºF and the span is 250ºF
- In addition, if the measured temperature is known at two different sensor output levels (i.e., ma's), the span and zero can be calculated directly.

# Smart Sensor

- Sensors with onboard microprocesssors that offer a number of diagnostic capabilities.
- Smart pH sensors determine when it is necessary to trigger a wash cycle due to buildup on the electrode surface.
- Smart flow meters use statistical techniques to check for plugging of the lines to the DP cell.
- Smart temperature sensors use redundant sensors to identify drift and estimate expected life before failure.

# Aplikasi Sistem Instrumentasi pada Industri Migas



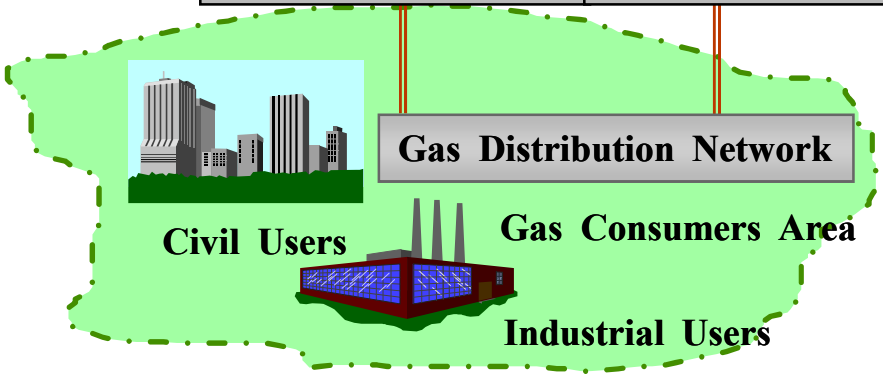

Compressor or Pumping Station

Gas / Oil Pipeline

Compressor or Pumping Station

Gas Reducing & Metering Station

Gas Reducing & Metering Station




***Automation dari wells sampai pengguna***

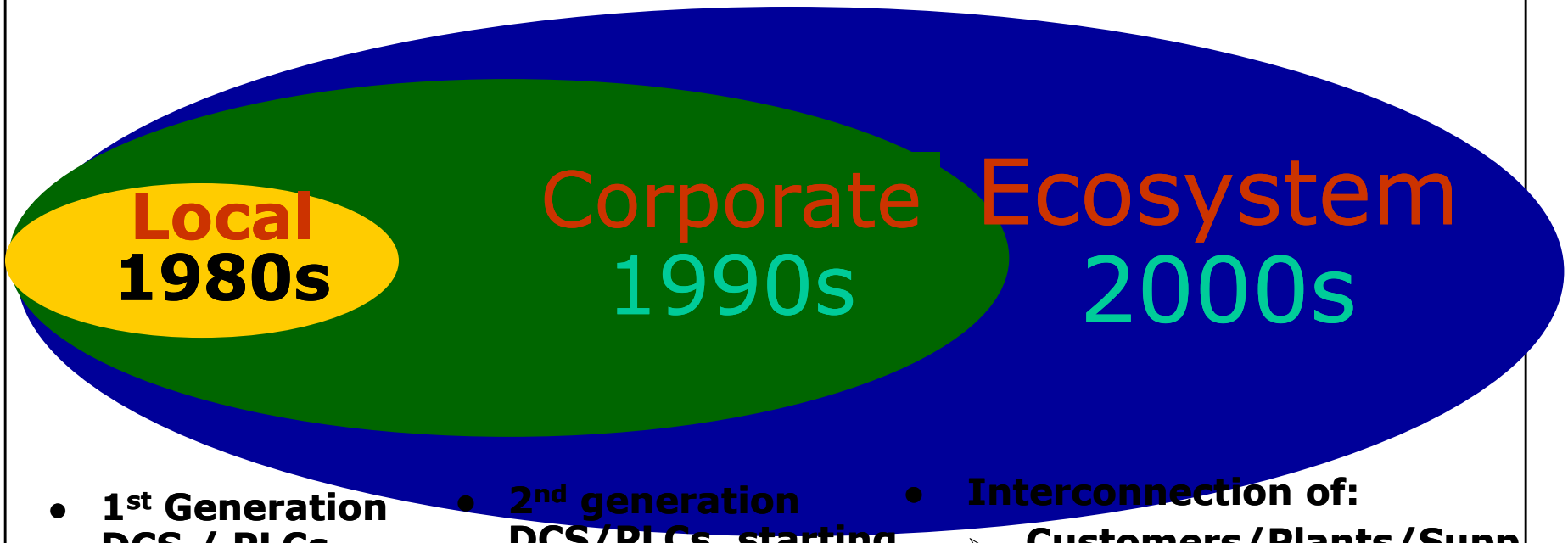
# Teknologi Instrumentasi Konvensional



# Teknologi Otomasi Baru



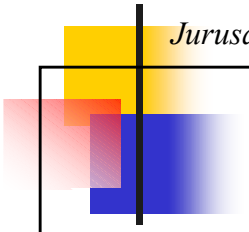
# Evolusi Teknologi Otomasi




- 1st Generation DCS / PLCs
- Proprietary systems/networks
- Introduction of workstations

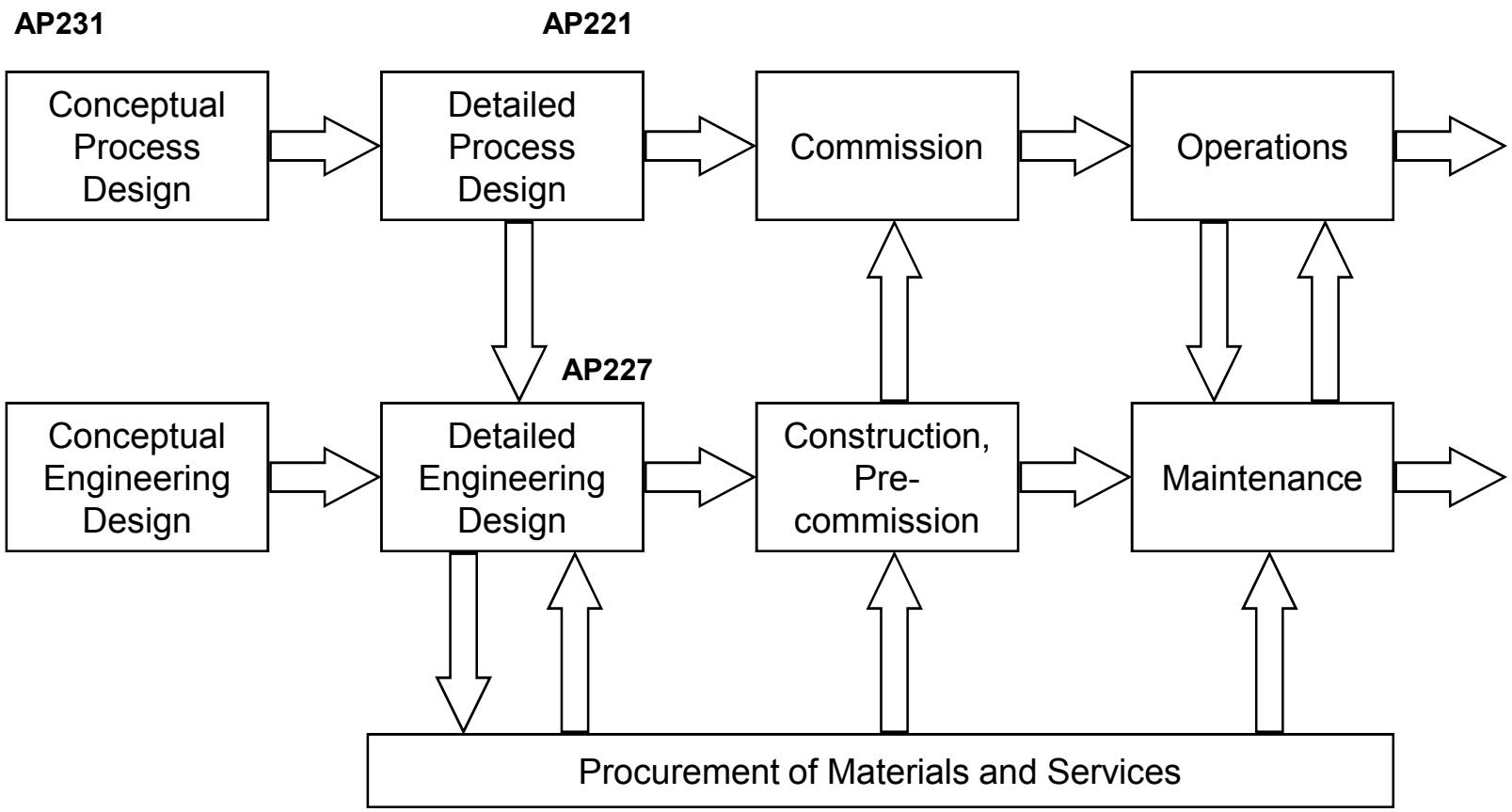
- 2nd generation DCS/PLCs, starting to enable connections
- PC based supervisory systems
- Internet/Intranet
- Business process integration: ERP, CRM, SCM…

- Interconnection of:
  - Customers/Plants/Suppliers
  - All systems & workers
  - Workers in all roles
  - Business & manufacturing processes
  - Effective use of information



# Introduction to the Process Industry

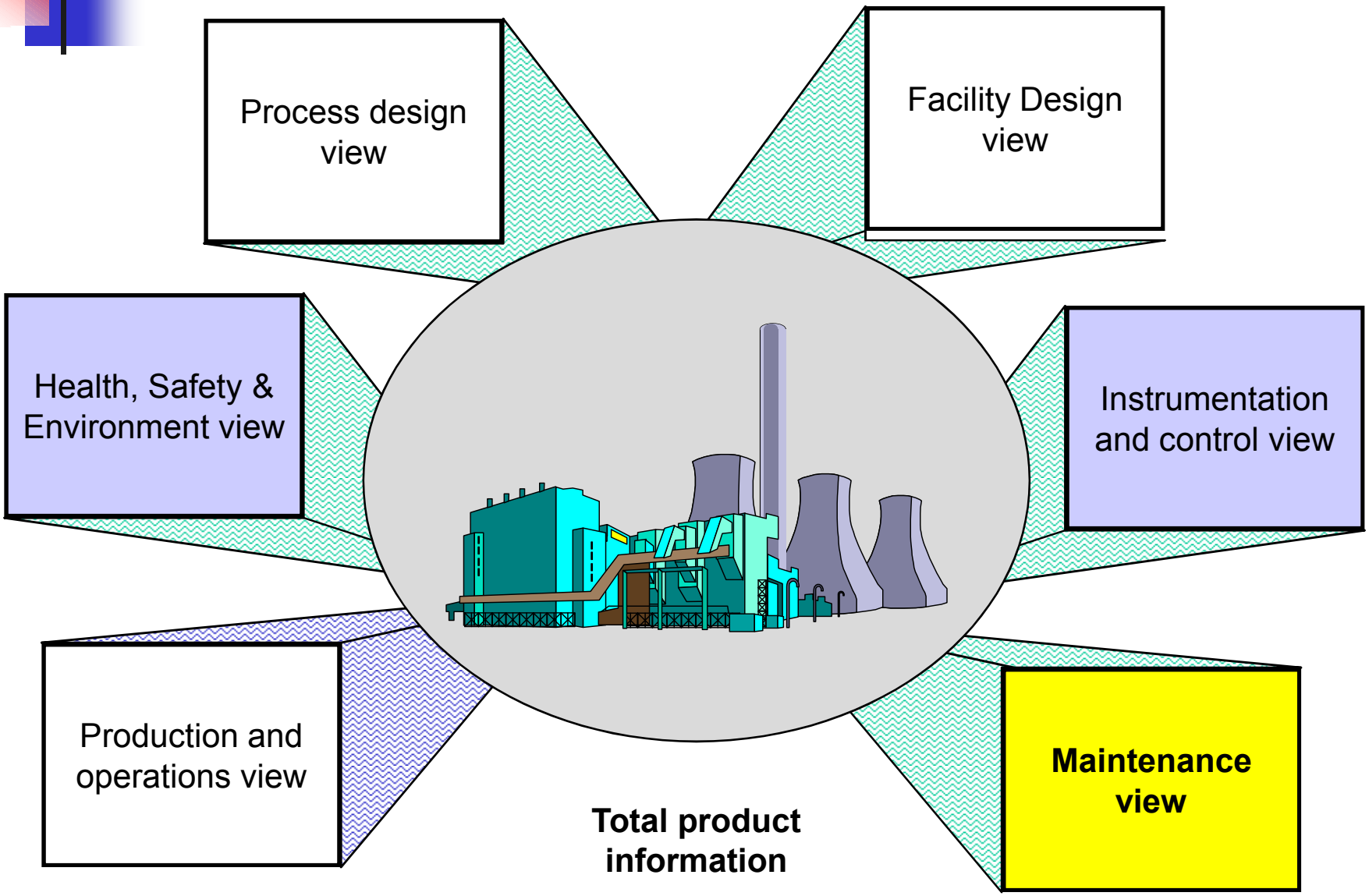
# STEP and the Plant Life-cycle






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# Discipline/life-cycle specific views



# Facility & Equipment Specifications

## ⇩ Process & Instrumentation Diagram

- Identification of plant items
- Classification of plant items
- Composition and properties of plant items
- Connection of plant items
- Physical and functional viewpoints
- Shape representation (3D)

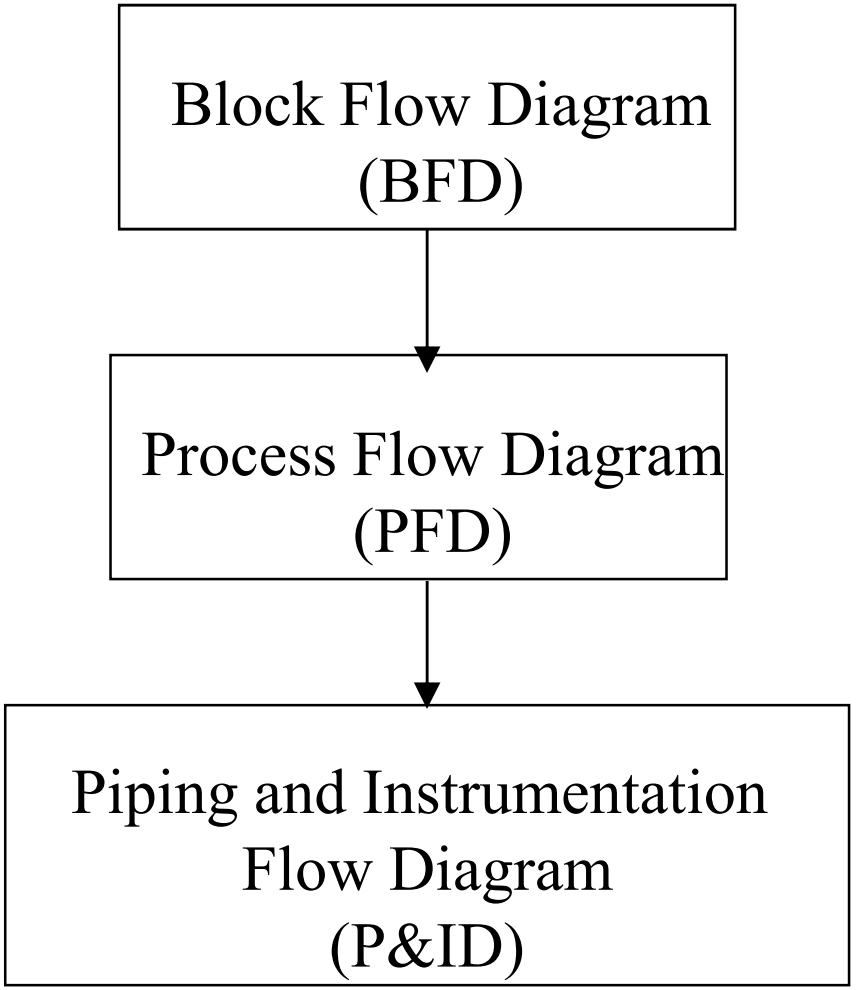
## ⇩ Process Flow Diagram

- Identification and description of equipment
- Identification of major instrumentation and valves
- Stream identification, description and properties
- Temperature, pressure and flow quantities
- Utility summaries

# Operations & Maintenance

- Safety systems & procedures
- Operating manuals & procedures
- Troubleshooting guides
- Pilot plants
- Field tests
- Analysis results
- Sample results
- Process control
  - Control loops
  - Process measurements
- Log sheets, reading sheets, checksheets
- Operating modes

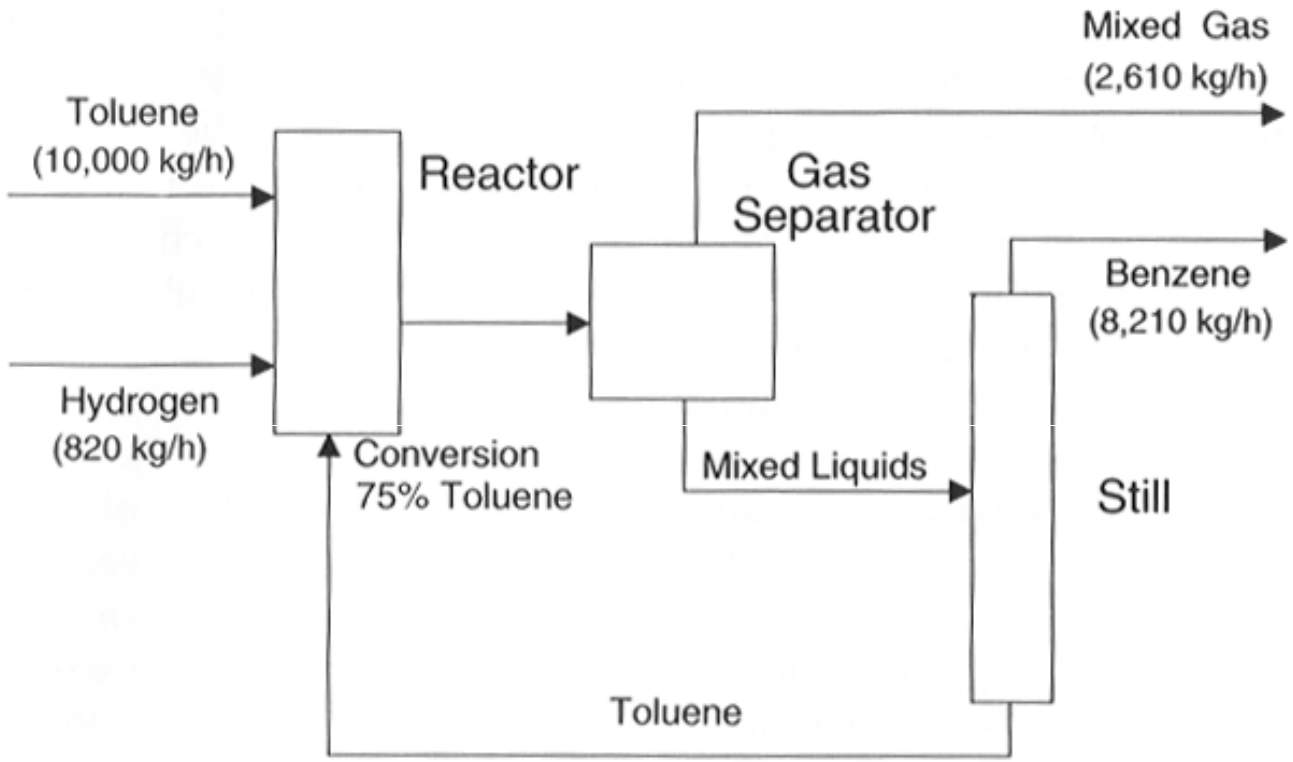
# Chemical Process Diagrams



# Block Flow Diagrams

- Give a clear overview of a process, uncluttered by details.
- Each block represents a process function, which in reality may consist of several pieces of equipment.
- Useful for conceptualizing new processes.
- Often used as a starting point for PFDs.
- Especially useful in oral presentations.

# Block Flow Diagram




Reaction : $C_7H_8 + H_2 = C_6H_6 + CH_4$

Block flow process diagram for the production of benzene.

# Convention and Format for Block Flow Diagrams

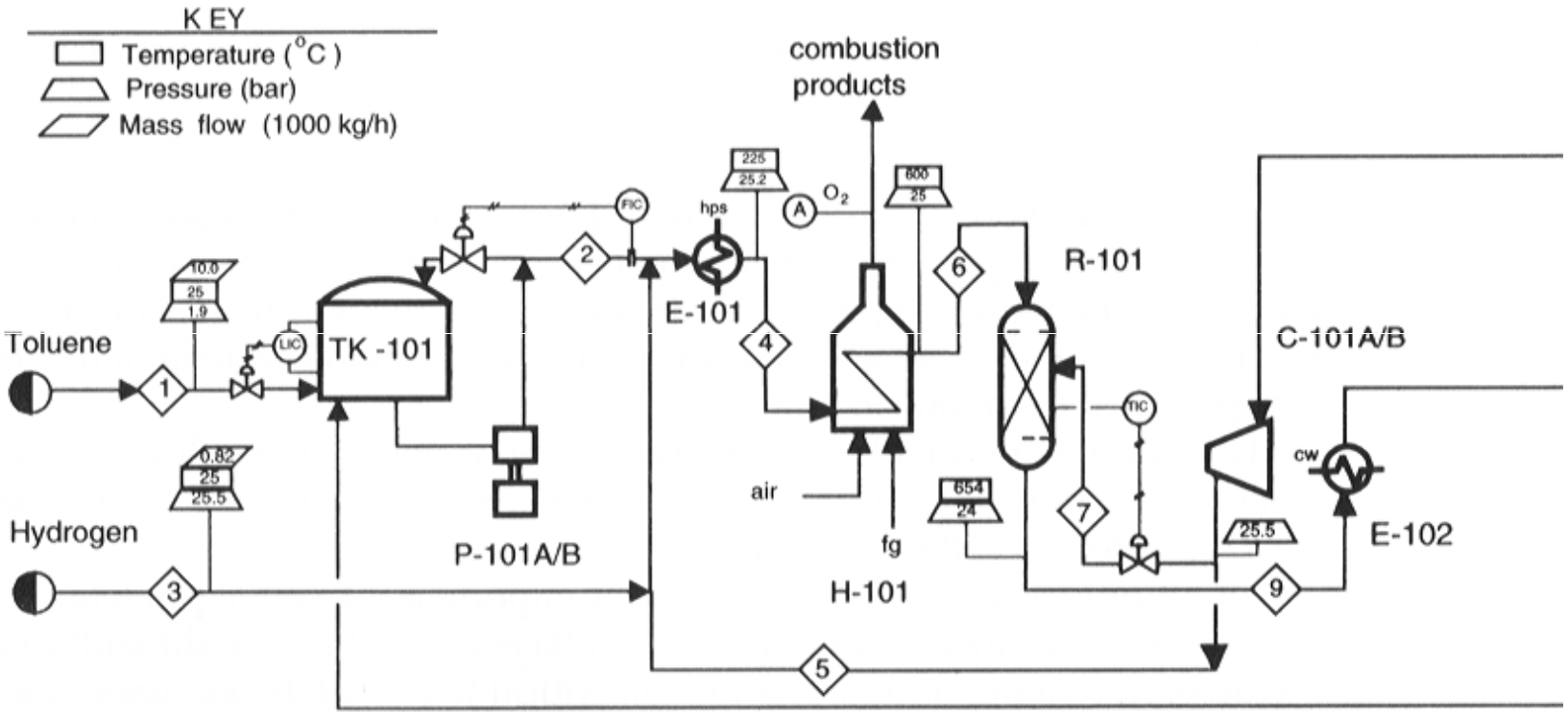
- Operations shown by blocks.
- Major flow lines shown with arrows giving direction of flow.
- Flow goes from left to right whenever possible.
- Light stream (gases) toward top with heavy stream (liquids and solids) toward bottom.
- Critical information unique to process supplied.
- If lines cross, then the horizontal line is continuous and the vertical line is broken (true for all chemical process diagrams).
- Simplified material balance provided.

# Process Flow Diagrams

- Much more complex than a BFD.
- Will include the following information.
  - Major equipment with names, numbers and descriptions
  - All streams shown with number, process conditions, and chemical composition. The latter two may be shown directly on the PFD or on an accompanying stream table.
  - All utility streams to major equipment
  - Basic control strategies and control loops for normal operation.

# Process Flow Diagram

| TK-101 | P-101A/B | E-101 | H-101 | R-101 | C-101 A/B | E 102 |
|---|---|---|---|---|---|---|
| TOLUENE STORAGE | TOLUENE FEED PUMPS | FEED PREHEATER | HEATER | REACTOR | RECYCLE GAS COMPRESSOR | REACTOR EFFLUENT COOLER |




Benzene process flow diagram (PFD) for the production of benzene via the hydrodealkylation of toluene.

# Piping and Instrumentation Diagrams (P&ID's)

- P & ID's represent the last step in process design
- Requires completed process flow diagrams (PFD's)
- P & ID's are a key document for construction and operation of a facility
  - The source of data for instrument lists, equipment lists, piping isometrics.
  - Referred to frequently during HAZOP, startup, routine operation, maintenance, debottlenecking, and upgrades
- A process cannot be adequately designed without proper P & ID's

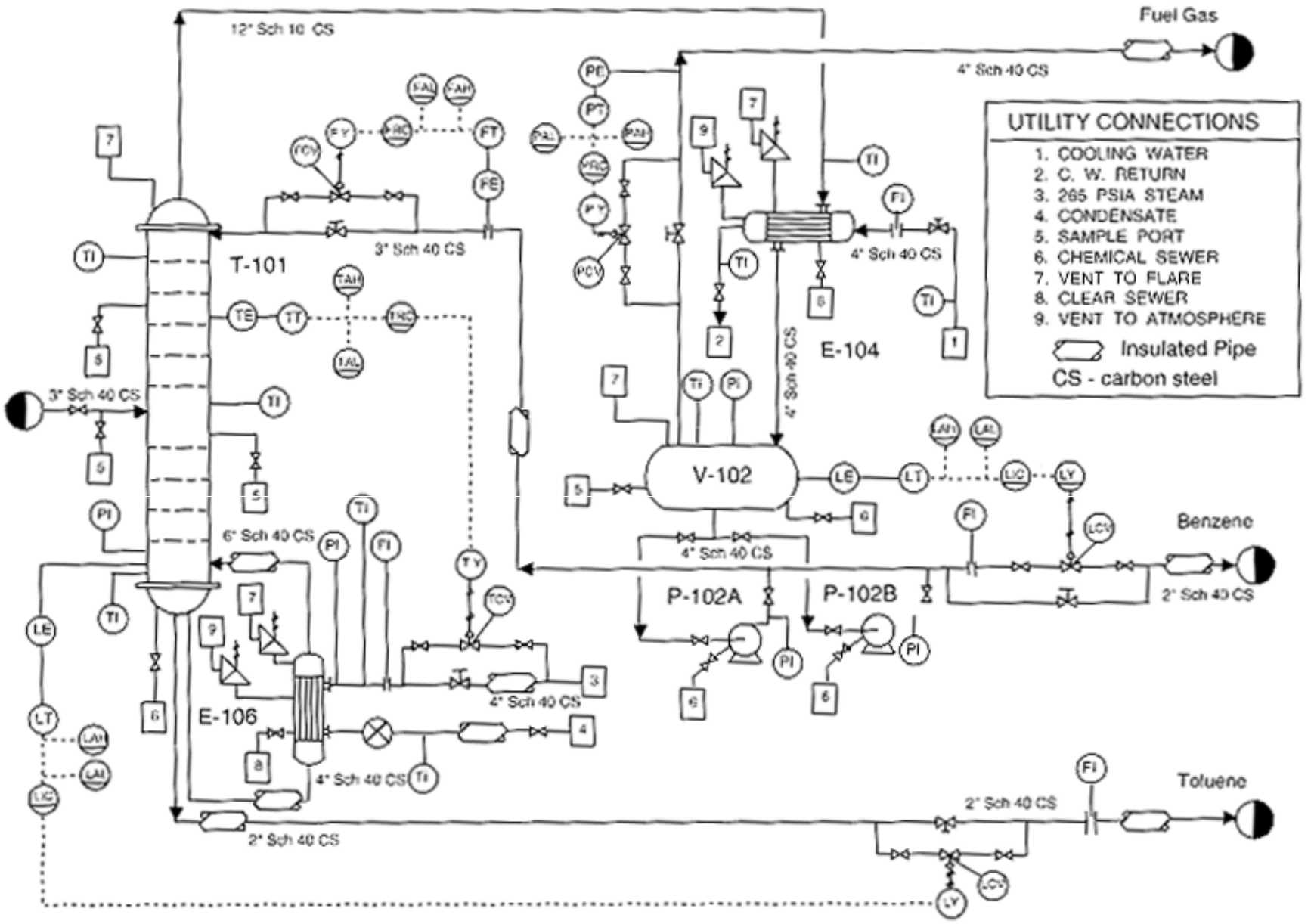



**Figure 1.7** Preliminary piping and instrumentation diagram for benzene distillation. (Adapted from Kauffman, D., *Flow Sheets and Diagrams*, AIChE Modular Instruction, Series G: Design of Equipment, series editor J. Beckman, AIChE, New York, 1986, vol 1, Chapter G.1.5, AIChE copyright, © 1986 AIChE, all rights reserved)

# Importance of P&IDs

- The P&ID is the last stage of process design and serves as a guide by those who will be responsible for the final design and construction. Based on the P&ID:
  - Mechanical and civil engineers will design and install pieces of equipment.
  - Instrument engineers will specify, install, and check control systems
  - Piping engineers will develop plant layout and elevation drawings.
  - Project engineers will develop plant and construction schedules.

# Generation of Drawings and Illustrations

- Up to the 1960s, all engineering curricula emphasized engineering graphics.
  - Tedious, labor-intensive manual process.
  - Chemical engineering programs typically dropped the requirement in the 1970s.
- CAD (computer-aided design) software became widespread in the 1980s.
  - Very powerful and flexible, but had a very steep learning curve.
- Engineers usually have draftspeople generate their drawings.
  - Industry standard for professional draftspeople is AutoCAD.
  - Installed in our computer lab.

# Generation of Drawings by Engineers

- However, we must communicate with draftspeople, and sometimes we must generate the drawings ourselves.
- Fortunately, new, easily learned software allows engineers to generate high quality drawings without investing large chunks of one's career in learning the tools.
  - Microsoft Visio Professional is a good example.
  - Visio has many standard templates, including good process engineering templates.
  - Standard MS Office interface.
  - Installed in our computer lab.
  - Available for purchase at HiTech for $149.