Lecture-5
Flowsheeting, Material & Energy Balance

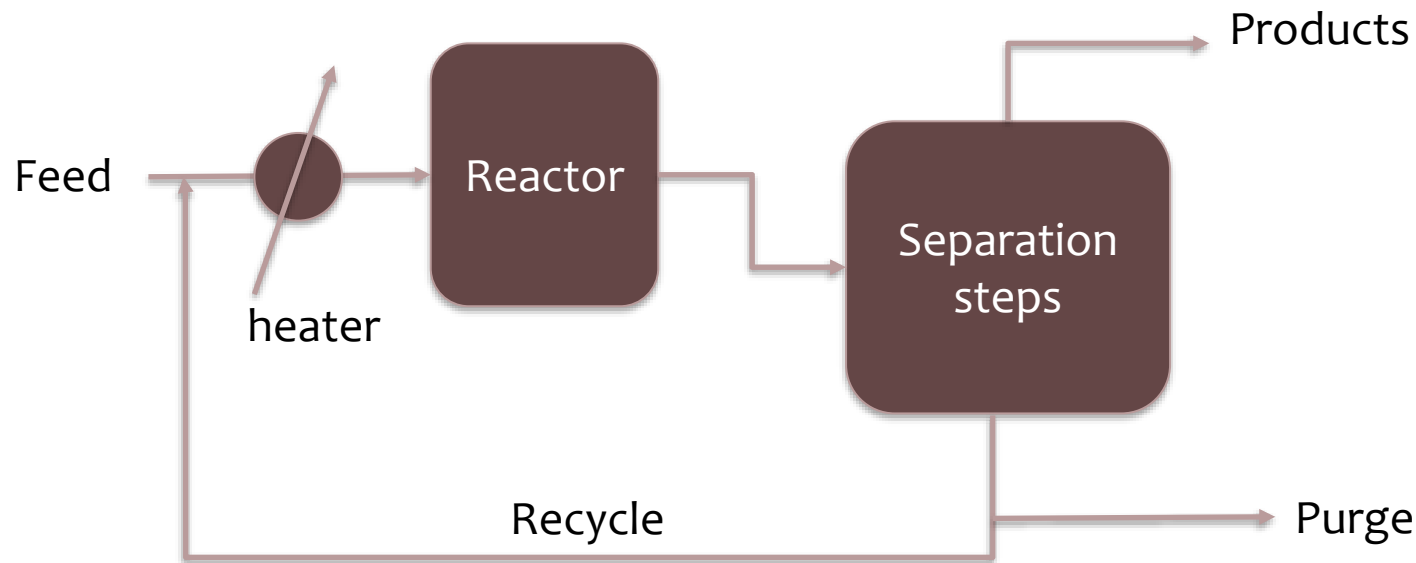## CHE261A: Chemical Process Industries

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Process

A production process is a *system of process equipment*, *material and energy flows*, task specification, information flow, and workforce employed to produce a product.

Various drawings

- ## Block diagram
  - Process overview with operating conditions
- ## Process flow diagram (PFD)
  - Includes stream table (component mass & overall energy balance, stream physical properties, operating & design conditions etc.)
- ## Piping & Instrumentation diagram (P&ID)
  - Includes piping, metering & control information
- ## Isometrics
  - Includes elevation, bends etc.
- ## Process equipment drawings
  - Design data of equipment

Various stages of process development

- Conceptual stage/feasibility study
  - Block diagram
  - Overall material balance
  - Feasibility economics
- Basic engineering
  - Design basis
  - Technology selection
  - Component balances and energy balance
  - PFD
  - Actual plant cost ($\pm 50\%$)
- Detailed engineering
  - P&ID, Isometrics, equipment drawings
  - Actual plant cost ($\pm < 20\%$)
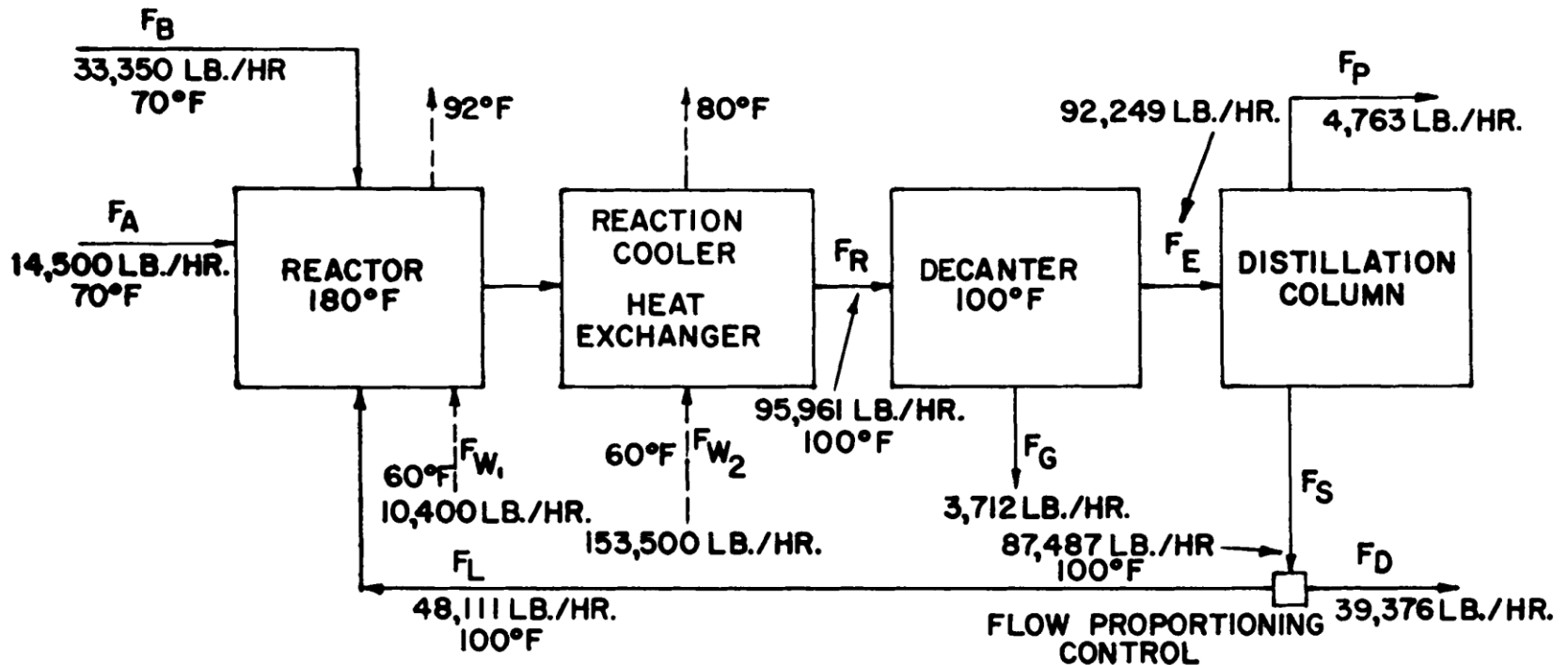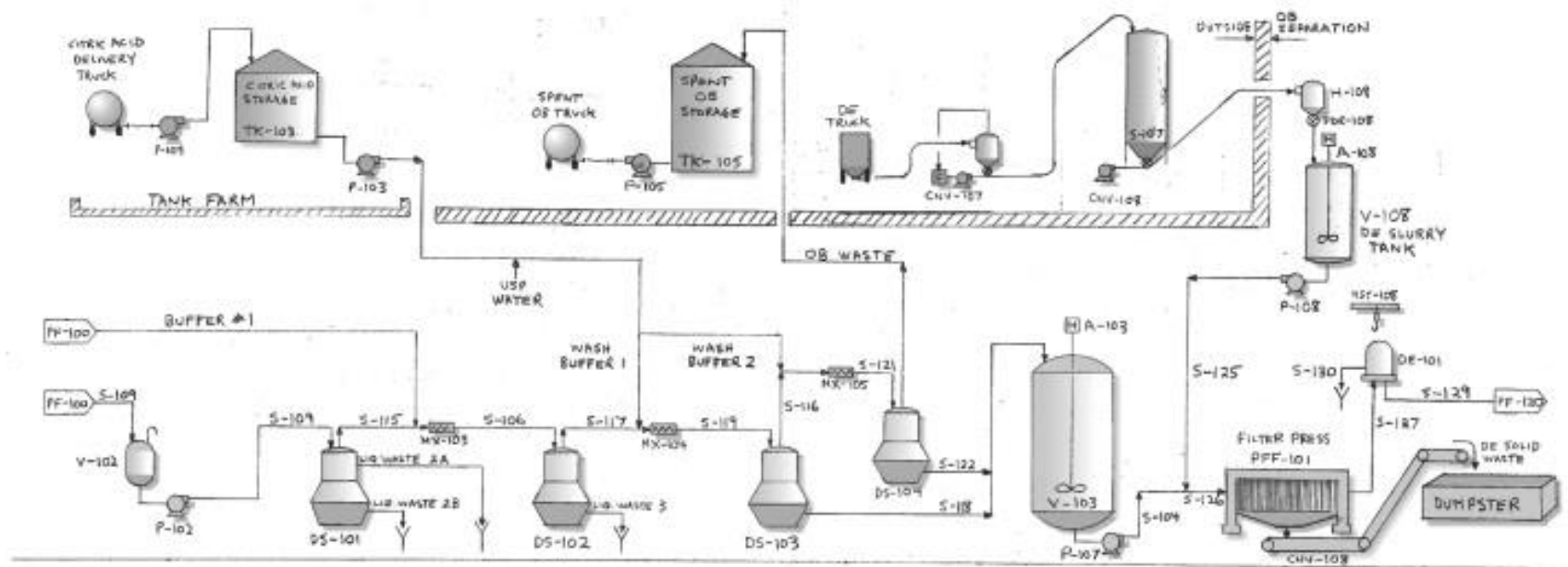- Project Implementation

Block diagram example

Fig. 1. Process showing relationship of process units, main stream rates, and stream temperatures

Williams & Otto (1960)

PFD example
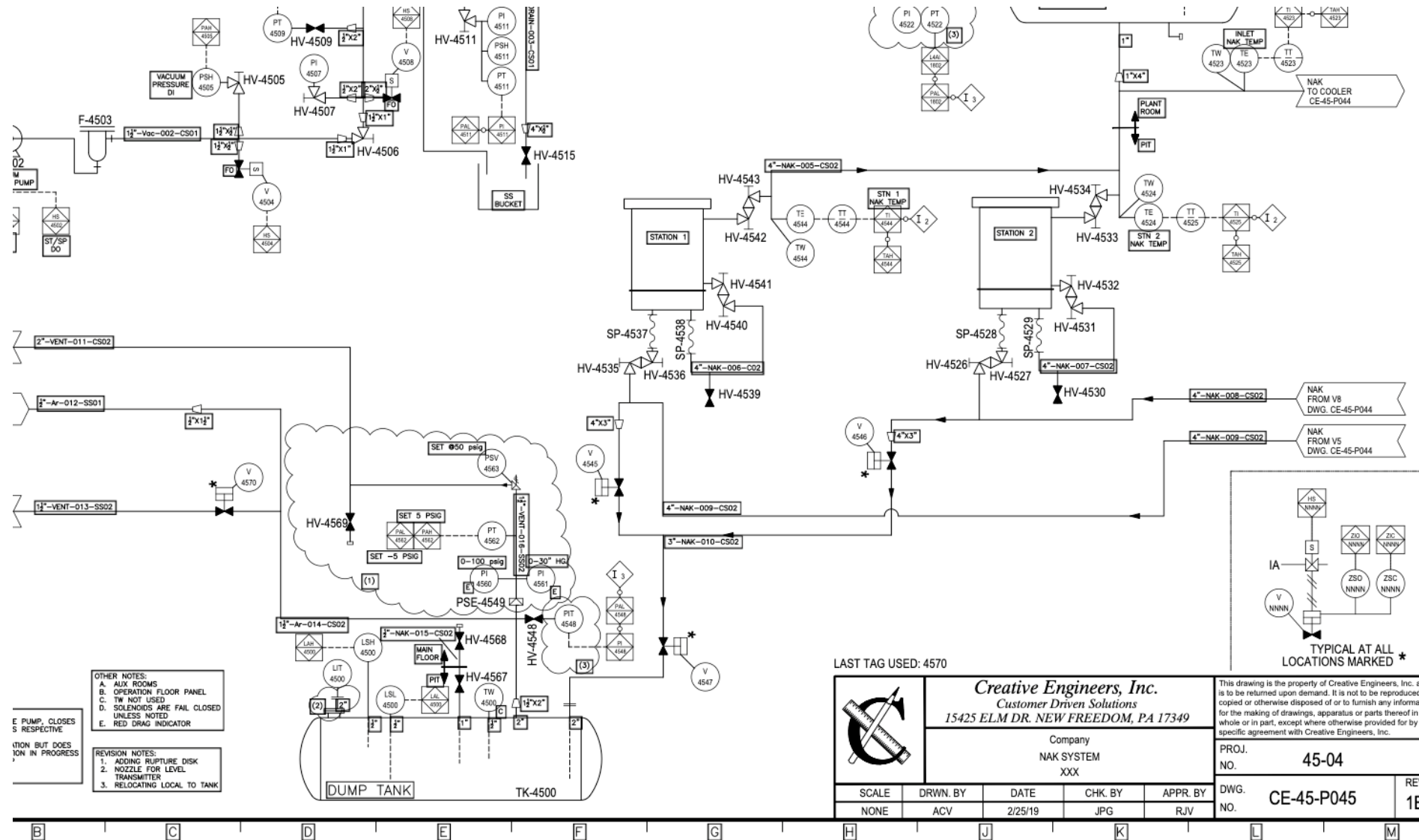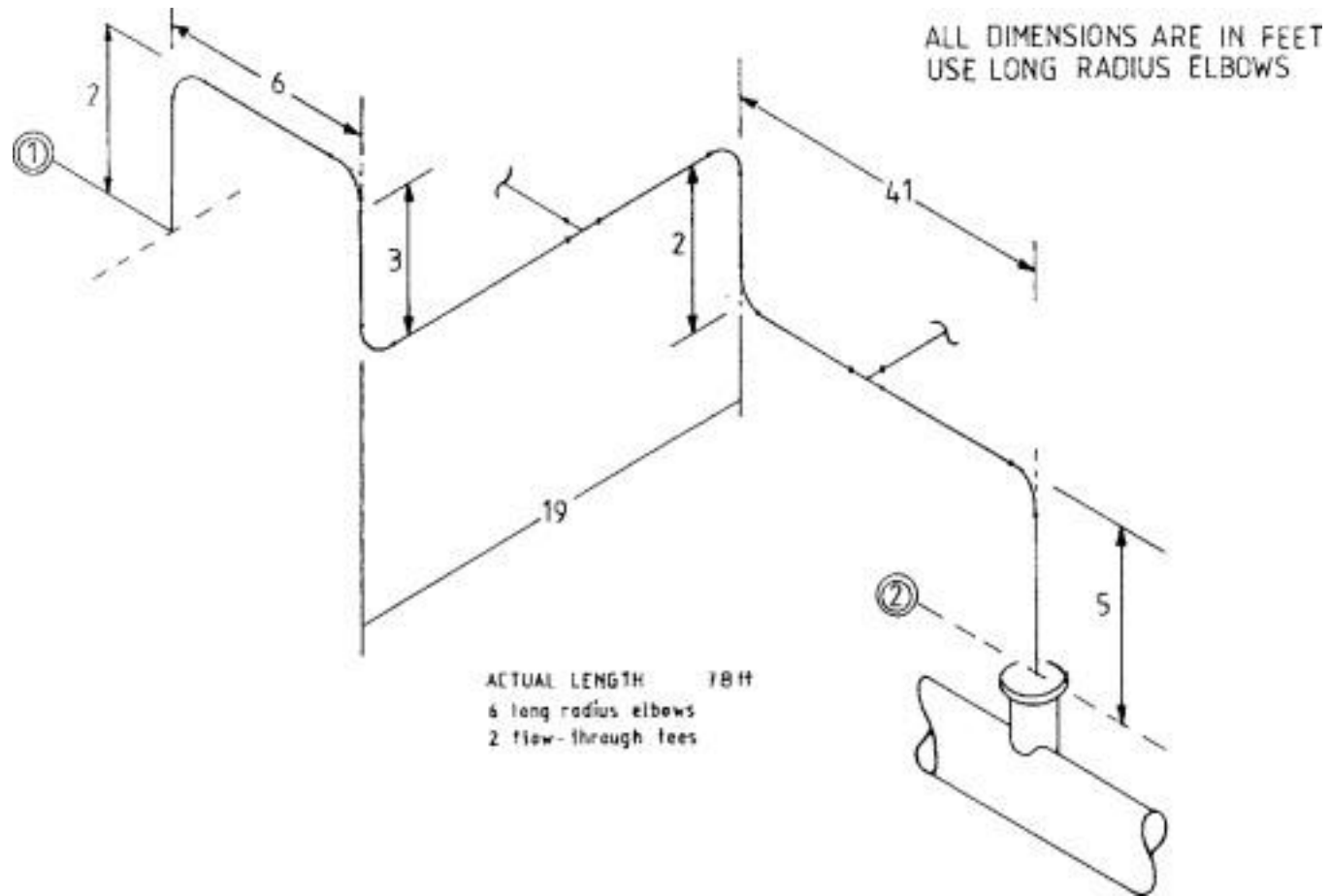
Stephen Hall, Rules of Thumb for Chemical Engineers
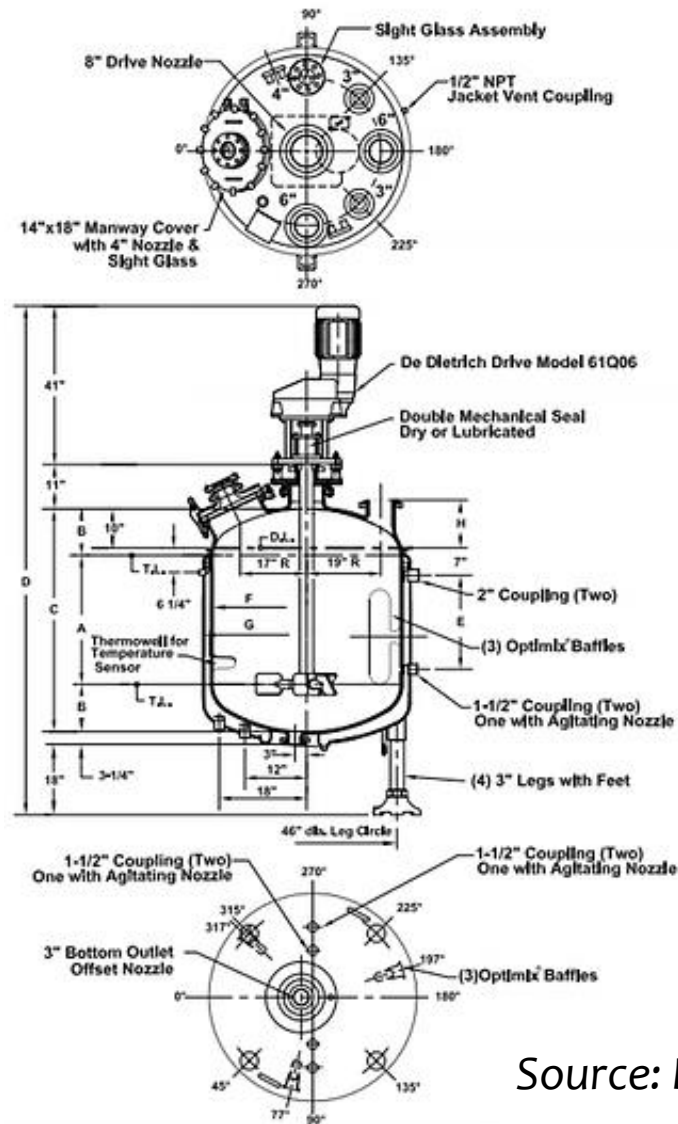
P&ID example

Isometric drawing example

A. Kayode Coker, Fortran Programs for Chemical Process Design, Analysis, and Simulation

Equipment drawing example

Source: De Dietrich process systems

Water purification process

Can you draw a block diagram?

ISBL

OSBL

| Non-potable water source | → 100 L/d → | Overhead tank | → 10 L/d → | Prefilter | → | UV-filter |

Overhead tank → For domestic use

Prefilter → x g/d → Sediments

RO-filter → 5 L/d → Drinking water

RO-filter → 5 L/d → Rejected brine

Inside battery limits: process boundary
Outside battery limits: auxiliary units & support infrastructure