Optimal Design of Energy Systems

Chapter 2

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Chapter 2. Designing a workable system

2.1 Workable and optimum systems

- There are many possible answers to a design problem

- But, only one solution is the optimum
  - Cost
  - Size
  - Weight

nonworkable < workable < optimal

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2.2 A workable system

① Requirement of the purpose of the system

② Satisfactory life and maintenance costs

③ Within imposed constraints

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2.3 Steps in arriving at a workable system

① To select the concept

② To fix parameters

2.4 Creativity in concept selection

◎ Creativity
- old ideas : should be reviewed
- cost change : old times vs. today

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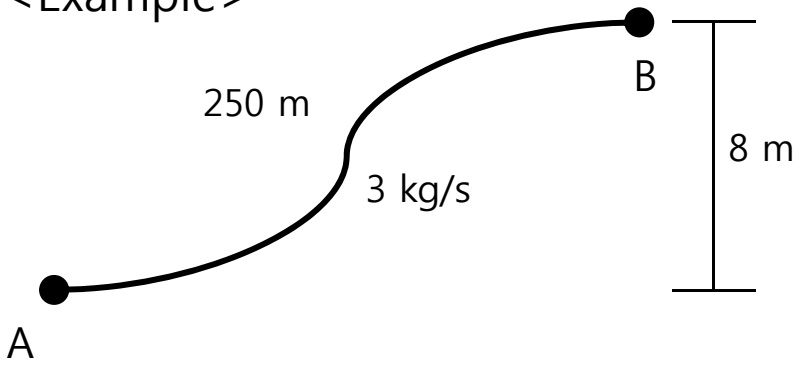
2.5 Workable vs. optimum system

<Example>



<Question> Pipe diameter?

<Solution>

① $\Delta p_{gravity} = (8\ m)(1000\ kg/m^3)(9.8\ m/s^2) = 78.5\ kPa$

② $\Delta p_{friction} = 100\ kPa$ (arbitrarily chosen)

③ $\Delta p = 178.5\ kPa$, $m_{pump} = 3\ kg/s$

} ④ Pipe diameter = 50 mm

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2.5 Workable vs. optimum system

Minimize the cost

Pump cost

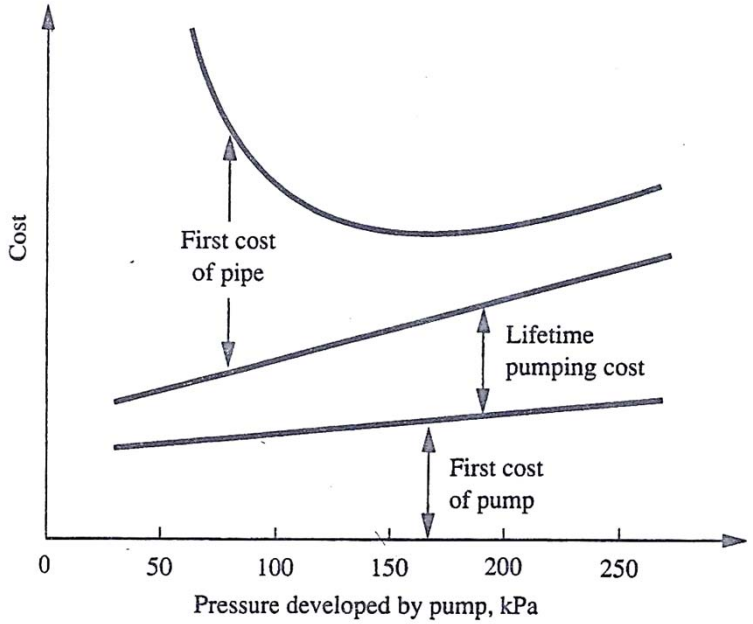
+

pumping cost

(ex> electricity)

+

pipe cost



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2.5 Workable vs. optimum system

Arbitrarily selected solution (workable system)

Improvement over the arbitrary selection

(optimum system)

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2.6 Design of a food-freezing plant

- Major decisions : (1) location, (2) size, (3) type of freezing plant

- Sequence

1. Location (adjacent to a refrigerated warehouse)

2. Freezing capacity

(amount of the crop, potential sales, etc.)

3. Concept of the plant (Fig 2-2)

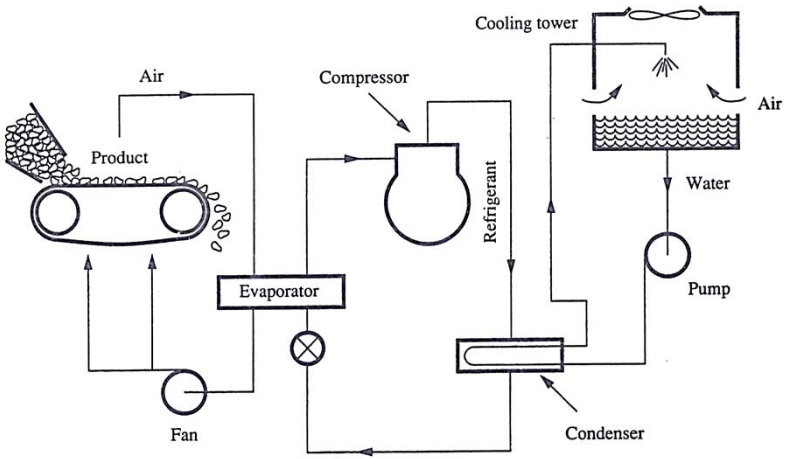

FIGURE 2-2
Schematic flow diagram of freezing plant.

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2.6 Design of a food-freezing plant

4. Quantify (cooling load 220 kW, Table 2.1)

5. Individual components selection

TABLE 2.1

	Temperature, °C
Air, chilled supply	−30
Return	−23
Refrigerant, evaporation	−38
Condensation	45
Condenser, cooling water, inlet	30
Outlet	35

Components : conveyor length & speed, air-cooling evaporator, two-stage compressor, condenser, water pump(cooling tower), etc.

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2.7 Preliminaries to the study of optimization

(1) Economics (Chap 3)

(2) Mathematical modeling (Chap 4, 5, 13)

(3) System simulation (Chap 6 & 14)

(4) Optimization (Chap 8 to 12)