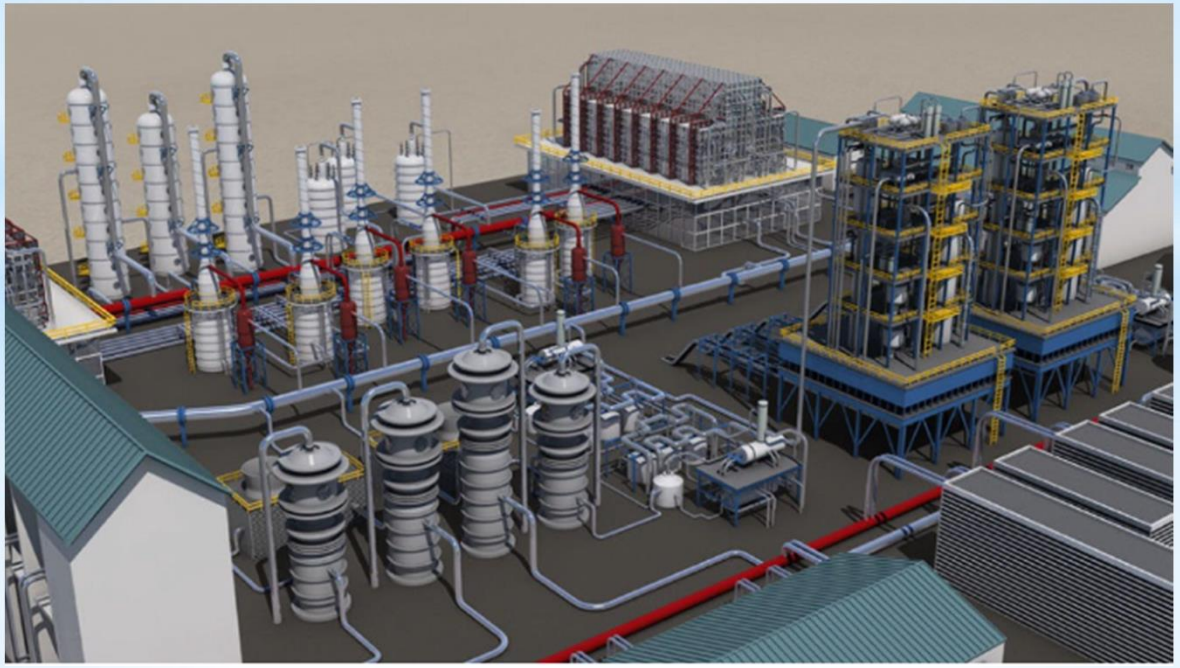
Breakup: L –T –P –C

4 –0 –0 –4

Chemical Engineering Design II

CHE-S401



Abhishek Kumar Chandra

What is design?

Design is a creative activity.

or

Design is a complex and varied activity.

Chemical Engineering Design

creation activity or idea or as creation manufacturing process to fulfill public need or commercial opportunity.

one of the most rewarding and satisfying activities undertaken by an engineer.

Aim of chemical engineering design

Construction of new chemical plants.

Expansion or revision of existing plants in order to increase the productivity.

Modification of existing plant in order to change the product or the way of production.

Optimum design

Almost every case chemical engineer encountered by several alternative methods which can be used for any given process or operation.

For example:

Formaldehyde can be produced by

- catalytic t dehydrogenation of methanol,
- controlled oxidation of natural gas,
- direct reaction between CO and H,

under special conditions of catalyst, temperature, and pressure.

- Each of these processes contains many possible alternatives involving variables such as

gas-mixture composition, temperature, pressure, and choice of catalyst.

It is the responsibility of the chemical engineer, in this case, to choose the best process and to incorporate into the design the equipment and methods which will give the best results

Optimum

Economic design

If two or more methods giving exactly same final results, the preferred method would be the one involving the least total cost. This is the basis of an optimum economic design.

One typical example:

Determining the pipe diameter to use when pumping a given amount of fluid from one point to another.

This can be accomplished by using an infinite number of different pipe diameters.

However, an economic balance will show that one particular pipe diameter gives the least total cost.

(cost for pumping the liquid + cost of installed piping system.

Operation design

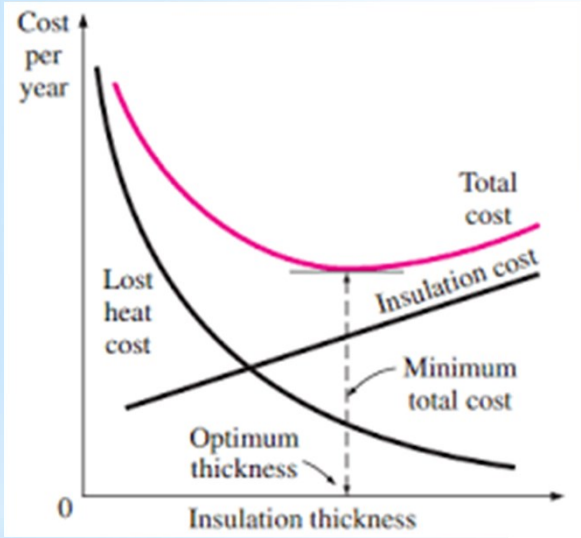
Many processes require definite conditions to obtained the best results. Such as

- temperature,
- pressure,
- contact time,
- other variables

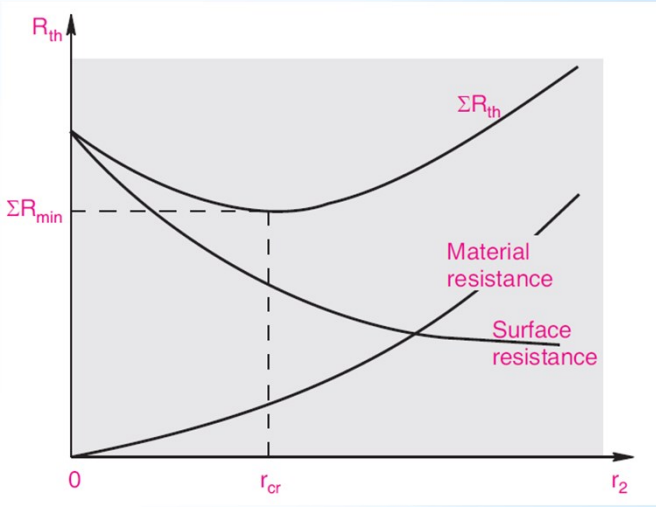
It is often possible to make a partial separation of these optimum conditions from direct economic considerations.

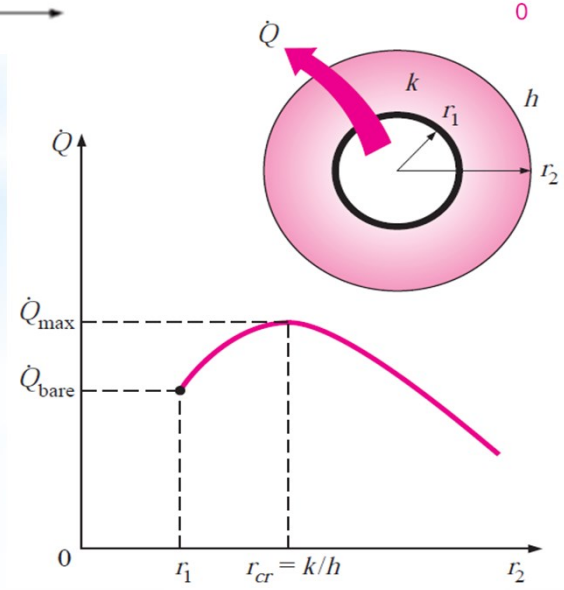
In cases of this type, the best design is designated as the optimum operation design.

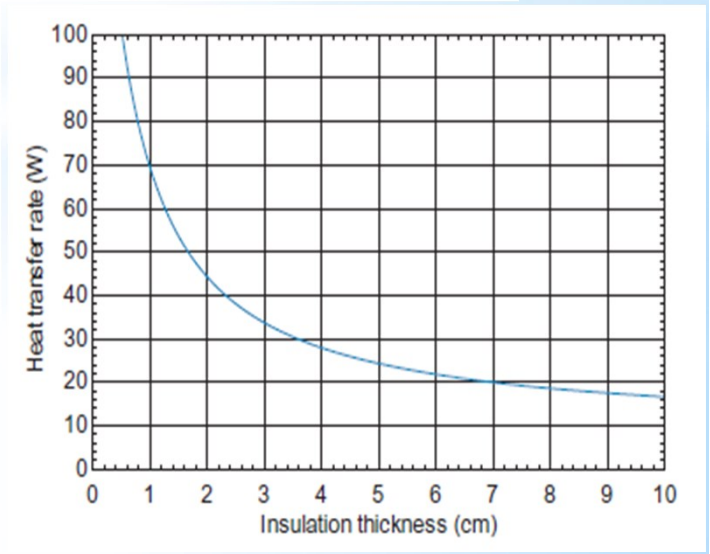
Economic insulation thickness



Effect of insulation thickness on heat transfer rate







Chemical Engineering Design

I

Design steps for chemical processes

Process design development
- Feasibility survey
- Flow sheet presentation

Flowsheet synthesis and development
- Material balance and energy balance

General design considerations
- Health and safety hazards;
- Loss prevention;
- Environmental consideration;

Cost estimation
- Cash flow for industrial operations

II

Anatomy of a chemical manufacturing process
- Codes and standard,
- Factor of safety
- Degree of freedom

Prediction of physical properties

Pumps
- Types of pumps
- Criterion for selection of pumps

Equipment selection, specification and design
- Separation processes
- Solid- solid separations

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Interest and investments costs

- Depreciation:
- Profitability,
- Alternative investments and Replacements

Optimum design and Design strategy

- optimum solution methodologies

Material selection for equipment

- Liquid solid separators
- Separation of dissolved solids
  1. evaporation
  2. crystallisation
- Liquid- liquid separation
  1. decanters,
  2. centrifugal separators
- Gas – solid separation
  1. gravity settlers
  2. cyclones,
  3. electrostatic precipitators

Separation columns

- Design method for binary system
- Multicomponent distillation

Heat transfer equipment

- Types of exchangers
- Design of following equipment
  1. double pipe,
  2. shell and tube
  3. Condensers
  4. Evaporators

Mechanical design of Pressure vessels

- Column design
- Head and closures
- Vessel supports

Text and Reference Books:

- R. K. Sinnott, Coulson and Richardson's Chemical Engineering Series, Chemical Engineering Design Vol 6, Elsevier
- E. E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Elsevier
- S. M. Walas, Chemical Process Equipment - Selection and Design, Butterworth Series of Chemical Engineering
- R. Smith, Chemical Process Design and Integration, Wiley
- V. V. Mahajan and S. B. Umarji, Joshi's Process Equipment Design, Laxmi Publications
- S. B. Thakore and B. I. Bhatt, Introduction to Process Engineering and Design, McGraw Hill Education