

2003 National Exams

98-Chem-A5, Chemical Plant Design & Economics

3 Hours Duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of the assumptions made.
2. Any non-communicating calculator is allowed. This is an OPEN BOOK exam.
3. The questions are of equal value. The candidate will answer any five of the seven questions. Only five questions that you answer will be marked.
4. Most questions require an answer in essay format. Clarity and organization of the answer are important

1) **Cost Estimation (20 marks)**

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- **“What exactly is a ‘factored equipment estimate’?”**
- **What’s a “base cost”. “bare module cost” and what is included in the latter?**
- **What factors are applied to get a total estimate of the plant?**
- **What do these factors take into account ?**

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2) **Process Selection and Design (20 marks)**

It has become almost an essential that a process designer must make every attempt to design as safe a plant as possible within the constraints of acceptable profitability and acceptable risk. There are four general rules to be followed as given below.

1. **Minimize**
2. **Substitute**
3. **Moderate**
4. **Simplify**

Give examples of what these four rules would mean in an actual design.

3) **Risk Assessment (20 marks)**

The following table gives values of Minimum Acceptable ROIBT (Return on Investment before Taxes)

Industry	Percent ROIBT		
	Low-Risk Projects	Average Risk Projects	High Risk Projects
Industrial Chemicals	11	25	44
Petroleum	16	25	39
Pulp and Paper	18	28	40
Pharmaceuticals	24	40	56
Metals	8	15	24
Paints	21	30	44
Fermentation Products	10	30	49

The decision of whether a new project is low risk, Average risk or high risk is quite subjective and usually requires an in-depth knowledge of the industry and considerable experience.

- Give some general consideration that might indicate whether a project is a low, average or high risk project.
- There have been procedures developed that allow one to make an attempt to quantify risk, describe this approach.

4) Profitability Evaluation (20 marks)

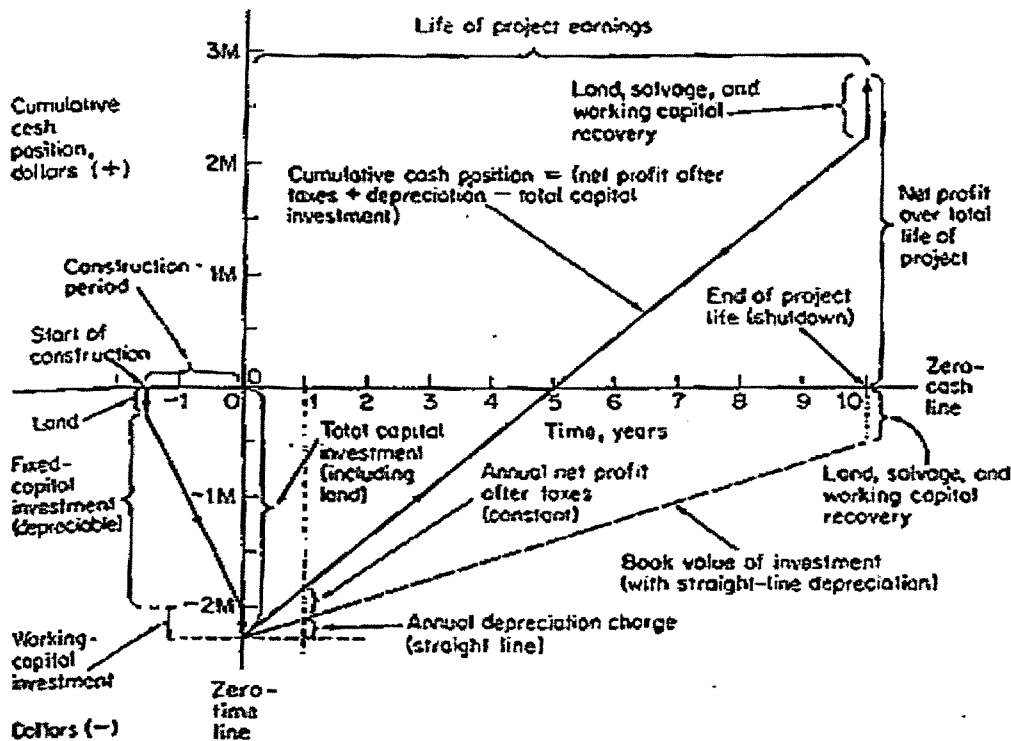


FIGURE 6-2

Graph of cumulative cash position showing effects of cash flow with time for an industrial operation neglecting time value of money.

The above figure is a typical cash flow diagram. Using the concept of the above diagram show how you would demonstrate Rate of Return on Investment, and Payout period on the basis of no interest and including interest.

5) Computers and Process Engineering (20 marks)

Toyota has been known for being in the forefront of using computer systems in order to design and build excellent automobiles. Boeing has had similar success with their new airliner. How have computers in a similar fashion impacted the design and operation of hydrocarbon process units?

6) The role of Optimization in Design and Operation of Chemical Processes (20 marks)

Optimization can be as trivial an exercise as the selection of optimum pipe diameter where one must choose between savings in initial capital cost by the use of a smaller diameter as compared to higher operating costs "pumping energy costs" over the life of the project. The relative cost of the particular metallurgy used enters into this assessment. More sophisticated optimization procedures have been developed for much more complex systems. Briefly describe techniques that could be used in the following instance. These methods should consider design and operations issues.

Methanol is produced by reacting a mixture of Syngas with additional CO_2 . This mixture is fed to a reactor where some conversion takes place to methanol and by-products. This reaction is an equilibrium reaction and it is exothermic. In a flash vessel the unreacted gases are separated from the liquid portion of the product and recycled to the reaction. As a general rule for reactions of this type higher conversions will result in a rapid build up of impurities in the recycle stream which in most instances impairs the efficiency of the catalyst. This is usually compensated for by a bleed stream of a portion of the recycle gases.

7) Mass Transfer (20 Marks)

There are many types of mass transfer operations. Describe four that could be used for separations and give an example of their application. Discuss the advantages or disadvantages of each for the selected application.