May 2010 National Exams

04-Chem-A5 Chemical Plant Design and 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) **Flowsheet Synthesis and Development (20 marks)**

Any process engineers during their career may be called upon to develop a speculative design for a novel process for which there is only bench scale data available. Describe what would be involved in a typical design of this nature. What are the key issues that should be resolved at this point of process assessment?

2) **Software Use in Process Design (20 marks)**

Most process engineers rely on computer software in the field of process design. One of the more important tools is the Flowsheet Simulator such as Aspen, and Pro/II. Although these simulators were primarily developed for the Oil and Gas and Petrochemical business there are many more processes being proposed that are known as biochemical. Has the candidate any comments as to whether these robust flowsheet simulators may be used in the design of bio processes. What additions to the typical simulator would be required to make them fully functional in this field?

3) **Health & Safety. Loss prevention and Environmental Issues (20 marks)**

In today's environment the process designer must take the issues of Health and Safety, Loss prevention and Environmental stewardship into consideration. Currently many governments are promoting the capture of CO2 and its subsequent sequestration into underground formations.
Near Lake Nyos in the Cameroons in 1986, after a natural release of carbon dioxide. Approximately 1,700 villagers were asphyxiated, along with 3,500 livestock.
Has this natural catastrophe any possible relevance to the rush to collect and sequester massive amounts of CO2?

4) Economic Feasibility Assessment (20 Marks)

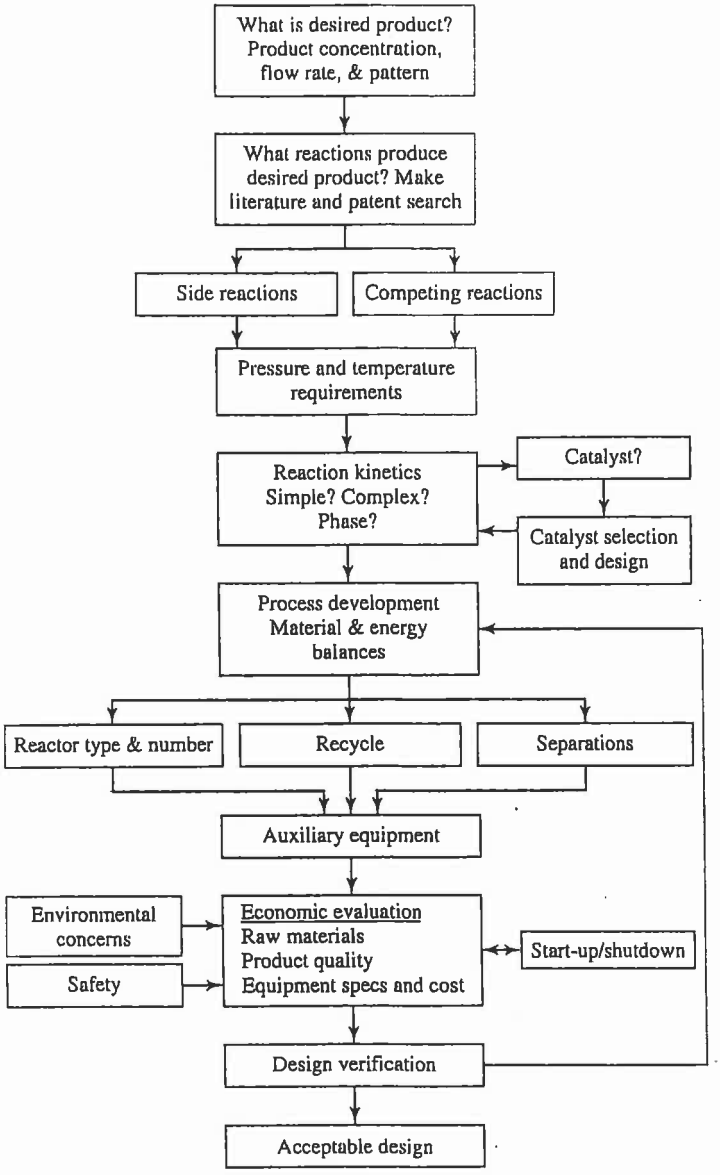
Generally the net present worth method combined with the discounted cash flow rate of return method is preferred for making economic feasibility assessments. These are simply accounting procedures normally carried out using appropriate software. However in today's global economy there are many factors to be considered that are very difficult to predict. Accordingly it is unlikely that one can visualize an orderly market. Examples of these are globalization, the increasing importance of emerging economies such as India and China, distortions in the marketplace such as the Feed in Tariffs for allegedly "green" energy and so on. In many situations process engineers have a major role in preparing appropriate information for senior management to make decisions. Are there procedures available that make an attempt to give a reasonably estimate of process economic feasibility? What are these and how are they used.

5. Process Optimization (20 Marks)

Profit margins are generally relatively limited in today's economy. In a typical process, Capital and subsequent maintenance cost of equipment is a most important issue. Energy and carbon footprint are critical operating issues as may be the consumption of water for example. Where is optimization applied in design and operation of a typical process unit?

6. Chemical Reactor Design (20 Marks)

The following flowchart is a graphical representation of Reaction Design and Evaluation. Currently there is an emphasis on what is known as green engineering. With respect to this concept where in the process of design and evaluation would "green" principles be important? As in all aspects of process design tradeoffs can be very important. Are there any potential tradeoffs in this process?



7 Selection of suitable reaction scheme (20 Marks)

As a process designer you have to design a continuous system which will contact a powder with a strong especially toxic acid. The powder is very abrasive and should it settle out, it essentially sets up into a concrete like solid.
There are many considerations to be dealt with in this system. Outline the potential problems and give some thought as to what a reaction system would look like that could deal with this.