December 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. The primary reference text is M.S. Peters and K.D. Timmerhaus, *"Plant Design and Economics for Chemical Engineers"* ***Fifth Edition.***

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)

Process designs can vary all the way from a "back of the envelope" study to a complete detailed design that could be handed over to a contractor. There are many possible reasons that justify some form of process design. Discuss some of these.

2) Software Use in Process Design (20 marks)

GIGO (Garbage in Garbage out) is always a risk in the use of simulation software. One often overlooked issue is physical and thermodynamic data. Why should this be the case, and where does one get the necessary data. How does one know if the data is reliable?

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. With the proliferation of blogs and other means for activists of all stripes to disseminate unscientific scare stories, "the risk of low level radiation from the Bruce Power steam generators to be shipped to Sweden" being a current example. What potential effect will this have on a process designer when designing a unit that has some measure of risk associated with it? There probably are very few chemical process designs that don't have some risk associated with them.

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.

Is it reasonable to carry out an economic assessment on a proposed project and ignore factors that are becoming increasingly important in the global economy? Have you any suggestions as to what would be a good approach to this problem. An example might be the effect of production of a high quality diesel using the Gas to Liquid process in areas of the world where there are large amounts of "stranded gas". Stranded gas is a term used to describe light hydrocarbons mainly methane that are produced during crude oil production. In many areas of the world this gas has simply been flared.

5) **Process Selection (20 Marks)**

There has been a major renaissance of interest in biochemical processes recently. Often this is driven by misconceptions about the longer term security of hydrocarbon supplies and controversial issues such as climate change. There certainly may be some real advantages to biochemical routes as compared to more conventional chemistry. Assume the following situation, a bioprocess has been developed which yields a mixture of mainly higher fatty acids (C12,C14 and C16) and some ethanol. In order to produce a biodiesel the acids must be esterified with the ethanol. There are two potential processes, using a strong acid ion exchange resin, or using an enzyme. As a process design specialist how would you compare these alternate routes?

6) **Chemical Fractionation Design (20 Marks)**

There are many mass transfer devices used in fractionator design. Describe four and give an indication of the advantages of each and where they would be used.

7) **A specific design problem (20 Marks)**

You are designing a fractionator which will deal with a product that is quite temperature sensitive. What design aspect can be applied in order to deal with this problem?