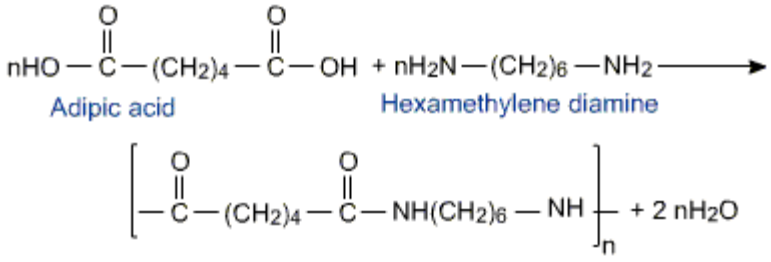
"Manufacturing Facility for Nylon 6 6"

DEADLINE FOR ELECTRONIC SUBMISSION TO AIChE IS MIDNIGHT, Friday, June 16, 2017.

Project Background and Motivation

Nylon 6 6 is a co-polymer produced via step-growth polymerization of Adipic Acid and Hexamethylene diamine (HMDA). The two monomers each have 6 carbon atoms, which is what gives Nylon 6 6 its name. Nylon 6 6 is a widely used chemical product in a variety of industries, including textiles. The reaction chemistry is illustrated below:



[1]

Process Description

Nylon 6 6 is synthesized by polycondensation of hexamethylenediamine and adipic acid. Equivalent amounts of hexamethylenediamine and adipic acid are combined with water in a reactor. This is crystallized to make nylon salt, which has precisely stoichiometric equivalents. The nylon salt goes into a reaction vessel where polymerization process takes place either in batches or continuously (this choice is up to each individual group, but you must justify your decision!). Removing water drives the reaction toward polymerization through the formation of amide bonds from the acid and amine functions. Thus molten nylon 6 6 is formed. It can either be extruded and granulated at this point or directly spun into fibers by extrusion through a spinneret (a small metal plate with fine holes) and cooling to form filaments (your choice!). [2]

Design Requirements

Your task is to prepare a complete economic analysis for building a grass roots plant to produce 85MM lbs/yr of Nylon 6 6 from Adipic Acid and HMDA. You may assume that the plant will be built in the Calvert City, Kentucky area. You may use any publically available resources necessary to complete your design including patents, technical reports, literature or other resources. You must keep SAFETY and SUSTAINABILITY in mind as you prepare your design reports. Note that this process requires the use of raw materials that are hazardous and/or flammable. You MUST describe your safety concept for this process. What are the process risks and how can those risks be mitigated? How will you set design pressures and temperatures for your process equipment? Can the principles of inherently safe process design be used to reduce the hazards of this process?

The project will incorporate a wide range of aspects related to chemical process and product design, e.g. flowsheet synthesis and simulation, heat and mass integration for resource

conservation, facility siting, process optimization, process economics, and also environmental, health and safety related issues. In the following section some information is given about the progress reports that need to be submitted during the course of this design project.

Project Objectives

Your objective is to design and analyze an industrial process for the production of Nylon 6 6. The final process will generate not only product streams, but also a side product stream. The final disposition of those streams must be taken into account both in the process design and in the economic analysis. In other words, it is your responsibility to determine what to do with the side product.

Furthermore, due to changes in market conditions, customer demands etc. it may be necessary to reduce the production at certain times during the year to avoid stockpiling too much product on site. Therefore you need to design your process/equipment for 100% capacity as well as a turndown case of 67% capacity.

It is important to not only design a process that is technically feasible but also controllable. You will need to propose a control strategy for the flowsheet. What variables will you control? What variables will you choose as fixed set points? What measured values will your strategy require? Describe how control fluctuations one column affect the other. Are there any special requirements for unsteady state conditions, such as start-up or shut-down? Is any additional equipment required to achieve good control, such as holdup tanks, or heat exchangers? How do your equipment choices affect your control strategy?

Finally, this system uses raw materials and generates products that are hazardous and/or flammable. Describe your safety concept for this process. Also do a HAZOP evaluation of the process. What are the process risks and how can those risks be mitigated? How will you set design pressures and temperatures for your process equipment? Can the principles of inherently safe process design be used to reduce the hazards of this process?

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A Few Final Thoughts…

- Remember that this is an open ended project. This means that you can take the project in almost any direction you find interesting. However, all design choices and changes in direction or scope must be fully justified with reasons explained.
- Just like a real-world project, you won't always have all the information you need. Therefore, you will be required to make assumptions along the way. ALWAYS state your assumptions and reasons for making them.

Report Requirements:

This report should follow the outline suggested in Seider, Seader and Lewin. Further details on what should be included in the design report can be found in that text. Write the document from the point of view of the organization's engineer making a report and recommendation to the organizations management.

1. Letter of Transmittal
2. Cover Page
3. Table of Contents
4. Abstract
5. Introduction
6. Process Flow Diagram and Material Balances
7. Process Description
8. Energy Balance and Utility Requirements
9. Equipment List and Unit Descriptions
10. Equipment Specification Sheets
11. Equipment Cost Summary
12. Fixed Capital Investment Summary
13. Safety, Health, and Environmental Considerations
14. Other Important Considerations
15. Manufacturing Costs (exclusive of Capital Requirements)
16. Economic Analysis
17. Conclusions and Recommendations
18. Acknowledgements
19. Bibliography
20. Appendix

References:

Seider, W., J.D. Seader, and D.R Lewin, Product and Process Design Principles: Synthesis, Analysis and Evaluation, Wiley, 2003.

Nieschlag, HJ, J.A Rothfus, and VE Sohns,Nylon 1313 from Brassylic Acid, I and EC Product Research and Development, Vol 16, Pg 101, March 1977

Nylon 1313 Synthesis and Polymerization of Monomers, Journal of Polymer Science Part A-1 Vol 5 1967.

[1] Preparation of Nylon-66 - membrane solutions
http://nylon66membrane.com/Preparation-of-Nylon-66.html

[2] Nylon 66
https://en.wikipedia.org/wiki/Nylon_66

Note: This problem statement has some hypothetical data and thus does not necessarily represent an accurate real case.