Team 20: Insane in the Membrane

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Introduction

Throughout the entire project, Team 20 never waivered on the commitment to use the chemistry, engineering, and problem-solving skills they gained from Calvin to address the needs of this broken and wounded world.

Team 20 set out to design a chemical plant to synthesize amino acids via organic synthesis.
We pivoted to the unnatural amino acid market after consulting with Dr. Tatko and worked to design a plant to produce aliphatic amino acids which are being used in drug delivery research. Poor drug delivery today results in harmful side effects and wasted medicine, which is detrimental to the patients both physically and financially.

Because the side chains resemble the phospholipid components of cell membranes, they help localize attached molecules to the cell membranes to target cell surface proteins. By using custom amino acids, medical researchers can find the right amino acid to target the specific cell type that needs treatment. By combining the medicine and the amino acid, the cells that need help will get the drug they need delivered at a much higher rate.

The team created a plant design that allows for the synthesis of multiple compounds with the same equipment to help fine tune the products for precise drug delivery, with the flexibility of being able to add new compounds similar to the existing products at our consumer's request. This will allow us to develop strong relationships with consumers and help to accelerate research on drug delivery.

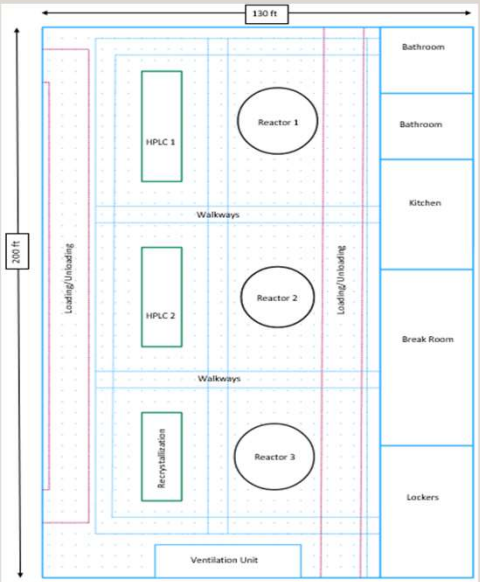
Equipment

Batch Reactors:
- Agitator blades to keep the mixture stirred
- Jacketed and to control reaction temperature
- Glass lined to prevent corrosion of reactors
- Vented to safely dispose of gasses

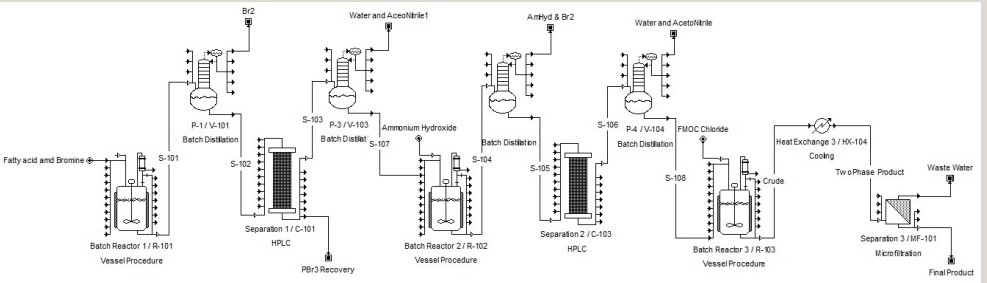
High Performance Liquid Chromatography:
- Allow for the purification of process intermediate (95%)
- Allow for recycling starting materials (80%)
- Using water and acetonitrile as solvents

Recrystallizer:
- Fitted with vacuum to operate at low temperatures
- 150 L capacity handles final product batch size
- High purity machine used in similar FDA approved products

Batch Distillation
- Removing volatile reactants and solvents prior to subsequent process steps



A top view of our production layout, facility also has storage, maintenance, and offices



Our Process Flow Diagram (PFD) for the conversion of cheap carboxylic acids into valuable unnatural amino acids for use in medical research in the area of drug delivery

Objectives

Team 20 set out to design a plant to convert inexpensive, readily available carboxylic acids into significant amino acids for use in medical research.

The team also wanted to create a flexible process to allow for several different products to be created using the same equipment to help reduce costs.

Team 20 worked diligently to ensure that there would be enough time in the batch campaigns to allow for customer requested products to be produced without interfering with the demand of our flagship products.

The team sought to help positively impact the community as it is going to be located in an area of high poverty, high crime, and a historical hotspot of discrimination.

Acknowledgements

Team 20 is very grateful for all the help we received from many wonderful people on this project.

Industrial advisor: Dr. Phil Brondsema

Chemistry Faculty: Dr. Mark Muyskens, Dr. Chad Tatko

Engineering Faculty: Dr. Jennifer VanAntwerp, Dr. Jeremy VanAntwerp, Dr. Wayne Wentzheimer

Faculty Advisor: Dr. Andrew Wilson.

Conclusions

We were able to design our plant with capabilities to recycle unreacted starting materials by using interstage batch distillation and HPLC separations, reducing costs and emissions from our plant.

Our interstage design allows for the conversion of carboxylic acids into amino acids in three steps, making it flexible enough to produce multiple different products using our equipment.

The market for unnatural amino acids is growing at roughly 10% per year and will reach $10 Billion within the decade. We are easily capable of capturing 3% of the market and have a tremendous opportunity to grow. We have a forecasted IRR well above the MARR over the first 10 years.

Our plant will help give back to the community through donations to food banks and programs that aim to equip young adults with skills to help them become employable. It is very important to our team that we are helping people both with our products and service to our community.

Teamwork, helpful guidance, and application of knowledge learned throughout the past four years led to the successful completion of a challenging and rewarding senior design project.

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