Liquid Nitrogen Packed Column Distributor Design

Overview
Air Products and Chemicals Inc. tasked the design team to come up with new concepts for a liquid nitrogen distributor for a packed distillation column. The design team at Penn State was paired with engineering students from Shanghai Jiao Tong University (SJTU) in Shanghai, China. Working with Air Products and SJTU, the team developed a final concept and then modeled the distributor design in SolidWorks and performed a flow analysis using FLUENT. The final design consisted of two layers. The top layer receives the initial flow from an inlet nozzle and distributes it to a second layer that further dispenses the liquid to the packing below.

Objectives
The goal of this project was to create a new concept for a liquid nitrogen distributor. The new design was to be more efficient and implemented in their current distillation column design.

Approach
- The design team first gathered customer specifications from Air Products and Chemicals to help guide the design criteria.
- Thorough external research was performed in order to identify designs and patents currently in use.
- Concept generation was the next and most extensive part of the project. The team came up with nearly one dozen concepts that were then presented to the sponsor.
- After presenting the most suitable concepts to the sponsor, the group then obtained feedback and tweaked the design to further meet the customer’s criteria.
- A final concept was selected to further analyze.
- The Penn State team modeled the distributor in SolidWorks and the Shanghai Jiao Tong team performed the fluid flow analysis using FLUENT.
- Results of the fluid flow were analyzed for even distribution and efficiency.
- The design team presented Air Products and Chemicals with the results and findings.

Outcomes
- The design team created a design that is both efficient and meets all design criteria of the sponsor.
- Maximum velocity difference between any holes on the bottom layer of the distributor deck is 0.18m/s.
- V-shaped distribution troughs prevent debris from clogging holes
- 12 sided polygon design simplifies the manufacturing and assembly process