Preliminary Plant Design For Bitumen Separation Using Ionic Liquid

**Overview**

IL Fuels LLC invented a novel way to separate bitumen from tar sands via ionic liquids. Our problem was to create a preliminary plant design with the capability of producing 5,000 barrels of bitumen per day while maximizing the recovery of ionic liquid and water in the system. We were also asked to calculate the start up costs of the plant and the projected capital costs over five years.

**Objectives**

- Created a preliminary plant design capable of producing 5,000 barrels of bitumen/day
- Maintain a maximum of 0.2% loss of ionic liquids to the cleaned sands
- Improve overall efficiency of the proposed plant design

**Approach**

1. We worked backwards from the initial production requirement of 5,000 barrels of bitumen/day to calculate flow rates for all the components in the system streams by using mass balance.
2. From the flow rates and other known variables, we were able to contact vendors for quotes on the needed components: pumps (dual diaphragm and progressive cavity), centrifuges (decanter and high speed), rotary drum mixer, vacuum distillation units (VDU), and tank (conditioning and storage).
3. After testing, IL Fuels determined the residual ionic liquid in the sand from the counter-current belt washer was too high and wanted us to find a way reduce the percentage, which would aid in lowering the operation costs.
4. In determining what component would be best to remove IL from the sand, we compared the counter-current belt washer to a vacuum belt filter.
5. Our sponsor’s headquarters is located in Penn State’s Energy Institute, and our group was fortunate enough to meet with them on a weekly basis to discuss our progress and concerns.
6. We used ASPEN HYSYS, a comprehensive process modelling system, to create a model of the plant stream.
7. We validated our results through an economical analysis.

**Outcomes**

- Cost of production per barrel of bitumen ~ $3.26
- Our economic analysis projected a loss of $4 million per year for the IL.
- The savings we calculated are tentative and are based on the components used in our plant design; in reality these may not be used.
- Based on our economic analysis, IL Fuels would make back their investment in less than two years.