The Gamecock Chemical Company proposes construction of their Texas Cumene Plant. The new plant is to produce 100,000 tonne per year of cumene from commercial grade benzene and purchased propylene feedstock.

**Project Objectives**

The project team has been asked to produce a conceptual design, simulation and profitability analysis for the proposed plant.

**Technology Review**

The process was simulated using Aspen HYSYS. The Excel spreadsheet CapCost was used to perform the economic evaluation.

This process successfully produces 110,000 tonne per year of cumene. Simple distillation through three towers separated cumene from the other contaminants and side reaction products with a purity of 99.52 mole%.

**Thermodynamics**

The thermodynamics packages used for this process were NRTL for the liquid model, and Peng-Robinson for the vapor model and the DOWTHERMA model. NRTL qualitatively estimates the solubility of complex organic compounds in common solvents, like benzene. Peng-Robinson calculates VLE calculations, liquid densities for hydrocarbon systems, and multiple phase systems over a wide range of temperatures and pressures, well.

**Reaction Chemistry**

Overall Reaction:

$\text{C}_6\text{H}_6 + \text{C}_3\text{H}_6 \rightarrow \text{C}_9\text{H}_{12}$

$\text{C}_9\text{H}_{12} + \text{C}_3\text{H}_6 \rightarrow \text{C}_{12}\text{H}_{18}$

Rate laws:

$r_1 = k_1 \text{C}_p \text{C}_b$

$r_2 = k_2 \text{C}_c \text{C}_p$

Where $k_1 = Ae^{-\frac{E_a}{RT}}$ and $k_2 = Ae^{-\frac{E_b}{RT}}$

**Reaction Chemistry Continued**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Reaction (1)</th>
<th>Reaction (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>2.8x10^7 kmol/s*m²</td>
<td>2.32x10^7 kmol/s*m²</td>
</tr>
</tbody>
</table>

**Cumulative Cash Flow Diagram**

The process has a cumulative cash position of ($108.48 million) over a period of 12 years. The rate of return on investment is 82.18% and the payback period is .9 years.

**Recommendations**

The cumene production process is recommended to be implemented. With a payback period of less than one year, the capital cost will be quickly recouped. The plastics industry is growing with a continual need for cumene. This open market for cumene allows the process to make $164,309,607.89 solely off of selling the cumene. This plant, if run according to the specifications described in this report, will be profitable and recommended for the company.

**References**