Coker Gas Plant Design

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Executive Summary
Coking facilities are refineries that upgrade residual oils from crude distillation to more valuable light hydrocarbons. These processes usually involve fractionation columns, which separate the coking products into fuel gas, liquified petroleum gas, naphtha, and heavier ends. Using Aspen Plus® and Aspen HYSYS®, we designed a coking gas plant to separate light gases, C₃s, C₄s, and heavy mixing components in a sour feed stream originating from the top of a coking process fractionator.

Our finalized design recovers nearly 100% of the fed refinery fuel gas, 92% propylene, 96% propane, 92% butylene, 74% butane, and 99% gasoline mixing component at full capacity. All product purities are above 90% with the exception of refinery fuel gas and butylene which have purities of 65% and 73% respectively. Product purity meets all prescribed specifications, including successful extraction of H₂S and CO₂ contaminants.

The sale of these products corresponds to an annual market value of $292.8M. With annual fixed costs of $49.3M and variable costs of $70.3M, our plant yields an investor rate of return of 23.6%, a 0.5% improvement on the alternative design. This is based on an estimated total permanent investment. The payback period is estimated at 4 years with an annual return on investment of 27.0%. The primary design also has the added benefit of improved product qualities and simplification of the sour gas sweetening system. Investment viability is most sensitive to product sales price and operating costs. The sensitivity of sales is of particular concern given the current economic landscape surrounding petroleum futures.

Sour gas and the amine treatment required for H₂S removal represent the primary safety concerns in the process, scoring 80/125 in a system FMEA analysis and achieving the maximum weighted environmental index factor using Biwer’s method when compared to other process components. These concerning elements were mitigated through process control implementation or on-site handling outside of the scope of this project.

Keywords
Coker gas — Separation process design — Chemical engineering

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