

Case Study 3 – Corn Ethanol Plant Retrofit and Restart

Using #2 yellow corn (livestock feed quality) as a feedstock, ethanol and high protein livestock feed (distiller's grain) can be produced via a yeast fermentation process. A group of investors (including this consultant) identified such a corn ethanol plant which was originally built in 1989 and failed to economically produce by three different owners. The group purchased this bankrupt facility with the intention of retrofitting and restarting the facility.

Due to budget constraints, this consultant was the sole engineer responsible for identifying, coordinating, and resolving engineering issues with other firms and vendors. This facility had many engineering and process design issues leading to its three previous failures. The main issues to poor operation identified were:

- Poor fermentation management (infections that could not be eliminated without frequently shutting down).
- Inoperable water recovery system (multiple effect evaporation), leading to unregulated process water discharges.
- Inadequate distillation design (deficient in arrangement and control).
- Poor operations management (low online stream factor, inadequate procedures, and no implementation of industry best practices for safe and productive operation).

To identify the majority of the process design and control issues, this consultant developed a system-wide, fully integrated simulation of the entire process (including steam generation and cooling utilities) using Aspen Plus®. The application of this model was critical to understanding and developing solutions for all the major issues (and a myriad of minor issues) mentioned above. This consultant also provided dynamic modeling of certain operations to improve process control, specifically for the distillation system.

The reengineering effort, conducted over a 6 month period, resulted in the following process improvements:

- Conversion of the continuous fermentation system to a batch fermentation system, including major improvements in supply and exit piping (to remove infection sources), fermenter mixing and heat removal.
- Elimination of the poorly designed evaporation system, replaced by a suitable triple effect co-current evaporation system that is driven completely by the distillation column overhead vapor as a heat source (major process heat recovery).
- A revamp of the existing distillation system that currently outperforms industry expert capacity estimates by 160%.

Because of this significant reengineering effort, combined with strong operations management, the retrofit and restart was a complete success. The entire plant, originally designed to produce 14 million gallons of ethanol per year now operates profitably at up to 28 million gallons of ethanol with less than \$1 million additional incremental expansion investment (above the original purchase and retrofit cost).

The energy consumption for the plant consistently operates at approximately 16,000 BTU/gallon ethanol produced (and as low as 15,700 BTU/gallon), well below industry average for a corn ethanol plant with no distiller's grain dryer, and at least 15% below the energy consumption for implemented 'state-of-the-art' corn ethanol processing technology.