Optimizing the efficiency of cryogenic refrigeration equipment and maximizing Natural Gas Liquid (NGL) recovery

**Benefits:**
- Increase process stability and reduce variation
- Reduce cryogenic refrigeration energy consumption an avg. of 2 - 5%
- Increase NGL yield an avg. of 0.5 - 1.0%
- Payback in less than 12 months

**The Challenges**
Cryogenic refrigeration liquefies Natural Gas Liquids (NGL) by operating at low temperatures in the range of -100 to -150 degrees Fahrenheit. These temperatures are achieved by the refrigeration system, typically propane, and a turbo-expander/compressor. The challenge is to minimize the energy used by coordinating operation of the expander/compressor, and the propane refrigeration system, the net effect of these 2 process units is a very low operating temperatures.

At these low temperatures, ethane and heavier NGL in the gas stream condense, while methane remains in gas form. This allows for the NGLs to be separated in a demethanizer column. Lowering the cryogenic refrigeration temperatures increases NGL yield, but at the cost of added energy. In addition, energy on the expander side is recovered to re-compress the gaseous methane effluent on the turbo-compressor side of the equipment. This must be accounted for in the energy balance.

Rockwell Automation recognizes these challenges and offers an application that delivers valuable information to the cryogenic refrigeration process to help improve plant stability, increase NGL yields and optimize energy savings.
Model predictive control (MPC) allows for the most accurate, highest fidelity models to be implemented helping optimize the plant.

**Cryogenic Refrigeration Application**

The Rockwell Software Cryogenic Refrigeration application from Rockwell Automation uses Model Predictive Control (MPC) and neural networked Soft Sensor™ technology to continuously drive the process to reduce overall variability and operate at peak process performance.

**Pavilion8 Modeling**

The MPC technology continuously assesses current and predicted operational data, compares that data to the desired results and computes and downloads real-time supervisory setpoint targets. The Pavilion8 modeling tools are robust and incorporate engineering process knowledge to allow for the most accurate, highest fidelity models to be implemented helping optimize the plant. Rockwell Automation provides a single software solution that handles linear and nonlinear processes simultaneously for easy configuration and consistent results.

In order to help maintain the economic benefits, the MPC software includes built-in controller performance metrics that continuously monitor key plant variables, utilization, time constraints and deviation targets. The application is easily configured for the economic specifics of the plant.

Natural gas is chilled to extremely low temperatures in the range of -100 to -150 degrees Fahrenheit through the cryogenic refrigeration process. The cryogenic refrigeration application is designed to reduce NGL and gas product quality variations, thereby maximizing the recovery efficiency of NGL liquids.

The Cryogenic Refrigeration application unifies and stabilizes the performance of the molecular sieves, heat exchanger network, turbo-expander/compressor, demethanizer, and the propane refrigeration system. The Pavilion8 software achieves this by optimizing chiller duty, respecting the constraints of refrigeration compressor inlet pressure and chiller inventory, and minimizing temperature and flooding constraints in the demethanizer.

Pavilion8 helps balance NGL recovery objectives with the economic cost of refrigeration energy requirements. As temperatures are lowered, NGL yield increases, but at the cost of propane refrigeration. These objectives must be met within all plant constraints. Furthermore, the application helps maximize the NGL quality C1/C2 ratio, or in ethane rejection mode, maximize C2 rejection into pipeline gas.

**Application Benefits**

The Cryogenic Refrigeration application:

- increases ethane recovery an avg. of 0.5 - 1.0%
- reduces plant variability
- increases consistency in the natural gas to the pipeline and NGL liquids allowing the plant to operate closer to equipment constraint without violation
- reduces energy use an avg. of 2 - 5%.