Nitech™ Nitrogen Rejection Technology: Efficiency Without the Complexity Typically Associated with Nitrogen Rejection

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In 1994, a new technology for separating nitrogen from natural gas was introduced with a full-scale processing plant located near Mist, Oregon. Several years of research and development by BCCK Engineering, Inc. preceded the installation of the facility. Prior to the installation of the Mist unit, BCCK engineers spent a significant amount of time optimizing the nitrogen rejection unit (NRU) simulation to ensure that hydrocarbon recovery was as efficient as possible, while providing a design that was economical and uncomplicated. To ensure a less complicated design, BCCK scheduled interviews with operators of conventional cryogenic NRUs to survey operational concerns. The results of these discussions prompted BCCK to develop and patent a nitrogen rejection technology, Nitech™, which requires no cryogenic rotating equipment, as these elements are consistently responsible for facility downtime and excessive operating expense. This work also provided a design with only three main components, which reduces capital costs and delivery time when compared to conventional technology. The success of the flagship Nitech™ NRU in Oregon prompted the installation of ten additional Nitech™ facilities in the domestic United States. Although each unit is centered around the core Nitech™ design, each facility has unique challenges due to differing gas compositions, flowrates, and operating conditions.

The eighth of eleven Nitech™ NRUs installed to date is located near Mobile, Alabama. The Client approached BCCK with specific concerns to be addressed in order for the facility to be successful. First, the facility would process gas incoming from a nitrogen flooding project; therefore, the inlet flowrate and inlet nitrogen content seen by the facility could vary significantly. Next, the facility had to be designed to tolerate a high CO2 content (relative to other technologies) as

no additional treating beyond the capability of the existing amine facility was to be provided. In addition, the economic viability of the project dictated that the selected technology would be highly efficient, with regard to hydrocarbon recovery. Finally, the Client was interested in installing a facility that would have a high on-line time with no additional operating personnel required for day-to-day operating and maintenance.

Solutions

Varying Inlet Flowrate

To meet the first Client requirement of flexibility with respect to inlet flowrate, BCCK designed the Nitech™ facility to accommodate gas cap blowdown with an operating range of 5 to 20 MMSCFD without plant recycle or facility modifications. In addition, BCCK designed the facility with increased turndown capability to allow the facility to operate at lower flowrates at the end of the field life.

Inlet Nitrogen Content

The Nitech™ facility was designed to accommodate an inlet nitrogen content ranging from 18 to 40 mol percent. The lower nitrogen limit is set by the requirements for regeneration of the molecular sieve dehydration system for this facility, as the molecular sieve beds are regenerated using rejected nitrogen. Should the inlet nitrogen content fall below 18 mol percent during the life of the project, a simple regeneration compressor, cooler and scrubber would be added so the facility could be regenerated using inlet gas. The addition of this equipment, if necessary, would allow the facility to process inlet gas with an inlet nitrogen content varying from 5 to 40 mol percent. The flexibility of the facility is accomplished without control of inlet composition. From its inception, the Nitech™ process was designed for separation of nitrogen from methane knowing that for most applications, compositions and flow rates would indeed change over time. Conventional technology ties the reflux system to the tower reboilers, which greatly limits flexibility for changes in nitrogen content. Nitech™ controls

the reflux system and tower reboilers independent of each other, which allows wide swings in inlet nitrogen content.

Carbon Dioxide Tolerance

An existing conventional amine facility at the Client's plant site removes carbon dioxide from the inlet gas to a level of approximately 160 ppmv. Because the Nitech™ unit operates at higher temperatures when compared to conventional cryogenic facilities, existing treating was adequate for the Nitech™ facility without concern of CO2 freezing as may have been experienced with other technologies. The Nitech™ facility is designed to handle CO2 concentrations as high as 300 ppmv without the addition of further CO2 treating. For most conventional cryogenic systems, molecular sieve CO2 treating would be added to the facility in order to reduce the CO2 to acceptable levels. Using molecular sieve to treat for CO2, in addition to dehydrating the inlet gas, significantly increases the size of the molecular sieve beds as well as the amount of regeneration gas required, which would increase the operational costs and complexity of the system. BCCK's most recent installation, in operation for almost one year, operates without any CO2 treating on a gas stream of approximately 200 ppmv CO2 and has had no CO2 freezing issues at the facility.

Hydrocarbon Recovery

Traditional cryogenic NRUs are typically very efficient, generally realizing hydrocarbon recovery rates in excess of 99 percent. Cryogenic facilities also have the advantage over other technologies in that the amount of hydrocarbons (VOCs) vented with the rejected nitrogen is very low thereby simplifying the permitting process. The Nitech™ facility near Mobile exhibits a hydrocarbon recovery rate in line with conventional cryogenic systems, in excess of 99 percent with no VOC emissions. BCCK's most recent Nitech™ facility is achieving near 99.9 percent recovery. There are no technologies, other than cryogenic, that can achieve this efficiency.

High On-Line Time and Simple Operation

Because of Nitech™'s simple design, high CO2 tolerance, flexibility to inlet nitrogen content and flowrate, the Client expected a high online time. Indeed, since start-up in summer of 2002 of the Mobile NRU, online availability of the Nitech™ unit has been near 100% with all shutdowns related to equipment outside of the NRU. Minimal ancilliary equipment and no rotating cryogenic equipment has also allowed the Client to operate the facility with use of current operating staff as additional operators for the Nitech™ NRU were unnecessary. Training of the current operating staff was handled on location in less than one week's time.

Additional Benefits

High Nitrogen Pressure

As previously mentioned, the Mobile NRU is located on an existing nitrogen flooding project. As such, rejected nitrogen from the NRU facility can be reinjected into the field to enhance recovery. A benefit of the Nitech™ process over other technologies is that the rejected nitrogen stream is vented at near 300 psig thus minimizing reinjection horsepower requirements.

An additional result of the high-pressure nitrogen is the lack of need for an instrument air system. The Mobile Nitech™ facility is able to use nitrogen as instrument gas for both the NRU facility and existing facility equipment. The existing instrument air system was inadequate to meet the needs of the existing facility and was unreliable at times. The high-pressure nitrogen vent provided the Client with a reliable instrument gas source, and eliminated the need to purchase, operate and maintain a new instrument air system.

Integrated NGL Extraction

The Nitech™ facility was installed downstream of an existing refrigeration plant operating with a cold separator temperature of approximately -30°F. Nitech™

was able to enhance NGL extraction by separating NGLs at -90°F and feeding those liquids to the existing fractionation train, thus improving the NGL recovery of the facility.

Short Project Completion Time and Quick Start-Up

The Nitech™ process is relatively simple and requires minimal equipment. As such, the duration of the project from contract signature to start up of the Mobile Nitech™ facility was approximately 26 weeks. The initial start-up of the facility took less than 24 hours to produce on-spec product.

Because the Nitech™ facility strategically stores refrigeration in the column after a shut down, the facility can be started up quickly without the need to drain liquids with a cryogenic sump. Typically after a short shutdown, such as a power outage or compressor maintenance of 24 hours or less, the Nitech™ unit comes on-line instantaneously selling on-spec product. Operating experience with the Nitech™ technology indicates that the Nitech™ unit is capable of instantaneous online start up with shutdowns as long as 48 hours.

Conclusion

BCCK's patented Nitech™ technology including its simple design, flexibility, carbon dioxide tolerance, and cryogenic recovery capabilities met all Client requirements. The Nitech™ design provided the Client with better flexibility with respect to inlet flowrate fluctuations and varying nitrogen contents. Beyond meeting the requirements, the technology provided a quick delivery and thus faster establishment of cash flow and a reduced number of components equating to a lower capital cost and more streamlined operation.

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