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Unsaturated Gas Plant Retrofit Concepts

By Jerry Lacatena

Refinery processes, such as coking and catalytic cracking, produce substantial quantities of sour gases. Unsaturated gas plant feeds are largely comprised of paraffinic and olefinic light hydrocarbon components, such as C_2's and lighter, C_3 - C_4, plus some C_5 and naphtha, H_2S, and other light material. C_3's and C_4's can be recovered as separate streams, or as LPG, since these streams represent saleable hydrocarbon products of considerable value.

Typically, the gas plant is integrated in the refinery configuration as part of an FCC or Delayed Coker unit, and located downstream of the source unit's fractionator. Some plants also recover light ends from a number of refinery off-gas sources commingled in a common unsaturated gas plant, which may sometimes be referred to as a vapor recovery unit (VRU). Basic VRU configurations typically include a two stage wet gas compressor, absorber/stripper or de-ethanizer, debutanizer, C_3/C_4 splitter, and amine absorption on selected sour streams. It is a scheme that performs well and has been reliable.

The yield of light ends components can be sensitive to many factors, such as feedstock properties and certain operating conditions in the source unit. As the source unit feed rate increases or operations become more severe, the gas make usually tends to increase as well. The gas plant processing capability may then need to be revisited to compensate for those changes, or prudently determine what limiting factors would be encountered.

The alternative to debottlenecking would be to recover less gas product and vent to fuel gas or flare, which usually is economically punitive and potentially environmentally undesirable. The refinery must define the actual target component recovery and product purity basis, yields, and specifications for the products that are to be produced. Care must be taken in retrofit design to ensure that necessary provisions and controls are incorporated that will achieve processing objectives, and enable operations to be safe, flexible, and robust enough to meet performance guarantees while maximizing profitability.

Depending on the existing gas plant's original design, configuration, and extent of limitations anticipated, there are some general retrofit concepts that should be considered to make the most out of existing equipment. Some of these may include:

- Decrease in selected temperatures, such as lean oil, cooling water, or limited refrigeration
- Slight increase in pressure within mechanical design constraints

Work Highlights

Mechanical Engineering

- *Reviewed design and operating information associated with the fatigue failure of a small diameter connection located in a marketing terminal with the objective of determining its root cause. While other factors may have contributed to the failure, it was most likely caused by vibration. Recommendations were made to improve the mechanical integrity of this and other similar small diameter connections located at that site and other terminals.*

Process, Operations & Safety

- *Provided lube processing (Vacuum Unit/PDA/Extraction) and crude blend planning support for a domestic refiner processing local crudes.*
- *Assisting a refiner with flue gas system analysis and upgrade to increase reliability, process operating flexibility, and improve mechanical integrity.*
- *Assisting a major refiner with intellectual property database management.*
- *Provided pilot plant support associated with the assessment of pertinent design practices/engineering standards, and general process consultation.*

- Installation of high performance / capacity tower internals
- Changes in heat balance / preheat / integration
- Installation of absorber intercooling to balance tower loading
- Adequate water removal provisions
- Revisit the lean oil recycle and/or sponge oil rate
- Reuse of existing towers in alternate tower service or replacement
- And more …

Structured packings are generally not considered where diolefins can polymerize and may promote fouling. Compression is usually a major cost consideration, and minimizing changes to the wet gas compressor that would require capital investment is usually preferred, but would have to be evaluated in the context of the process requirements and implications. Note that if refrigeration options are viable, care must be taken to avoid formation of hydrates, which have a tendency to form when temperatures drop. These hydrates are solid or semi-solid compounds, resembling ice-like crystals. Should hydrates accumulate, they can impede the flow of gas through valves and equipment.

As you might expect, targeting for a significant capacity increase may result in a high required investment cost. This would then require reexamining the retrofit strategy, and weighing adjustment of the basis vs. evaluation of separate new or modified facilities via case studies and their associated costs.

Although simulation modeling using commercially available computer programs is usually necessary, use of a refinery's existing model calibrated with actual operating data would save time and can serve as a baseline so the effect of potential changes can be readily evaluated. Any new computer model files that are developed can usually be transferred back to the refinery for their potential use in subsequent optimization work.

Overall, the evaluation of unsaturated gas plant expansion needs can be achieved with proper tools and expertise. Carmagen Engineering has technical consulting staff that can assist you to meet your gas recovery objectives on a wide variety of plants and technologies.

About the Author

Jerry Lacatena has over 35 years of process engineering experience in a broad range of design applications and technologies. He is a proficient and organized multi-tasker, having extensive plant design experience on numerous revamp and grassroots projects throughout the world, with projects ranging from feasibility studies, technology evaluation, FEED, EPC development, to plant performance testing. Jerry has excellent presentation, communication, coordination, and interpersonal skills utilized to develop strong working relationships with team members, clients, vendors, sub-contractors, and technical licensors.

Please contact Jerry Lacatena (jlacatena@carmagen.com) if you'd like more information on Carmagen's expertise in this area.