

TechTalk

Pros and cons for fabrication and start-up of refinery units

Stick-built vs. Modular Units

Traditionally, refinery units are constructed on-site in a stick-built (site fabricated) fashion. MOGAS Systems & Consulting (MS&C) approach is to completely build a modular process unit off-site in a controlled environment and provide delivery of a complete system. The module features a superior design, increased safety and push-button availability in one of the most complicated operations in a heavy oils unit. MS&C modules drive down both capital expenses (CAPEX) and operating expenses (OPEX).

Disinterested Review of Costs Comparison

While conditions and labor rates vary widely around the world, IHS Chemical, a global chemical industry research and analysis company, studied modular construction in 2016*. They concluded that for every \$6M spent on a stick-built system, the same outcome could be achieved for \$4M if using modular designs that were built in a low-cost country and transported to site. The \$2M savings derived from the typical module yard costs being substantially lower than stick-built costs.

* Source: IHS Chemical Bulletin 2016 Issue 3

MS&C Review

MS&C identified additional cost savings with modules that the IHS Chemical did not account for.

First, the design is optimized by the OEM that has a better understanding of the particular process within the unit. For example, a properly engineered and optimized module may be built with 10-inch pipe, while the same process in a stick-built design would typically use larger pipe, even up to 18 inches. This overly conservative approach by stick building adds cost with no performance gains over a module. The expense for larger steel pipe, welding, inspection, pipe fittings, and associated valves necessary with a stick-built unit are not required in an MS&C modular construction. This reduces the overall cost to the end user when going with an MS&C module and a footprint reduction of up to 40%.

Secondly, the IHS Chemical study assumes engineering work starts over for each project. This is true for a stick built, but not for an MS&C module. Valves, piping and other components that are required, regardless of the fabrication method, account for approximately 75% of the total cost. This leaves 25% for engineering and other costs that vary from stick built to module. Since each stick-built unit is custom, the engineering is created new every time. However, with an MS&C module there are many pieces of the core design that do not change from one project to the next. This reduces engineering costs.

Additional benefits unique to MS&C modules include:

- a PERFORMANCE GUARANTEE in addition to standard warranties on components. A PERFORMANCE GUARANTEE states that the modular unit will perform as intended by the customer for the duration of a pre-determined period. This includes all components (valves, piping, etc.) and programmed instrumentation (DSC / PLC, etc.), and the process modes for operation, such as low- and high-pressure warm up, hot standby, steady state, train switch over, black oil draining, high- and low-pressure cool down, flush and depressurization. A PERFORMANCE GUARANTEE provides the end user additional piece-of-mind not typically seen with stick built units by directing single point responsibility instead of shifting of performance issues between different component suppliers.
- application experience of engineers. Construction engineers must have heavy oil experience to understand the complications in that application. This is true for both EPC stick-built units and MS&C modular units. For example, control valve sizing is one of the most critical elements in a let down station. This is done based on the vast experience and knowledge of the module supplier with heavy oils processing units. It is common for stick-built EPC construction teams to rotate from project to project, and not build upon the lessons learned from their last project. MS&C engineers are a core team whose focus has been only heavy oils for decades. Their knowledge is shared amongst the team to provide consistency between projects with continuous improvements.

Finally, the customer has a positive impact to their NPV (net present value) if the revenue stream begins earlier since modules have a shorter build schedule. The net benefits can be substantial compared with stick-built costs. Therefore, the CAPEX is lower with a module.

Improved Safety

MS&C modular units improve overall plant safety in three ways.

1. The module is tested as a complete assembly versus individual components—which leads to less operational risks and a quicker start-up—before becoming integrated with the unit, and rigorously verified using FEA (finite element analysis) software. Every conceivable operating mode—from both trains on the module being hot, to one train hot while the other is cold, to both trains being cold—are analyzed and the design optimized to accommodate these very different modes of operation. This improves the reliability of the units to ensure:
 - no leaks at any joints
 - maintenance personnel safety when removing control valves while the other line is still in operation, and
 - the correct pipe anchoring systems are used to allow for movement of the piping during different plant operations.
2. By automating the module's operation—not just of day-to-day activities, but also abnormal or infrequently used modes—operators are free to monitor and maintain the rest of the facility so it performs as well as the MS&C letdown modules. Plant personnel are not required to be around the modules during normal operations for confirmation that the train has been cleaned, properly cooled, depressurized, and cleared of any remaining liquids, and ready for maintenance. Once the automated process is complete, maintenance personnel can confirm isolation of the train and easily assess when it is safe to remove a control valve for maintenance work.
3. MS&C modules employ proprietary valve technology within patented y-valves to not only reduce the module size significantly, but also to eliminate areas for plugging that traditional designs create. By eliminating 'dead zones' within the y-valve, process fluid cannot pool and cool and allow coke to form and solidify. MOGAS severe service y-pattern valves in MS&C modules eliminate coking zones completely to always ensure a clear and open path to either module train as needed. Around the y-valve ball, potential coking is cleared using MOGAS' proprietary purging and flushing.

Enhanced Performance Leads to Improved OPEX

A better understanding of the controls by MS&C engineers promotes an enhanced performance of the final unit. Figure 1 demonstrates how an MS&C

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modular letdown unit provides benefits over a traditional letdown system. Features such as a hot standby, purge, and flush contribute to greater availability. However, the biggest advantage is in the fully redundant control valve.

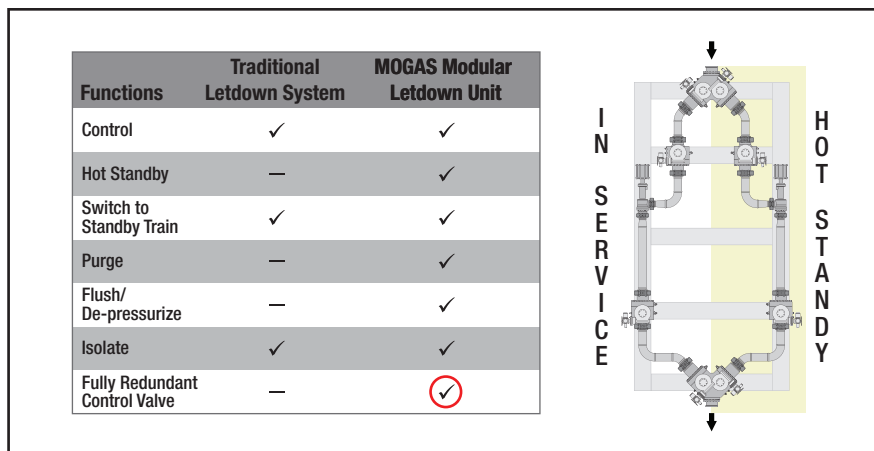


Figure 1: Benefits of a Module

These functions are incorporated in an MS&C module, but not in a stick-built system. The availability of MS&C unit exceeds 99.97%. This is possible because of the unique 100% / 0% operating philosophy (run-to-failure). Technology licensors originally intended these plant letdown stations to operate this way. Issues with past mechanical limitations forced plants to deviate from this intent for greater availability of their systems in the case of an upset. MS&C modules allow plant operators to recapture this original design intent by providing uninterrupted access to both trains of the letdown module with the push of a button. MS&C employs an advanced warming system that fully warms and pressurizes both control valves and process lines without wearing out expensive control valve trim or the need to manually warm up a train over a prolonged period. This increases the availability of the system and the entire plant.

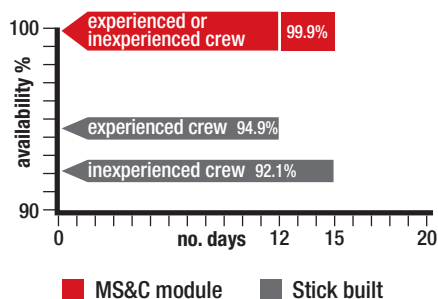


Figure 2. Availability comparison

Using an MS&C module, an experienced crew has an availability of 99.9%. With stick-built, construction availability is reduced to only 94.9%. For this example (Figure 2), an experienced crew is capable of performing the necessary maintenance on a shutdown lasting 12 days. If the crew is not experienced and a shutdown stretches out to 15 days, then the availability difference goes down to 92.1%, while MS&C module maintains 99.9%. The availability analysis assumes two trains in parallel per letdown station and three letdown stations in series. Furthermore, the MS&C-designed module allows for a two-year service life, whereas the stick-built unit has a three-month service life.

This prolonged operational stability allows for improvements in the plant's overall conversion rate. And, even more important, with today's technologically improved plants and advertised greater conversion rates, long-term steady state operation of the facility is a must. By making both trains instantly available and providing programming for the switching from one side to the other at a moment's notice, the stability of the level in the separators can be maintained, providing greater conversion rates for longer periods of time.

Finally, with increased availability and improved stability over longer periods of time, upsets are reduced. By maintaining continuous stable control, hydrogen use and catalyst waste are reduced due to unplanned cutbacks in reactor operations. Coke and solids build-up are reduced plant wide as conversion rates are maintained and temperature excursions in the reactor are minimized. All of this leads to increased product capacity as more of a desired product is produced on the first pass, reducing the need to recycle product, and allowing the facility to process additional raw product.

Safety—coupled with enhanced performance through greater availability, improved conversion rate, and reduced upsets—leads to reduced plant OPEX over the lifetime of the facility.

Conclusion

Improved safety alone could be considered sufficient cause for choosing an MS&C module over stick building. The design and automation not only reduce the likelihood of an accident, but by not having personnel in the danger zone between crowded valves, the impact of an event is greatly reduced. When safety is combined with enhanced performance through greater availability, improved conversion rate, and reduced upsets, the end result is reduced OPEX. Considering both lower CAPEX up front and lower OPEX during operation, the choice for modules over stick built becomes clear.