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Confront Refinery Challenges

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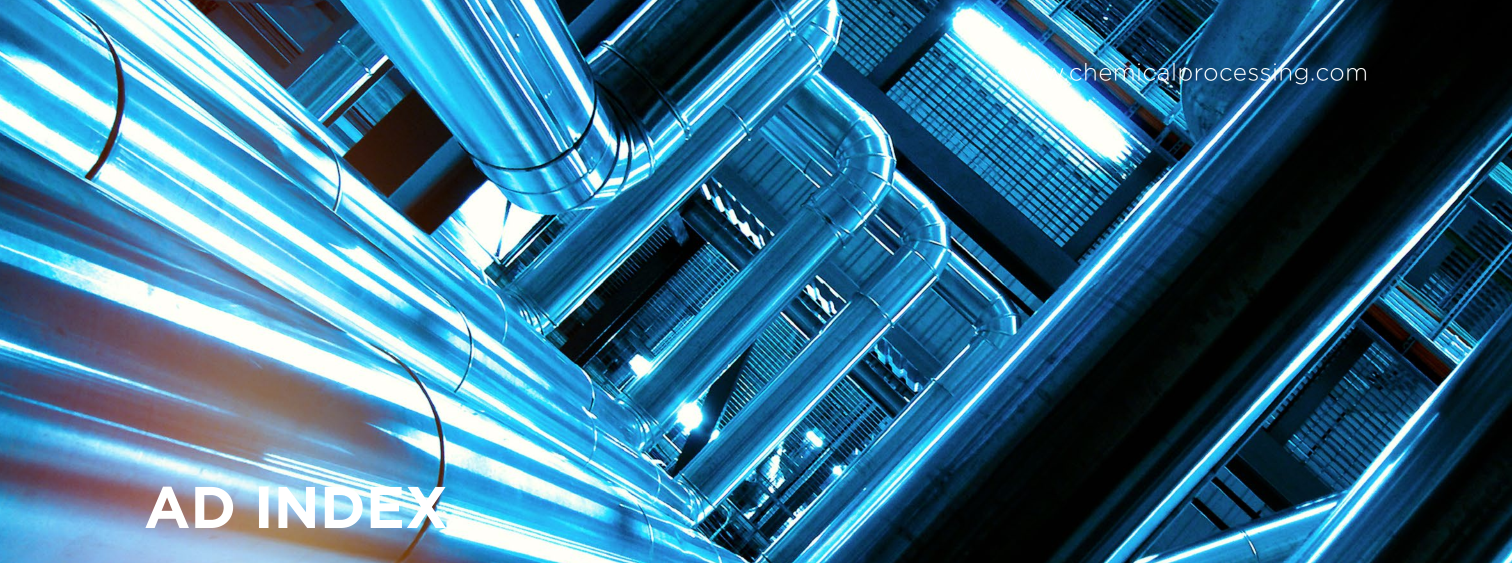

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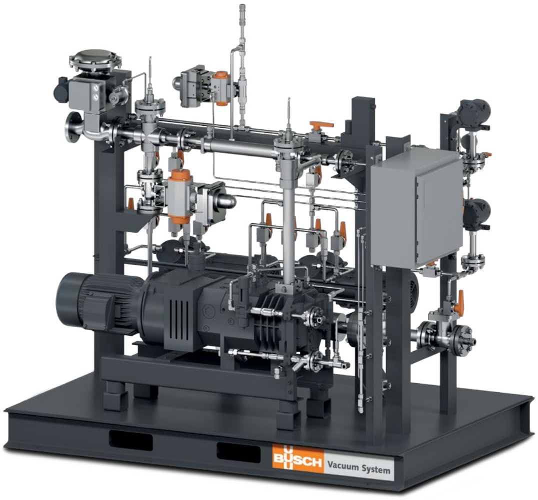

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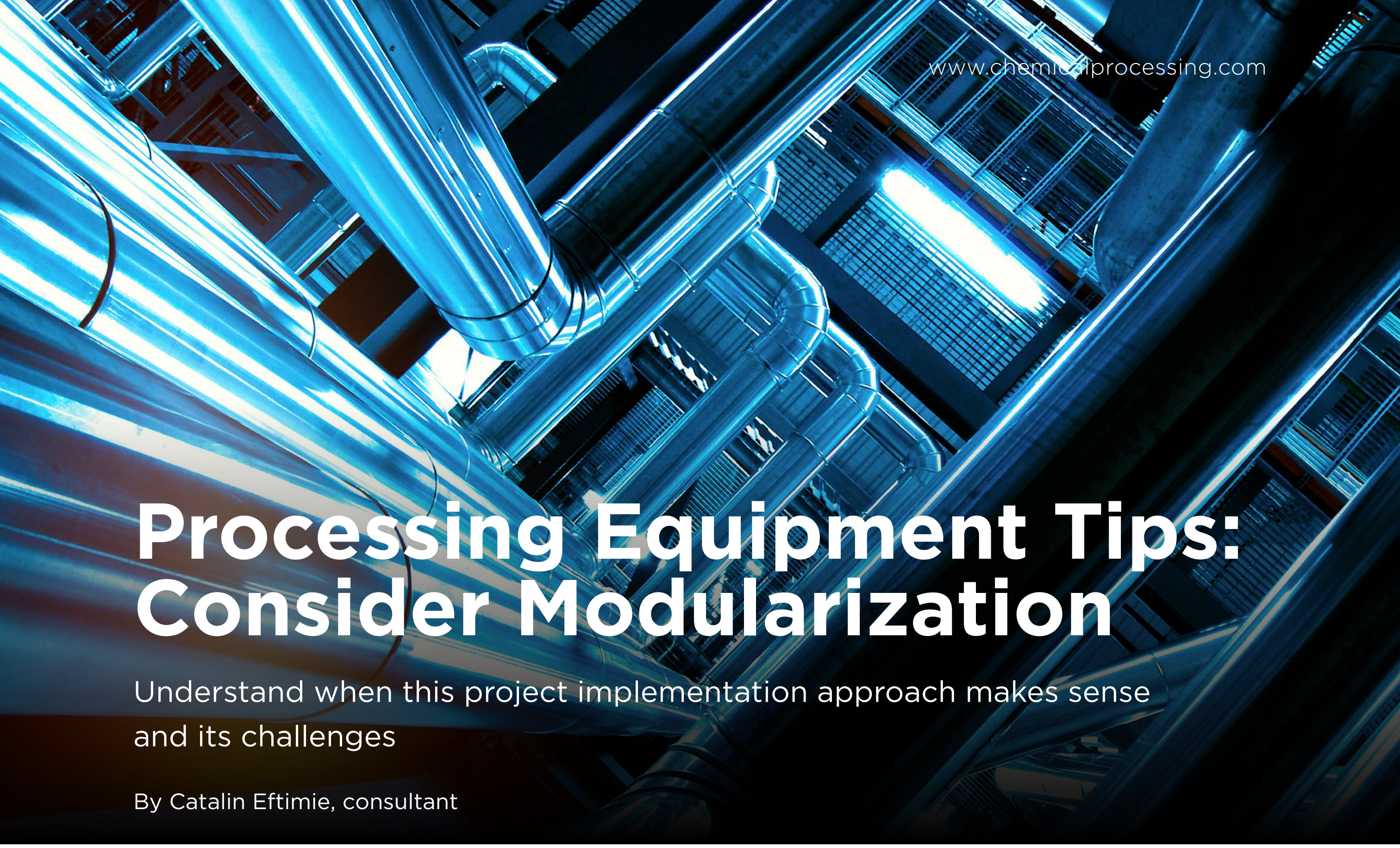


Processing Equipment Tips: Consider Modularization

Understand when this project implementation approach makes sense and its challenges

By Catalin Eftimie, consultant

Modularization aims to reduce the number of interfaces, the total installed cost (TIC) and overall schedule length of a project while optimizing the return on investment and allowing standardization of future similar projects. Originally used for offshore platforms starting in the 1980s, this design philosophy has made slow progress in onshore applications. However, today's low oil prices are prompting increasing interest in modularization because it promises to cut project costs.

In contrast with conventional field-constructed (stick-built) projects, modularization splits a unit into parts — so-called "modules" — to be prefabricated in an offsite workshop and assembled later onsite on a pre-laid foundation. The defined modules are compact and portable, and offer the combined functionality of multiple skids. Modules also are self-supporting and consequently removable, if required. From a design perspective, this means focusing at a package level rather than on individual equipment as is the case with conventional engineering.

Modularization offers many significant benefits including cost savings by reducing field erection; higher quality and safety from having fabrication done in an offsite shop; decreased schedule (by up to 25–50%); increased efficiency; module mobility and re-usability; and less site construction complexity due to fewer interface points for modules, reduced onsite logistics, etc. These advantages become even more important at remote locations, and at any site contending with adverse weather/climate, lack of skilled personnel onsite, and concerns about downtime on brownfield projects.

However, the approach also poses critical challenges that if not addressed properly can trigger higher costs and delays. So, a careful evaluation of the viability of modularization is essential.

ASSESSING VIABILITY

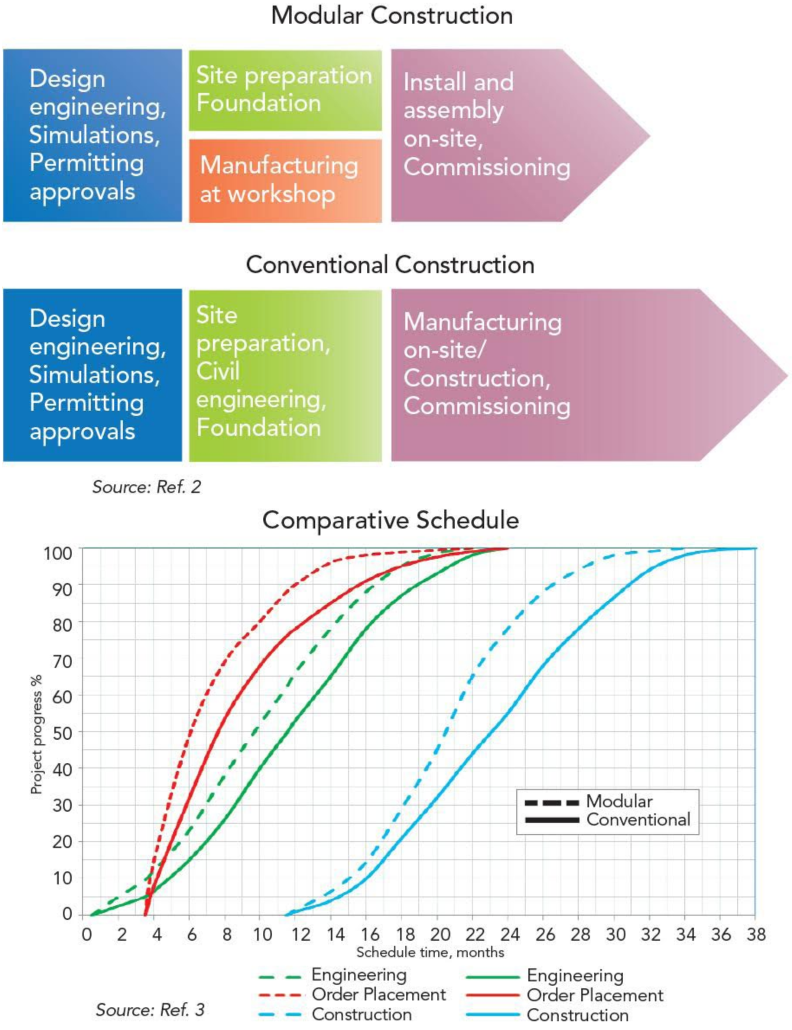
The decision about whether to use modularization should be made very early after starting a project, typically during the conceptual/pre-front-end-engineering-design phase, when the engineering consultant evaluates the most cost-effective design strategy. A feasibility study of modularization versus stick-built design should take into account the owner's input and assess all critical factors. The following points deserve particular consideration:

- Is future plant capacity suitable for modularization? The approach already has proven itself for mini-refineries with capacities up to 50,000 bbl/d, gas plants up to 200-million scfd capacity (in two similar trains) and floating production, storage and offloading (FPSO) units.
- Are there any restrictions on where and who can fabricate modules? Depending on modules type and complexity, you must assemble a shortlist of potential fabricators, which later will be refined based on local codes and regulations, distance from final destination, country taxes or other criteria.
- Is modularization impacted by shipping and transportation limits? Existing transportation infrastructure (highways, railway system in place, sea access) at fabricators or the destination may become critical. Typical modules sizes are 12 ft ×12 ft × 60 ft up to 24 ft × 24 ft ×120 ft by truck/rail, or larger by sea; weight limits are up to 400–600 tons by truck/rail or as much as 12,000 tons by sea.
- How would equipment spacing limitations impact modularization? Plant owner standards may not always align with the equipment spacing philosophy of fabricators; in such cases, industry practice (i.e., existing similar facilities) may become decisive.
- Are site permits available at the start of the project? This can save considerable time in project development. However, a project can progress in a fabricator workshop in parallel with permit application in case of modularization versus typical standard stick-built projects.
- What is the availability of onsite heavy-lift cranes (> 300 tons per module)? This may impact modules' sizing. When such cranes are needed, proper scheduling of their availability onsite is

essential to avoid runaway project costs.

- How experienced are the shortlisted fabricators in modularization? Demonstrated competence in previous modularization projects may become a major advantage in favor of adopting modularization.
- What is the gap between field and shop fabricator labor cost and productivity? Invariably labor costs are lower (by as much as two-thirds) and productivity is much higher when work is done in a fabricator's shop rather than onsite.

Modularized projects, if properly managed, can provide significantly compressed metrics. Figure 1 illustrates schedule savings typically achieved by a modularized project compared to a conventional stick-built one.



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COMPARING THE APPROACHES
Figure 1. Modular construction, when feasible, offers compelling benefits.

ADDRESSING POTENTIAL CHALLENGES

Modularization also poses some negatives. Some of the most important issues are:

1. Cost of first design can exceed that of the conventional design by up to 50–60% or reach as much as 12% of the TIC [1] depending on familiarity and past experience of the contractor with the modular approach.

Solution tips: Because the front-end effort is more intense than in conventional engineer-

ing and the number of long-lead items is greater with orders placed much earlier during the project, good planning, scheduling, and activities sequencing are crucial to meet hookup and commissioning target dates. You must identify and freeze module interfaces early to allow progress of parallel workshop and site activities, restrict deviations to a minimum, and ensure continuous schedule alignment. Good coordination and claim management are essential because procurement starts at an earlier stage. In addition, expediting needs to be constantly evaluated to anticipate and avoid major delays.
Common mistakes: Lack of previous fabricator and engineering/procurement/construction (EPC) contractor experience in completion of similar projects and especially lack of modular project management expertise.
Under-estimated aspects: Activities progress of various suppliers of modules may impact the overall schedule, as well as shipping routing and the local country's legislation and taxes. Also don't neglect coordination of activities onsite versus parallel ones in a fabricator's shop.

2. Equipment and instrumentation within a module have less access/maintenance space than in a conventional design. Module design must allow access to the components needing to be shut off; this may require advanced 3D ergonomics analysis.
Solution tips: Identify early critical items requiring periodical maintenance and ensure proper layout access.
Common mistakes: A focus on making the module more compact to fit into the shipping limits without any consideration of accessibility of personnel to key instrumentation or critical equipment.
Under-estimated aspects: Often a conflict arises between EPC contractor and fabricator equipment spacing standards or versus typical industry practice.

3. Module sizes/weight limitations imposed by local transportation regulation impact the optimization of the level of modularization.
Solution tips: Follow industry practice or previous experience from similar projects.
Common mistakes: Combining too much functionality within a module to reach maximum limits may result in a high level of complexity.
Under-estimated aspects: Number and location of interface points, sometimes difficult to access or mismatching those of other modules to be assembled together.

4. The number of long-lead items is greater and ordering must be done earlier versus conventional design.
Solution tips: Develop a transportation strategy (e.g., access routes, loading/offloading facilities) for intense expediting and to ensure all design issues are

properly addressed.

Common mistakes: Design changes during the procurement phase.

Under-estimated aspects: Management of change process to deal with design changes unavoidable during project development.

5. Managing a modularization project within a conventional one requires consideration of equipment spacing requirements and confined area accessibility for maintenance in an existing limited plot area.

   Solution tips: Have a good understanding of operational issues and existing plant configuration.

   Common mistakes: Ignoring operational needs and only concentrating on complying with the available plot area.

   Under-estimated aspects: The cost impact of loss of productivity during downtime of brownfield projects.

6. Interface management and execution strategy requires experience in both offsite modular fabrication and field construction/assembly, which also implies supervision of multiple work sites and possibly more complexity.

   Solution tips: Previous experience with modularization projects helps in achieving a good coordination of multiple sites.

   Common mistakes: Misalignment of activities onsite with those in the fabricator shop.

   Under-estimated aspects: Importance of activities' sequencing.

7. Shipping incurs significant costs. Larger modules are transported by sea. Transportation and lifting in land-locked locations (with few or no roadways) also may become very challenging.

   Solution tips: When shipping by sea, you may need to consider damage, delays or loss risks and fees related to insurance, marine surveyors and customs, plus costs for heavy lifting and special transport.

   Common mistakes: Neglecting or minimizing the importance of having a detailed shipping plan.

   Under-estimated aspects: Characteristics of existing local transportation infrastructure.

8. Awareness of local national laws is critical for modularization project planning because they may impact shipping schedule and coordination between multiple sites.

   Solution tips: Gather early in the project all available information related to local legislation and get a clear understanding of local authorities' requirements.

   Common mistakes: Discovering too late hidden fees or shipping restrictions that may require readjustment of project schedule and replanning.

   Under-estimated aspects: The value of having a local contact familiar with local authorities' regulations.

9. Implementation of construction and quality standards or deviations from them may become critical.
   Solution tips: Use industry practice to resolve potential conflicts between fabricator and owner standards and adopt standards deviations, if justified. Fix standards to follow shortly after project kickoff and indicate them in the project procedure and execution manual.
   Common mistakes: Developing standards during project progress to address modularization issues.
   Under-estimated aspects: Local site legislation.

10. Material and equipment timely delivery and handling, heavy lifting/hauling, shipping constraints (truck/rail/barge), routing and clearances all are critical.
    Solution tips: Good planning can anticipate fabricator and onsite needs in materials, logistics and manpower.
    Common mistakes: Lack of heavy lift crane availability.
    Under-estimated aspects: Costs associated with maintaining onsite heavy lift cranes for longer duration.

11. Modularization is not as change-friendly as stick-built projects and so requires effective project management.
    Solution tips: Permit no changes (except for safety or code reasons) after process and instrumentation drawings are issued for design.
    Common mistakes: Design changes during procurement stage.
    Under-estimated aspects: Costs associated with modifications added to already fabricated equipment.

12. A fabricator not only must have the ability to build and assemble modules but also the capability to plan/coordinate their transport, which depends upon access to roads, rail system or deep water (for larger modules).
    Solution tips: Shortlist available experienced fabricators during the bidding phase; have the fabricator already selected when the project is awarded.
    Common mistakes: Poor expertise in modularization of selected fabricator or its logistics limitations.
    Under-estimated aspects: Heavy modules not acceptable to existing road infrastructure.

A HYBRID APPROACH

As the points above illustrate, modularization strategy can be very challenging. Sometimes hybrid solutions, which combine advantages of both modularization and stick-built, can make a project attractive in terms of budget, quality and delivery time. Pipe rack fabrication provides a good example. For large projects, modularization may require additional design time (10–15%), more steel for transportation and installation (20–30%), proper scheduling for material delivery earlier in addition to the availability of large cranes onsite to put pipe rack modules into place. An alternative hybrid solution might opt for pre-assembled pipe rack modules for smaller sizes (e.g., about 3-m wide) but rely on traditional stick-built methods for larger assemblies. Combination of the two project strategies is becoming more complex — but is feasible for companies with proven industry experience.

AN INCREASING NEED

The chemical and refining industries lag in adopting modularization compared to other heavy industries (e.g., automotive, civil infrastructure, shipbuilding, etc.). Process licensors and workshop fabricators have adapted faster to this new reality than EPCs, where efforts still are ongoing to improve their competitiveness.

The key elements in modularization are interfaces' standardization and change management. However, keep in mind a few other significant aspects:

- *Standardized modularization.* As already noted, mini-refineries with capacities up to 50,000 bbl/d, gas plants with as much as 200-million scfd capacity and FPSOs have been built and operated based on the modularized approach. Companies have reported important cost savings from replication or templating in multiple similar parallel trains. This implies that engineering companies will continue to adapt to the market with a new set of engineering standards and will become familiar with vendors' standards for packages and materials;
- *Minimizing peak staffing pressure in the field.* Maximizing the work in fabrication shops will continue to reduce reliance on increasingly scarce skilled field workers. This includes performing offsite most of the pre-commissioning and commissioning work;
- *Reorganization of engineering companies.* Many EPCs now are expressing more interest in reviewing for owners the integration and optimization opportunities of existing and future plants. In this area, modularization also may become a "preferred choice." In fact, many companies now have established a "module architect" position, which is a more-skilled engineering job requiring not only a techno-commercial overall project view but also the know-how of supply chain elements across multiple projects;
- *Technologies offered as packages.* Many licensors started and will continue to offer technologies based on a modularized package concept.

ASSESS THE OPPORTUNITY

With proper expertise and when applied based on accurate project coordination and planning, modularization certainly becomes a successful design strategy, one worth pursuing despite any reservation or resistance from teams used to the classi-

The key elements in modularization are interfaces' standardization and change management.

cal stick-built way of engineering. After all, modularization already has proven its benefits on many recent projects. Modularization allows moving complex and costly tasks from the field into the fabricator's yard — reducing risks and labor effort while improving quality, schedule and savings via higher offsite productivity. However, modularization requires both fabricators and contractors with strong knowhow based on past experience and lessons learned in similar projects.

The trend to modularization will continue in the coming years under the pressure of fluctuating oil prices and reduced availability of skilled workers, along with tighter environmental regulations.

However, successful modularization requires a more mature design and project execution organization. Engineering companies need to invest in this new reality. They must improve their expertise, be open to alliances with specialized fabricators, and especially adapt their project management approach to the challenges of standardized modularization. ■

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REFERENCES

1. Hesler, W.E., "Modular Design — Where It Fits," p. 76, CEP (Oct. 1990).
2. Meyer, W., "Modularization," Foster Wheeler/HBR (Aug. 2007), www.slideshare.net/gusgon/modularization.
3. "Need a New or Replacement Process Unit?," Integrated Flow Solutions, Houston (Sept. 2016).
4. Karlsson J., and Bjorklund, M., "Modular Design," *Wartsila Tech. J.* (Feb. 2008).
5. Jameson, P. H., "Is Modularization Right for Your Project?," p. 67, *Hydrocarbon Proc.* (Dec. 2007).


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Application Note
Safer Flare Operations
with In Situ Oxygen Analysis

Dividing Wall Column Provides Sizable Energy Savings

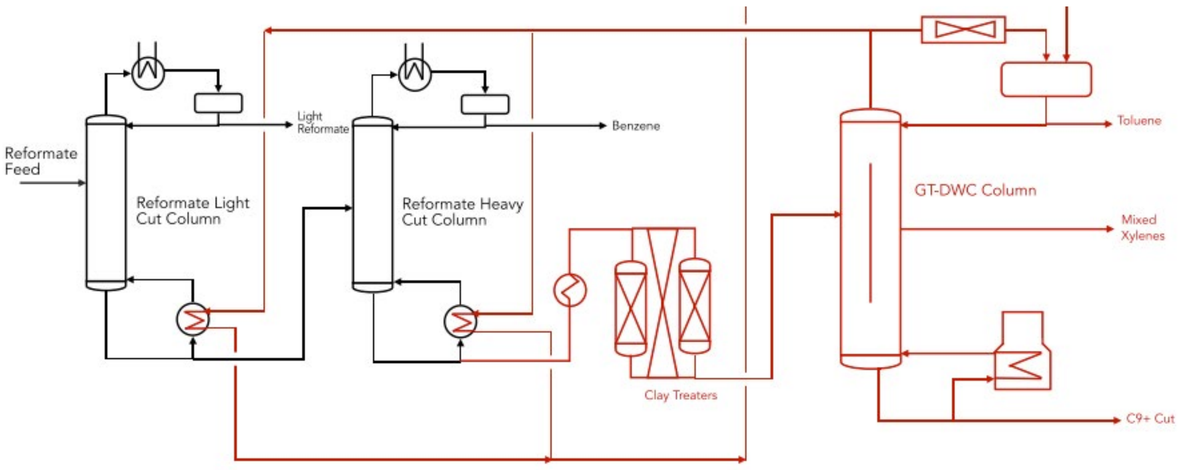
Refinery also significantly reduces capital cost for recovering mixed xylenes

By Manish Bhargava, Roomi Kalita and Joseph C. Gentry, GTC Technology US, and Norihito Suzuki, TonenGeneral Sekiyu

As energy sectors enter a phase emphasizing energy reduction, interest is growing in dividing wall column (DWC) technology for distillation. For example, a recent installation took place at a refinery complex in Chiba, Japan, owned by the TonenGeneral Group. There, the DWC recovers 230,000 t/y of high-purity mixed xylenes from a full-range reformate feed.

The project was implemented in early 2016 with the intention of rejuvenating petrochemical business in Japan. Mixed xylenes, along with other heavier components, traditionally had been used as gasoline base stock in the refinery. However, to improve profitability, TonenGeneral decided to separate the mixed xylenes. The DWC (Figure 1), which has a process-

DIVIDING WALL COLUMN
Figure 1. Unit for separating mixed xylenes now has been operating at Japanese refinery for over a year.



NEW FLOWSCHEME

Figure 2. Addition of the DWC and other modifications (shown in red) resulted in significant energy savings.

ing capacity of 1,170 bbl/d, has been fully operational since April 2016. It recovers 98.5% of mixed xylenes (C_8 aromatics) contained in the feed.

Opting for the DWC instead of a traditional distillation column for the separation provided significant savings: 19% in capital cost and 20% in utilities.

A DWC features a vertical wall that separates the column shell into two sections. This eliminates the thermodynamic inefficiencies associated with a regular column operating in a traditional sequence — and the need for an extra column to separate the same number of products.

The column operates at an elevated pressure (635 kPa). As a result, the hot overhead vapors are collected at 189°C and used to provide reboiling duties to the upstream reformate light-cut and heavy-cut columns, as shown in Figure 2. Prior to the DWC installation, the reboilers of those two columns operated on steam. Heat integration of the DWC with the upstream columns reduced steam consumption by 20 t/h.

The column has a diameter of 4 m and is approximately 80 m in height. Its large dimensions necessitated transporting the column in three parts, each 25–30-m long, and assembling them together on site.

The DWC internals were installed inside the tower after completion of pressure and air-tightness tests. The wall was tag-welded slightly off center (Figure 3). The whole installation took about two months to complete.

Table 1 summarizes the results of a performance guarantee test.

The purity of C_8 aromatics obtained during initial startup of the column was around 80–90 wt. %. Following stabilization of the column and implementation of an advanced degree of control (post June 2016), the purity now is maintained at around 99 wt. %.

Regulation of the column involves three primary control loops:

1. Side-draw product rate is cascaded to a temperature indicator (TI) on an upper tray.
2. Flow rate of fuel gas for the fired heater is cascaded to another TI on a lower tray.
3. Reflux flow rate is cascaded to the temperature of the overhead vapors, to control the heat provided to the upstream columns.

DIVIDING WALL
Figure 3. DWC internals were installed inside the tower with the wall tag-welded slightly off center.

AN ATTRACTIVE OPTION

Compared to conventional distillation columns, DWCs provide significant energy and capital savings, both approximately 20–30%. So, they hold a promising future for separations requiring distillation. ■

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Component	Test Result	Product Specification
Toluene	0.05 wt. %	-
Mixed xylenes Ethyl benzene	99.12 wt. % 14.43 wt. %	98.5 wt. % minimum 18.0 wt. % maximum
C_9 aromatics	0.12 wt. %	0.3 wt. % maximum
Non-aromatics	0.71 wt. %	1.0 wt. % maximum
Bromine index	2.0 mg/100 mg	20 mg/100 mg maximum

PERFORMANCE GUARANTEE TEST
Table 1. Results significantly exceed product specifications.


TRIAC


TRIAC
CONTROLS

Refineries: Rethink Corrosion Monitoring

Consider permanently installed wireless non-intrusive ultrasonic sensors

By Jake Davies, Emerson Automation Solutions, Permasense Technologies

Many refineries rely on equipment well past original design life. These assets, some of which now have been in operation for double that time, face an ever-increasing risk of failure due to internal corrosion attack.

Corrosion in refineries often is caused by contaminants in produced hydrocarbons that, over time, lead to deterioration of pipe and vessel walls. Loss of equipment integrity can result in unplanned downtime and costly repairs or, in the worst case, a catastrophic event posing major risk to personnel, the environment and stakeholder value.

Exacerbating the problem, many refineries no longer process the specific type of oil, such as sweet crude, they originally were designed to handle. The changing nature of oil feedstock magnifies corrosion problems in aging refineries.

For instance, in the U.S., refiners are taking advantage of the availability of light tight oils (LTOs), which afford significantly higher margins. The production of LTOs relies on the use of fracking fluids, a cocktail of chemicals for stimulating oil flow from the field. In many instances, these chemicals can end up in the crude oil feedstock to the refinery. In addition, the transportation of LTOs by railcar requires the addition of H2S passivator chemicals that can introduce other corrosion-related problems. These amine-based compounds can deposit as salts in the top section of crude towers, top pump-around and draw trays — with the resulting possibility of more corrosion.

NAPHTHENIC ACID CORROSION
Figure 1. Crudes with a high total acid number cause corrosion in areas operating above about 200°C.

Another example is Canadian oil sands crude, which has a high total acid number (TAN). Many of the world's existing refineries were designed to process crudes with a TAN of 0.3 mg KOH/g or less but lots of newer crudes have a TAN of 1 mg KOH/g or more.

High TAN crudes create naphthenic acid corrosion, a particularly aggressive and often localized form characterized by the "orange peel" effect (Figure 1). While this issue primarily affects crude and vacuum distillation units, the gas, oil and residue products fed to downstream conversion and hydroprocessing units also can exhibit TAN levels that cause problems in feed-section equipment fabricated from carbon steel.

Refiners have two principal mitigation strategies against corrosion: upgrading the metallurgy of many or all the susceptible areas, often to expensive high-nickel alloys or titanium; or using chemical corrosion inhibition treatment.

Both strategies should include online corrosion monitoring at critical locations to verify the state of the metallurgy upgrade or the inhibitor distribution and effectiveness. Alternatively, online corrosion monitoring can validate that the existing mitigation strategy is performing adequately.

ASSETS AT RISK

Refinery processing hardware prone to corrosion include sour-water strippers, crude and amine units, terminal jetties and many other assets.

Sour-water stripper tower corrosion and fouling from corrosion byproducts like iron sulfide are common operational problems compromising asset integrity. Tower and crude overhead sections are exposed to high levels of hydrogen sulfide and ammonia, and can experience excessive rates of ammonium bisulfide corrosion. High levels of cyanides from upstream units that concentrate in the overheads can compound corrosion risks (see Safeguard Sour-Water Strippers section on page 23).

Free cyanides can be deposited in the wet gas stream, causing hydrogen blistering. Cyanides can destabilize any passivation (iron sulfide) layer, causing it to flake off as free iron sulfide, resulting in plugging and fouling.

Amine systems are subject to corrosion by both carbon dioxide and hydrogen sulfide in the vapor phase, the amine solution and the regenerator reflux — as well as from production of amine degradation products in the amine solution. In refineries specifically, amine systems suffer from corrosion by several components such as ammonia, hydrogen cyanide and organic acids not generally found in natural and synthesis gases; some of these will accumulate at various points around the refinery amine system.

MONITORING CORROSION

Refineries can turn to two methods to measure corrosion: probes and ultrasonic sensors.

Corrosion probes, which have been in use since the 1960s, rely on an intrusive element with a sacrificial tip that sits in the process fluid. As the sacrificial tip corrodes, its electrical resistivity changes. The corrosion of the sacrificial tip is used to infer the level of corrosion being experienced by the surrounding equipment.

While simple to use, corrosion probes suffer from two disadvantages:

1. The center-line measured corrosion at the tip may not match the corrosion rate at the pipe wall.
2. The tip often corrodes away after two to three years while many refineries now operate five or more years between major turnarounds.

Ultrasonic measurement is a well-established technique for determining metal wall thickness. The technique involves the generation of ultrasound from a transducer placed directly onto the metal surface. The ultrasound travels through the metal until it is reflected off the back wall. The time difference between the sending and reflected signals correlates to the wall thickness.

Traditional ultrasonic manual inspection techniques only provide a snapshot of equipment integrity. Typically, personnel take measurements every six months to five years. Such long intervals between measurements pose a significant safety risk because a serious event can happen in a matter of hours or days. These traditional methods can't provide the accuracy, quality and frequency of data necessary to find problems, so mitigation can't be optimized without interrupting operations.

A NEWER OPTION

Today, refiners instead can opt for permanently installed, wireless ultrasonic wall-thickness-monitoring sensors for corrosion monitoring. The units generate on a continuous basis the data required to make proper decisions and provide this information directly to plant personnel.

These ultrasonic sensors are non-intrusive, so their installation cost is low, and can be mounted almost anywhere. Wireless data retrieval eliminates the need for cables, further decreasing installation and ongoing operating costs. Moreover, power packs should last until the next plant turnaround (typically, nine years' service is achievable). The simplicity of installation and long power-pack life make ultrasonic sensors well suited for use in remote locations only accessible during turnarounds.

Each sensor has a measurement footprint of approximately 1 cm^2, which is similar to the area required for manual ultrasound inspection. Thus, the probability of detecting localized corrosion attack using a single sensor is small. To increase the odds of detection, sensors often are installed as multi-point arrays at high-risk locations (Figure 2).

Process temperature variations affect all ultrasound-based measurements due to the change in speed of sound through the metal. The latest generation of sensors uses an integrated thermocouple to measure the metal surface temperature and can automatically compensate the wall thickness data for temperature variations.

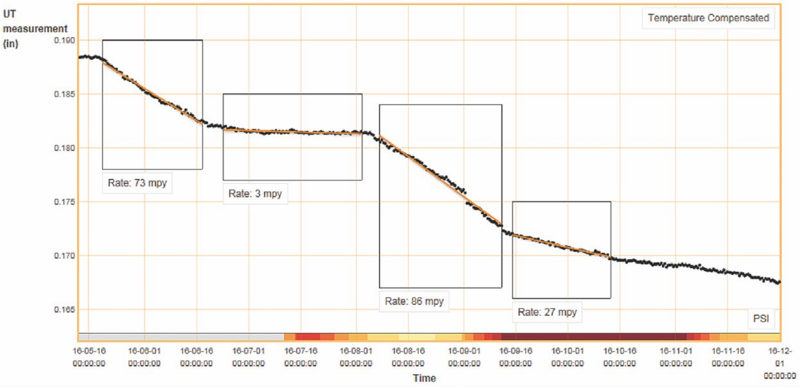
Wall thickness data from these sensors can go directly via the wireless network to PC-based analysis packages such as Adaptive Cross Correlation (AXC) software from Emerson (Figure 3). It can analyze and display information from dozens or even hundreds of corrosion sensors in a plant or refinery, and informs plant personnel when it discovers a problem.

Giving plant personnel access to this kind of corrosion information enables them to make the right decisions at the right time about when and where to carry out critical maintenance to support safer and more-economic operations.

Installing the non-intrusive corrosion sensors, a wireless network and PC-based software to process the data doesn't require a multi-day project requiring asset shutdown. Actually, deploying a real-time wireless corrosion monitoring system at strate-

WIRELESS SENSORS

Figure 2. Installing multiple ultrasonic units (orange) in areas at elevated risk of internal corrosion can help spot localized attack.



WALL THICKNESS

Figure 3. Analysis software can detect as little as 10 microns of wall loss.

gic locations on the outside of equipment only takes a matter of hours without any interruption to refinery operations.

IMPROVE CORROSION MONITORING

Beset with aging assets and crude feedstocks that are becoming ever-more aggressive from a corrosion standpoint, refineries face an increasing risk of equipment failure due to internal corrosion attack.

When equipped with timely information about corrosion problems, plant personnel can spot the dangers and take preventive action before corrosion presents a major operational risk. The enhanced insight provided by these real-time data allows refineries to improve safety, reduce operating costs and boost production from their aging assets. This can mean the difference between profit and loss, and between asset survival and extinction. ■

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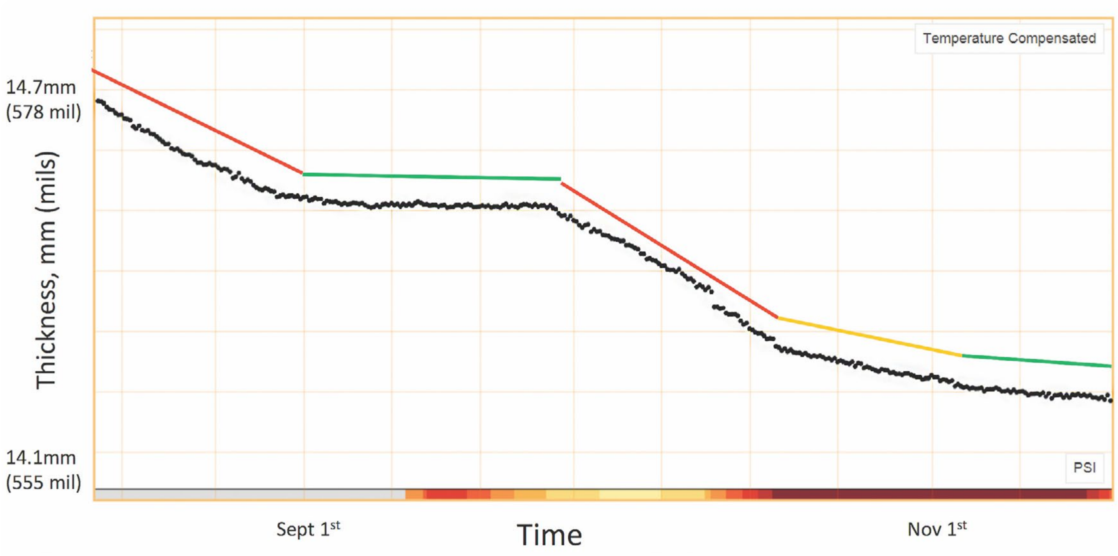
Safeguard Sour-Water Strippers

Sour-crude processing at refineries, unlike sweet-crude processing, often results in excessive levels of nitrogen, which leads to production of cyanides such as hydrogen cyanide. Cyanides can create corrosion issues in the sour-water system. Produced in the downstream conversion units (such as the fluid catalytic cracker or delayed coker), cyanide compounds concentrate into the water phase of the main fractionator overhead.

So, refiners can gain significant benefits from installing sensors continuously measuring wall thickness in high-risk areas of sour-water stripper towers. The monitoring data from these sensors enable determining if corrosion is taking place. This is especially valuable for understanding the correlation between corrosion rates and changes in feedstock or process conditions, minimizing the risk of leaks and fostering better forecasting of equipment retirement dates.

Continuous corrosion monitoring systems support the optimization of corrosion prevention and mitigation strategies, and also can provide data to justify decisions to upgrade to corrosion resistant alloys.



CONDENSER OUTLET CORROSION

Figure 4. Monitoring led to a process change — higher reboiler duty, made permanent in November — that reduced corrosion to a tolerable level.

Safeguard Sour-Water Strippers

For example, a European refiner installed several of Emerson's Permasense sensors around its sour-water stripper tower for general corrosion monitoring purposes. The focus was on the overhead condenser/overhead line, feed/effluent exchanger, tower bottoms line and reboiler outlet. In the course of routine monitoring, the refiner observed high corrosion at the overhead condenser outlet, which is fabricated from carbon steel.

Initially, the corrosion rate equalled 2.3 mm/y (91 mpy). However, testing on the unit showed that altering operating conditions, notably raising the reboiler duty, could significantly reduce the corrosion in this location. After operating conditions were permanently changed, corrosion fell to within tolerable limits in this area of the tower (Figure 4).

The increased reboiler duty produced more steam rising up the stripper, so more water was condensed in the overheads. This served two purposes: it reduced the hydrogen sulfide and ammonia partial pressure in the overhead system by dilution; and provided a washing of any ammonium bisulfide salts in the overhead condenser, thereby avoiding under-deposit corrosion.

Optimizing the reboiler duty extended the lifetime of the overhead exchanger and line by many years, resulting in a significant saving for the refinery from deferred equipment retirement and replacement costs. This was achieved because of the direct and rapid feedback on the impact of process condition changes on corrosion rates.

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Check out our library of white papers covering myriad topics and offering valuable insight into products and solutions important to chemical processing professionals. From automation to fluid handling, separations technologies and utilities, this white paper library has it all.

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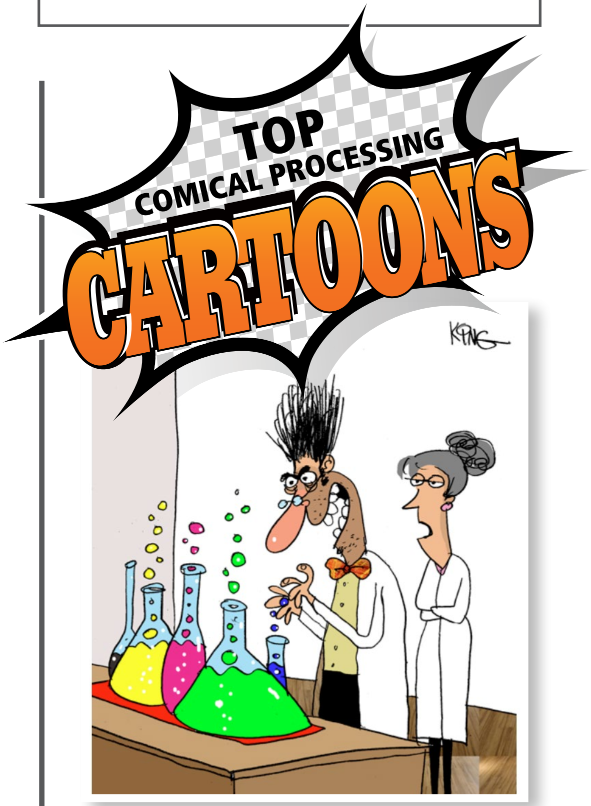

Visit the lighter side, featuring drawings by award-winning cartoonist Jerry King. Click on an image and you will arrive at a page with the winning caption and all submissions for that particular cartoon.