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New hydrogen solutions meet clean fuels regulations

As the clean-fuels deadlines rapidly approach, refinery owners are driven to evaluate their operations and determine the optimal overall solution for cost-effective compliance. Many refiners have chosen hydrotreating technologies to reduce the sulfur content of fuels. However, in some cases, this solution has led to a new problem: obtaining sufficient hydrogen to meet operational needs of the hydrotreater. Refiners who encounter this problem have several alternatives. They can:

- Buy additional hydrogen from a third party
- Optimize the operations of the existing hydrogen plants
- Replace the existing hydrogen plant with a new, more efficient unit.

In making this decision, refiners typically evaluate the availability and cost of purchasing hydrogen from a third party in conjunction with the cost of debottlenecking an existing hydrogen plant or replacing the existing plant with a new, more efficient plant. The initial capital investment, along with the startup, operating and maintenance costs, must be considered for either of the latter two alternatives. Because of recent technological advancements—such as replacing the CO_2 removal unit with a pressure swing adsorption (PSA) unit that produces higher purity hydrogen—modern hydrogen plants are more efficient and cost less to operate than older plants. Refiners may be surprised to find, when they complete the analysis, that building a modern hydrogen plant is sometimes the most attractive option.

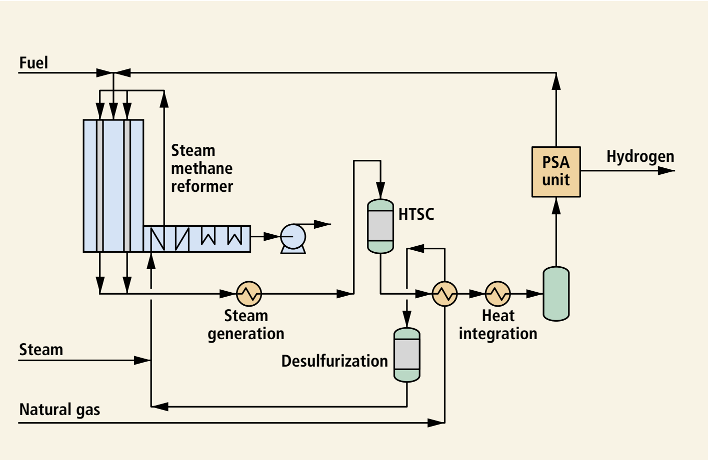

FIG. 1. Schematic of the modern hydrogen plant.

If a refiner decides to build a new hydrogen plant, capital investment choices should be evaluated in the context of the total physical and operational parameters of the refinery (Fig. 1). Options include:

- Technology options, such as steam methane reformer (SMR) and partial oxidation unit (POx)
- Design options, such as co-current upfired, upflow reformer design and expandable geometric design
- Construction options, such as modular construction versus stick built
- Contracting options, such as cost reimbursable or lump-sum turnkey.

Technology options. The first thing a refiner must consider in hydrogen production is which technology to apply. Several technologies are available, including SMR, POx, water gas shift (WGS) and auto thermal reforming (ATR). Selecting technology to use involves the evaluation of many factors, such as capital investments, operating costs, the value of steam and feedstock availability. An engineering contractor with experience in the design and construction of different technologies is an invaluable resource. They can assist refiners to determine the advantages and disadvantages of any particular technology, especially for their individual operating environment.

Design options. In conjunction with technology choices, a refiner has more options regarding the design of the hydrogen plant. For example the H2Drogen design, developed by CB&I Howe-Baker, is used for lower capacity plants and incorporates a rugged up-fired, up-flow cylindrical SMR furnace, providing an economical, reliable, and energy-efficient hydrogen generating plant for capacities up to 6 MM scfd. The HYFORMING technology achieves unparalleled performance through an expandable geometric design, superior heat transfer and advanced metallurgy. While plants with capacity as low as 7 MM scfd can use this design, the geometric design can be expanded for capacities up to 280 MM scfd. In general, environmental regulations have driven the need for plants with larger capacity, making the HYFORMING technology more in demand.

Construction options. Another consideration for the execution of the job is whether the plant should be modularized or built onsite (stick-built). While this decision is influenced by many factors, the decision is generally driven by economics and schedule. Other factors include manpower availability, onsite labor costs, construction equipment access, shipping considerations, permitting regulations and site access.

A stick-built plant is the most straightforward execution method and can be the most cost-effective when there is ample available skilled labor and time. Even when there is not skilled labor available in the region, expert traveling crews can be efficient and cost-effective. Stick-built designs save the added expenses required to move or lease cranes for the installation process, to arrange for transportation logistics, to transport large modules over road, rail or barge, and to pay for the necessary permits to use public roadways or cross bridges with these large loads. Some equipment may be too large to transport, making the stick-build approach the only option.

In some cases, the benefits of modular construction can outweigh the advantages of stick-build. Building modules offsite and transporting them to the refinery minimizes disruption to existing refinery operations. When space is not sufficient for construction activities, modules can be lifted into place with cranes. Shop construction provides a safer environment by eliminating elevated work and scaffolding risks and project delays due to inclement weather are reduced. Quality control and consistency are often optimized in the shop environment.

The footprint of the refinery and the space available for the hydrogen plant must be considered as the construction methodology decisions are made. Improvements in heavy lifting and rigging equipment—that can now lift modules weighing up to 1,000 tons—have allowed the size of modules and pre-fabricated equipment to increase, making modular construction more viable. If this option is chosen, access to the site must be evaluated from several perspectives. For example, how will the modules be transported from the shop to the refinery? If both are located on the coast, barges provide an excellent transportation option. If not, road or rail access must be examined to determine the feasibility of transporting the modules to the site. Space within the confines of the refinery must also be reviewed to determine if a large crane can be effectively placed and used. Soil considerations for supporting the cranes must be included in this evaluation.

Engineering contractors that have experience in both modular and stick-built execution of jobs can offer valuable insight that will help guide the refinery to the lowest cost solution. Also, an engineering contractor that has in-house fabrication capabilities can offer distinct advantages in cost and quality over engineering contractors that do not have this capability.

Contracting options. One additional consideration the refiner should evaluate is the contracting strategy. While cost reimbursable contracts are viable when the full scope of work is unknown, contractors willing to perform lump-sum turnkey (LSTK) services are sharing the project risks with the refiner and therefore have more incentive to control costs. LSTK projects require less oversight, which frees refinery resources to perform other activities. For these reasons, LSTK projects are often the most cost-effective solutions in the long term.

Optimal choice. While capital expenditure considerations must remain at the forefront of the refiner's decision-making process, the specific needs of each individual refinery will dictate the options that are available and, ultimately, the solution that is optimal. The refiner who decides to build a new hydrogen plant will, first and foremost, select the technology and design that will ensure continued reliability of hydrogen production, complementing these decisions with construction and contracting methodologies that minimize disruption to existing operations and provide a cost-effective and safe solution for meeting the future hydrogen needs of the refinery. ■

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