



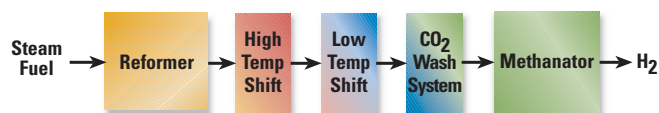
# UOP Polybed™ PSA System for Hydrogen Production by Steam Reforming

## Hydrogen

Steam reforming, or catalytic reforming of light hydrocarbons, such as natural gas, under a steam atmosphere, is the dominant technology for production of syngas, and thus, of hydrogen. The hydrogen produced by this process requires purification before it is used in downstream processes.

Without pressure swing adsorption (PSA), the purification route for steam reformers can not produce the hydrogen purity needed for optimum performance of catalytic processes. UOP's Polybed PSA system can easily purify the hydrogen to meet downstream process requirements.

For hydrogen purification without a PSA system, the gas from the steam reformer will pass through several conversion steps to minimize the carbon monoxide content. A wash or CO<sub>2</sub> removal system removes the carbon dioxide. Any remaining carbon monoxide and carbon dioxide are reacted to produce methane in a methanator. The hydrogen produced contains less than 10 ppmv of carbon oxides, but can achieve only a hydrogen concentration between 92 and 97 vol-% depending on the severity of the reforming reaction.



Steam reforming before development of PSA.

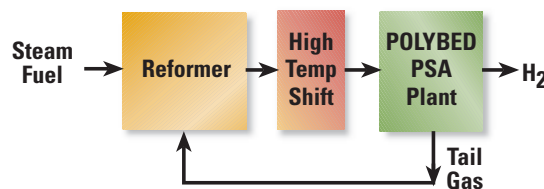
With a Polybed PSA system the CO<sub>2</sub> removal system and methanator become redundant. The PSA system will remove any unconverted methane, together with the carbon monoxide and the carbon dioxide, as fuel gas for the steam-reforming furnace.

### The Polybed PSA System:

- Provides a proven, cost-effective way to replace complex wet scrubbing purification systems
- Simplifies plant configuration and operation
- Produces higher purity H<sub>2</sub> than traditional wet scrubbing systems
- Produces H<sub>2</sub> at essentially feed pressure
- Provides valuable heat input to the reformer furnace
- Controls the variation of the Wobbe index of the tail-gas stream sent to the reformer for proper furnace operation



Gas Processing



Steam reforming with PSA system.

### Process description

The gas produced by the steam reforming reaction first passes through a shift reactor, where carbon monoxide converts to carbon dioxide and hydrogen. Leaving the shift reactor, the gas contains approximately 75 vol-% hydrogen, together with carbon dioxide, carbon monoxide, and some unconverted methane (plus nitrogen, if this was present in the feed to the steam reformer).

The Polybed PSA system adsorbs the CO, CO<sub>2</sub>, and other impurities in a fixed-bed adsorber at feed (high) pressure. The impurities desorb from the bed upon "swinging" the adsorber from the feed to the tail gas (low) pressure, and by using a high-purity hydrogen purge. The adsorbent does not adsorb the hydrogen.

Apart from the pure hydrogen product (up to 99.999 vol-%), the PSA system produces a low-pressure gas stream, the tail gas. It contains all of the impurities present in the feed gas and some of the hydrogen used for regeneration of the adsorbent. This tail gas has a heating value of 1,000 to over 2,000 kcal/Nm<sup>3</sup> (106-212 BTU/SCF), depending on feed gas composition. It is used as fuel gas for the steam reformer furnace where it provides 50 to 90% of the total heat input.

For proper operation of the furnace, a mixing drum in the tail gas line controls the cyclical variations in heating value of the off-gas. At the outlet of the mixing drum, the variation is typically less than  $\pm 3$  %.

### Commercial experience

UOP has extensive experience with PSA systems in steam reformer service. More than 200 installations have been supplied, including units producing over 220,000 Nm<sup>3</sup>/h of hydrogen (200 MM SCFD).

### UOP provides:

- Unparalleled international experience in project development, engineering, fabrication, and technical support
- Flexibility in project execution
- PSA systems optimized within customer requirements
- Worldwide sourcing to meet local requirements
- Shop fabricated skid-mounted systems for fast on-site installation and start-ups.
- Products and services with ISO-9001 certification
- Proven training programs
- Ongoing support after plant start-up

### For more information

For more information, contact your local UOP representative or our Des Plaines sales office:

e-mail: [info@uop.com](mailto:info@uop.com)

fax: +1-847-391-2253

phone: +1-847-391-2000

### UOP LLC

25 East Algonquin Road  
Des Plaines, IL 60017-5017  
U.S.A.

[www.uop.com](http://www.uop.com)

© 2007 UOP LLC. All rights reserved.  
The information in this document should not be construed as a representation for which UOP assumes legal responsibility, or an authorization or recommendation to practice a patented invention without a license.  
UOP 4810-4 0907

