

UOP Polybed™ Pressure Swing Adsorption (PSA) Systems

PSA systems for hydrogen production by steam reforming

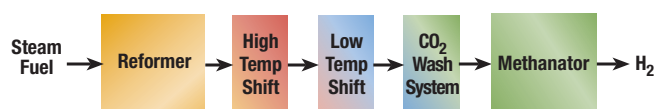
Optimum steam reformer integration, project execution, performance and reliability are obtained with UOP Polybed PSA Systems.



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

Using PSA for the purification of steam reformer hydrogen produces the high-purity hydrogen 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 CO₂ 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.



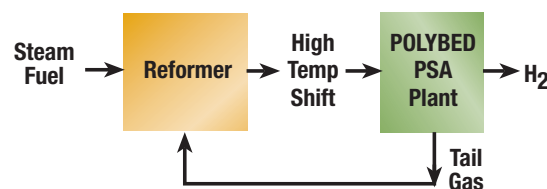
Steam reforming before development of PSA.

With a Polybed PSA system, the CO₂ removal system and methanator become redundant. The PSA system will remove any unconverted methane, 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 H₂ than traditional wet scrubbing systems

- Produces H₂ 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



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, 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, CO₂, 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 106-212 BTU/SCF (1,000 to over 2000 kcal/Nm³), 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 Wobbe Index variation is typically less than $\pm 3\%$.

UOP Polybed PSA systems are the most reliable way to get the highest purity hydrogen to help you meet clean fuel regulations and realize more valuable products per barrel of crude oil.

Commercial experience

UOP invented and developed Polybed PSA technology over 45 years ago. UOP has delivered over 900 PSA systems worldwide, processing over 40 different types of feedstock.

UOP was the first to commercialize PSA technology for steam reformer service. UOP has provided more than 390 PSA systems for steam reformer service with hydrogen production capacities ranging from 1 to more than 244 MMSCFD (1,000 - 268,000 Nm³/hr).

UOP provides:

- Unparalleled international experience in project development, engineering, fabrication, and technical support
- Flexibility in project execution
- PSA systems optimized to customer requirements
- Worldwide sourcing to meet local requirements
- Fixed pricing for accurate forecasting of project expenses
- Shop fabricated skid-mounted systems for fast on-site installation and start-ups
- Proprietary UOP adsorbents that enable higher hydrogen recovery
- Automatic operation that minimizes manpower requirements
- Superior quality control resulting in long-term safe, reliable operation
- Greater than 99.8% on-stream factor from the rigorous design and selection of the valves and control systems
- Maximum reliability for hydrogen production due to the control system that automatically adjusts to maintain production, even during upset conditions
- Lower capital cost due to adsorbent efficiency, process design and control philosophy
- Long adsorbent life (>30 years)
- Products and services with ISO-9001 certification
- Proven training programs
- Ongoing support after plant start-up
- Revamp services to enable existing equipment to meet your future needs.

For more information

For more information please contact your UOP representative or visit us online at www.uop.com.

UOP LLC, A Honeywell Company

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

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UOP 4810-4a October, 2011

