Clean Energy Solutions | Partnership | Success

H2X SOLUTIONS

XEBEC POWERS AN ENERGY EVOLUTION

Case Study: Reliability analysis of XEBEC's fast-cycle, rotary-valve PSA systems.

Objectives

Pressure Swing Adsorption (PSA) systems provide a well-established and reliable process for purifying hydrogen, methane and other gases from mixed gas streams. XEBEC Technologies (XEBEC) has made significant advancements in PSA technology, including the introduction of rotary valves and a much faster PSA process. For the past decade, XEBEC has been developing and selling its rotary valve PSA systems for industrial use. This case study looks at a long-term gas purification installation that includes XEBEC's rotary valve and fast-cycle PSA technology. The study covers more than five years of operating history to investigate the reliability of XEBEC's rotary valves and clearly demonstrate the costs and benefits of these advanced PSA systems.

XEBEC's fast-cycle, rotary-valve PSA system was selected because it met all customer requirements: extreme reliability, simple operation, rapid startup, minimal footprint, and the ability to produce the most cost-effective ultra-high purity

Project Background

A new steam reformer and XEBEC PSA system were selected to replace an aging chemical plant that supplied high purity hydrogen to a stainless steel production facility on the remote western coast of Honshu, Japan. MKK, Ltd, (Mitsubishi Kakoki Kaisha) was awarded the project and supplied its in-house reformer design with a XEBEC fast-cycle, rotary-valve PSA.

The plant was designed to deliver 407 NCMH (normal cubic meters per hour) of hydrogen continuously with less than 1 part per million of contaminants – more than 99.999% pure hydrogen. The PSA purifies a reformate stream which consists of approximately 75% hydrogen, 20% carbon dioxide, 2.5% carbon monoxide and 2.5% methane. The reformate is produced by a steam reformer that uses liquid petroleum gas as the feedstock for producing hydrogen. Tailgas from the PSA system supplies heat for the reforming process, making an efficient method for generating hydrogen. The installation is outdoors near the coast, where the ambient temperature can range from -25°C in winter to 35°C in summer.

XEBEC's compact, fast-cycle PSA systems and their reliable rotary valves proved a perfect fit for MKK, Ltd. in Japan.

Result: Strong Reliability, Low Cost of Ownership

Testing revealed the annual cost to maintain the advanced XEBEC PSA was US$3,157 including regular inspections and maintenance by site personnel, repair and service work using site personnel and XEBEC factory-trained service engineers, travel and all replacement parts. (For testing procedure and details, please see page 2 of this case study.)

Measure	Case Study
Service Internal	> 5 years*
Annual Cost for PSA Maintenance	US $3,157
% of Capital Cost	< 1.5%

This study shows that XEBEC's fast-cycle, rotary-valve PSA system is extremely reliable, with one of the highest availability figures of any gas purification technology on the market.

Maintenance and service costs are extremely low compared to all other PSA systems due to the simplicity of operation and the reliability and extended service interval of the rotary valves compared to conventional PSA systems. In addition, adsorbent materials last the life of the plant in many cases. The reduced equipment size and lower installation and operating costs are further benefits of this proven technology.

** XEBEC recommended service/inspection interval is every 2.5 years with service after five years. In this case, the 2.5 year inspection was declined by the customer.*

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Study Basis

To track system reliability, the study reviewed key measures of overall PSA reliability and cost of ownership figures.

Baseline

The system, including the XEBEC PSA, started commercial operation in March 2003 by meeting the design contract performance specifications during a 24-hour test. Online gas analysis of carbon monoxide and methane in parts per million was used, as well as feed and product gas samples that were sent to a laboratory for gas chromatography analysis. The product flowmeter was calibrated by the manufacturer on-site and a certificate issued. Hydrogen recovery could be accurately calculated from the feed and product compositions and product flow using mass balance formula. The performance test gives the baseline for tracking the process reliability over the life of the fast-cycle PSA. This test also confirmed that the guaranteed design specification was achieved or exceeded

Measure	Design Specification
Capacity	407 NCMH
Purity	99.999% H2 (<1ppm CO, CO2 and CH4 each)
Hydrogen Recovery	72% (@ 0.76 Mpag)

Significant Events

March 2003: Initial operation
October 7, 2003: Unplanned PSA downtime
October 9, 2003: Vendor part replaced, normal operation resumed
January 2005: Update on performance from customer
2005 – 2007: Periodic performance updates
May 2008 : Planned service of PSA completed in two days

Dependable Long-Term Operation

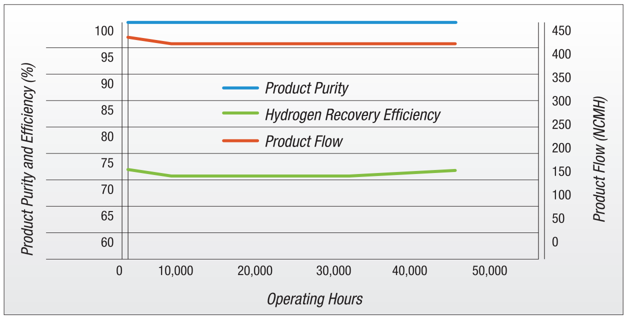
Operating hours and performance values from operations logs were provided over the period of this study. The first scheduled service of the PSA took place in May 2008 after more than five years, or 43,000 hours, of operation.

During that time, the one unplanned disruption in the first year was not related to the rotary valves. The disruption took two days of total downtime and the planned service in 2008 also took two days of downtime.

Availability and MTTR are calculated as:

Measure	Case Study
Operating Hours	43,000
Availability	99.78%
MTTR	48 hours

The data on PSA performance showed no degradation in the key performance measures of capacity, purity or recovery over the entire operating period.



Operating hours vs PSA performance

Definitions

Capacity – The quantity of hydrogen the system is able to produce in normal cubic meters per hour.

Purity – The quality of hydrogen produced in parts per million of contaminants in the product gas.

Hydrogen Recovery – The fraction (or percentage) of hydrogen that enters the PSA which exits as high purity hydrogen product (the balance is in the PSA tailgas which is burned for heat in the reformer).

Service Interval – Operating time between planned service.

MTTR – Mean time to repair or service.

Availability – The percentage of time the PSA is ready and available for normal operation and capable of making hydrogen at the required purity specification.

Operating Hours – Total cumulative hours that the PSA produced purified hydrogen.

Annual Maintenance Cost – Total maintenance and service costs over the period of study divided by the number of years in service.

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