

# Frequently Asked Questions - FAQs



## Xebec Fast Cycle PSA

We have compiled a list of questions with answers that are commonly asked by our customers. If you have a question that is not addressed below, please contact Xebec.

### How does a PSA work?

A PSA or Pressure Swing Adsorption System works on the principle of preferential “adsorption” or adhesion of certain gas molecules onto a solid adsorbent material under pressure, and the reversible nature of the process to release the adsorbed molecules at low pressure.

Pressurized feed gas is introduced to a vessel filled with adsorbent and the gas stream is purified as certain molecules are adsorbed onto the material inside the vessel. The “purified” product gas flows from the top of the vessel at pressure. Once the vessel has reached its adsorbent capacity, the gas flow is “switched” to a fresh column and the pressure is reduced in the loaded vessel to release the adsorbed molecules at low pressure as “exhaust” gas, thereby regenerating the adsorbent for another cycle. This process is fully reversible and repeats itself to provide a continuous flow of purified gas. Multiple beds are used to allow for near continuous process flows.

### How is the PSA controlled?

The operation of the PSA is controlled by pressure and cycle speed to achieve the desired flow and purity. Gas flows in a Xebec PSA are controlled by a set of rotary valves rather than the on-off switching valves found on a conventional PSA system. The rotational speed of the rotary valves is controlled by an analog signal from a PLC (Programmable Logic Controller) to the variable speed drive motor which turns the rotary valves. Operation, turndown, and product gas purity control are achieved by adjusting only the rotary valve rotational speed.

### How do the rotary valves work?

The PSA has one rotary valve (feed valve) connected to the bottom of each bed and one rotary valve (product valve) connected to the top of each bed. Feed gas is allowed to flow through a passage in the feed valve to at least one bed while, at the same time, purified product gas is allowed to flow from the bed through the product valve passage to the product line. Other flows are similarly connected through the rotary valve for exhaust, purge, equalizations, etc.

As the two valves rotate together, gas flows are gradually switched from one bed to the next to produce the efficient Xebec PSA cycle. Although this cycle is much faster than conventional PSAs (with the inherent advantages), this is still a very slow rotational speed of 1.0 to 0.3 RPM (Rotations Per Minute)

### What is the maximum turndown?

The maximum turndown is typically 40%. However, in some installations, Xebec has provided capacity turndowns to below 25% of maximum design capacity.

### How is purity measured and controlled?

The PSA operator normally provides the gas analysis equipment needed to measure and monitor PSA product purity going to their customer depending on their specific needs (i.e. accuracy, frequency, and what components to analyze). The PSA is commissioned to operate at the unit's design purity at the time of its performance test, including any turndown operation points. If conditions during ongoing operation change more than the 2.5% specified, adjustment of the PSA cycle speed may be required. In certain situations an online gas analyzer with a proportional output signal can be used as a control loop input signal to automatically adjust the PSA cycle speed depending on measured purity. This is best deployed when the feed conditions are expected to change frequently and the measuring instrument is well within its detection and drift limits.

### What kind of adsorbents do you use?

Xebec uses many different types of commercially available adsorbents such as activated alumina, silica gel, zeolites and carbon materials. The type and amount of each adsorbent is selected for your specific application and conditions as determined by our process engineers using advanced process models for Xebec's specific Fast Cycle PSAs.



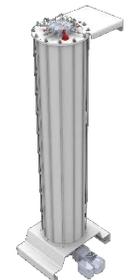
G0 Rotary Valve



G3/4 Rotary Valve



G2 Rotary Valve



G1 Rotary Valve

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### What is the life expectancy of the adsorbents / what can damage the adsorbents?

PSA adsorbents have been in operation without degradation in many cases for the life of the plant. Adsorbents can be damaged through mis-operation such as excess gas flows which "lift" the material causing attrition and breakdown of the beads. Also, liquids of any kind can strongly adhere to the adsorbent and reduce its working capacity.

### What levels of contamination can the PSA tolerate (H<sub>2</sub>O, VOCs, H<sub>2</sub>S, etc)?

The level of contaminants the PSA can tolerate depends on the components in question and the specific application. Please provide a list of contaminants, with the typical concentrations of each, to a Xebec Specialist to review. Examples of gas components that can lead to contamination include high levels of H<sub>2</sub>S, strong acids, high molecular weight hydrocarbons, etc. The PSA is designed to operate with gas streams saturated in water but liquid water should be removed prior to the PSA.

### What safety or protective systems do you supply with the PSA?

Xebec uses a HAZOP (Hazard and Operability) study method to identify and address risks associated with our systems. A gradual feed pressurization control prevents the adsorbent from being lifted during re-starts; a feed coalescing filter protects the rotary valves and the adsorbent from liquids and particulates and safety relief devices on each bed protects the plant for a fire case safety relief.

### What is the system reliability?

Xebec's PSAs have accumulated over 15,000,000 commercial operating hours (over 30,000,000 valve hours), with more than 200 plants in continuous duty.

The rotary valves are highly reliable, with recommended service intervals of 5 years, and an inspection at 2.5 years. Xebec's PSA installations have proven availabilities beyond 99.9%.

### How long does commissioning take?

Commissioning of a Xebec PSA typically takes between 3 and 5 days for small systems and 1 to 2 weeks for larger installations.

### What are the operating costs?

The operating costs vary depending on the PSA platform and the options selected. Operating costs for the PSA include power to the motor, which is typically under <0.5kW for small PSA3200 systems, up to 5kW for larger PSA3100 installations. Less than 0.5 NCMH of instrument air is required for automated isolation and control valves

### What about spare parts and other consumables?

Other operating consumables include feed filter elements and gear motor oil changes once every 2-3 years. Rotary valve seals typically will be replaced every 5 years.

### How can I tell if there is a problem with the rotary valves?

Xebec's rotary valves have been proven to be very robust and have been rigorously tested for quality prior to leaving Xebec's facilities. In the highly unlikely event where the rotary valves stop turning, an alarm is triggered. This could be caused by a power outage, drive or motor fault, or high torque at the rotary valves. Of the few faults of this kind, the power supply or drive has been corrected and normal operation resumed without a requirement for Xebec field service.

If rotary valve leakage should occur, the PSA would experience a lower than expected product gas recovery. However, product gas purity would be maintained so plant operation is not interrupted. Monitoring will provide operating staff with the ability to trend performance and schedule Xebec inspection/service at a convenient time.

### Can the product gas become contaminated?

Xebec's rotary valves are designed so that rotary valve leakage cannot contaminate the product gas. Also, in the event that the PSA is shut down suddenly, there is no rotary valve position that would allow product gas contamination. If the PSA is purged with an inert gas for maintenance or extended shutdown, Xebec's standard start-up procedures prevent contamination of the inert gas into the product gas.

### Can particulates be present in the product gas?

As with most gas processing equipment, small particles may be present in the product line during initial start-up, but they are not generated during normal operation of the PSA.

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### How can I tell if the PSA adsorbents are degraded?

Typically, PSA adsorbents will last the life of the plant. If the PSA is operated under conditions where flows or contaminants substantially exceed the unit's design conditions, the adsorbents can become deactivated and a loss of product gas recovery and/or capacity would be observed.

### Are there any hazardous materials in the PSA?

No hazardous materials are present in most PSA systems. A MSDS (Material Safety Data Sheet) is provided with the IOM (Installation, Operation and Maintenance) manual with every Xebec PSA.

### What electrical power requirements are necessary?

The PSA can be configured to handle a number of power sources. Our typical electrical power requirements are 120 VAC/1 ph/60 Hz, 230/400 VAC/3 ph/4 wire/50 Hz, or 200 VAC/3 ph/3 wire/50 Hz for the PSA motor. For instruments we typically require 120 VAC/60 Hz 1 ph, 220 VAC/ 50 Hz /1 ph, or 110 VAC/50 Hz/1 ph with some instruments requiring low voltage DC power, typically from a PLC/DCS source.

### What if gas conditions change or I want to operate at different product purity levels?

Once the PSA cycle is tuned at the time of commissioning, the cycle speed can be re-programmed or adjusted to the desired level of product purity, even with a different feed gas composition. If operating conditions change drastically (i.e. feed pressure changes), the PSA may require re-tuning by Xebec for the new conditions.

### What signals do I need to send to the PSA?

The signals required to operate Xebec's PSA include a 4 to 20 mA signal to the variable speed drive for the rotary valve motor, and signals to the instruments included on the PSA. Typical Xebec PSA installations require no more than 10 I/O signals.

### What is the PSA's start-up time?

The typical start-up time for pressurizing a Xebec PSA is 15 minutes. Under normal start-up conditions product purity is achieved once pressurization is complete. Re-starts can be considerably shorter.

### What happens after an emergency stop of the PSA?

After an emergency stop, the motor to the PSA stops and the feed and product isolation valves close. The PSA remains under pressure and the adsorber beds are stopped within their bed cycles. After the resolution of the emergency stop, the PSA is re-started and the unit resumes normal operation at the point where it stopped. If the E-stop lasts for more than an hour or two, the system should be de-pressurized per Xebec shutdown procedure to remove residual contaminants.

### Can the PSA operate outdoors?

The PSA is designed for outdoor operation with a protection rating of IP 53 or better. The design operating ambient temperature is from 4 to 48°C (40 to 118°F). For more extreme environments, a cold weather option (heat tracing with insulation) can be included to allow operation at ambient temperatures as low as -40°C

### What feed and exhaust pressure should be used for best performance?

This will depend on specific conditions but, generally, lower exhaust and higher feed pressure will improve performance and reduce PSA size. Typical conditions for feed pressure range from 4 barg to 27 barg with as low an exhaust pressure as possible.

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### About Xebec Adsorption Inc.

Xebec specializes in clean air and gas. With over 50 years of experience in adsorption technology, Xebec has supplied more than 9000 adsorption systems to more than 1500 customers worldwide.

This solid foundation of expertise and experience has led Xebec's evolution into renewable energy — developing products, systems and technology solutions for environmentally-responsible purification, generation, dehydration, separation and filtration equipment.

Today, Xebec designs, engineers and manufactures innovative products that transform raw gases into marketable sources of clean energy for the natural gas, field gas, biogas, helium, hydrogen and compressed air markets.