HATCO
Compression & Separation

Hydrogen Purification Package


PSA Technology



Energy Efficiet
H_2 Purifier Package

Features:

- Compressed gas
- Extremely flammable
- Odorless, colorless and non-toxic
- Can form explosive mixture with air, react violently with oxidants too

Specification:

- Hydrogen > 99.999%
- Oxygen < 5 vpm
- Moisture < 8 vpm
- Total Carbons < 10 vpm
- Nitrogen < 100 vpm

Hydrogen Purifier Unit Benefits

Hydrogen Gas sees price hikes at higher purity levels. A dedicated Purification plant can be an excellent way to get more out of what you can purchase from your current supplier, or increase capacity of what you can sell at a higher purity for that higher premium.

Applications:

We supply hydrogen for these processes to a wide range of industries including:

Petrochemical	The most important hydrogen-nitrogen compound is ammonia (NH_3. (Almost 90 % of ammonia goes into fertilizer production.
Pharmaceutical	To produce pharmaceutical intermediates.
Energy	To enhance heat transfer for cooling high speed turbine power generators and nuclear reactors and as a fuel for the growing fuel cell energy generation market.
Iron and Steel	Non-ferrous metals – for quenching and as a protective atmosphere for heat treatment at very high temperature such as in stainless steel manufacturing, also to support plasma welding and cutting.
Oil and Gas	To remove organic sulphur from crude oil, fuel oil and gasoline to enhance its performance.

The Right Solution for the Wide Range of Applications

Recovering and purifying hydrogen with PSA

For the purification of the hydrogen in a hydrogen generator the process of Pressure-Swing-Adsorption (PSA) is applied. The hydrogen recovery in a 4-bed PSA unit is approx. 80 % of most projects.

The HATCO hydrogen PSA units

Pressure Swing Adsorption (PSA) from HATCO is used to recover and purify hydrogen from a variety of hydrogen-rich streams. The technology relies on differences in the adsorption properties of gases to separate them under pressure, and is an effective way of producing very pure hydrogen.

The feed gas for PSA can be raw hydrogen from a wide variety of sources, including steam methane reforming, partial oxidation, cryogenic purification, methanol plant purge gases, ethylene off gas, styrene off gas, gasification and ammonia plants.

Plant data:

- Feedstock: hydrogen rich gas, synthesis gas
- Hydrogen capacity: up to 60.000 Nm^3/h
- Feed pressure: 6 – 40 bar
- Hydrogen purity: up to 99,999 vol. %

Plant features:

- Design for long lifetime
- High operational reliability
- High quality and high safety standard
- First class sub-suppliers for equipment and components
- Fully automatic operation and remote control
- Prefabrication in skids/modules
- Easy maintenance and accessibility

Additional/Optional features:

HATCO designs tailor-made and standard plants.
Depending on customers' focus and demands the hydrogen PSA systems are designed with either 4, 5 or 6 adsorber vessels and different modes of operation. Purities of up to 99,9999 vol.-% hydrogen product quality can be achieved at optimum recovery rates.

Individual plant concepts with respect to capacity control, adaption of operation mode for varying operation conditions and online purity monitoring etc. can be offered.

HATCO's hydrogen gas adsorption purifiers are available in explosion proof environments.
For hazardous locations, PLCs can be integrated to the unit directly, or routed through junction enclosures for remote control.

We are able to provide our plants with all necessary certificates and declarations.
Certificate for the entire equipment placed inside areas with potentially explosive atmospheres are also part of our scope of supply.

Separation by Pressure Swing Adsorption (PSA)

The Process:

The Pressure Swing Adsorption (PSA) technology is based on a physical binding of gas molecules to adsorbent material. The respective force acting between the gas molecules and the adsorbent material depends on the gas component, type of adsorbent material, partial pressure of the gas component and operating temperature. A qualitative ranking of the adsorption forces is shown in the figure 1.
The separation effect is based on differences in binding forces to the adsorbent material. Highly volatile components with low polarity, such as hydrogen, are practically non-absorbable as opposed to molecules as N2, CO, CO2, hydrocarbons and water vapor. Consequently, these impurities can be adsorbed from a hydrogen-containing stream and high purity hydrogen is recovered.

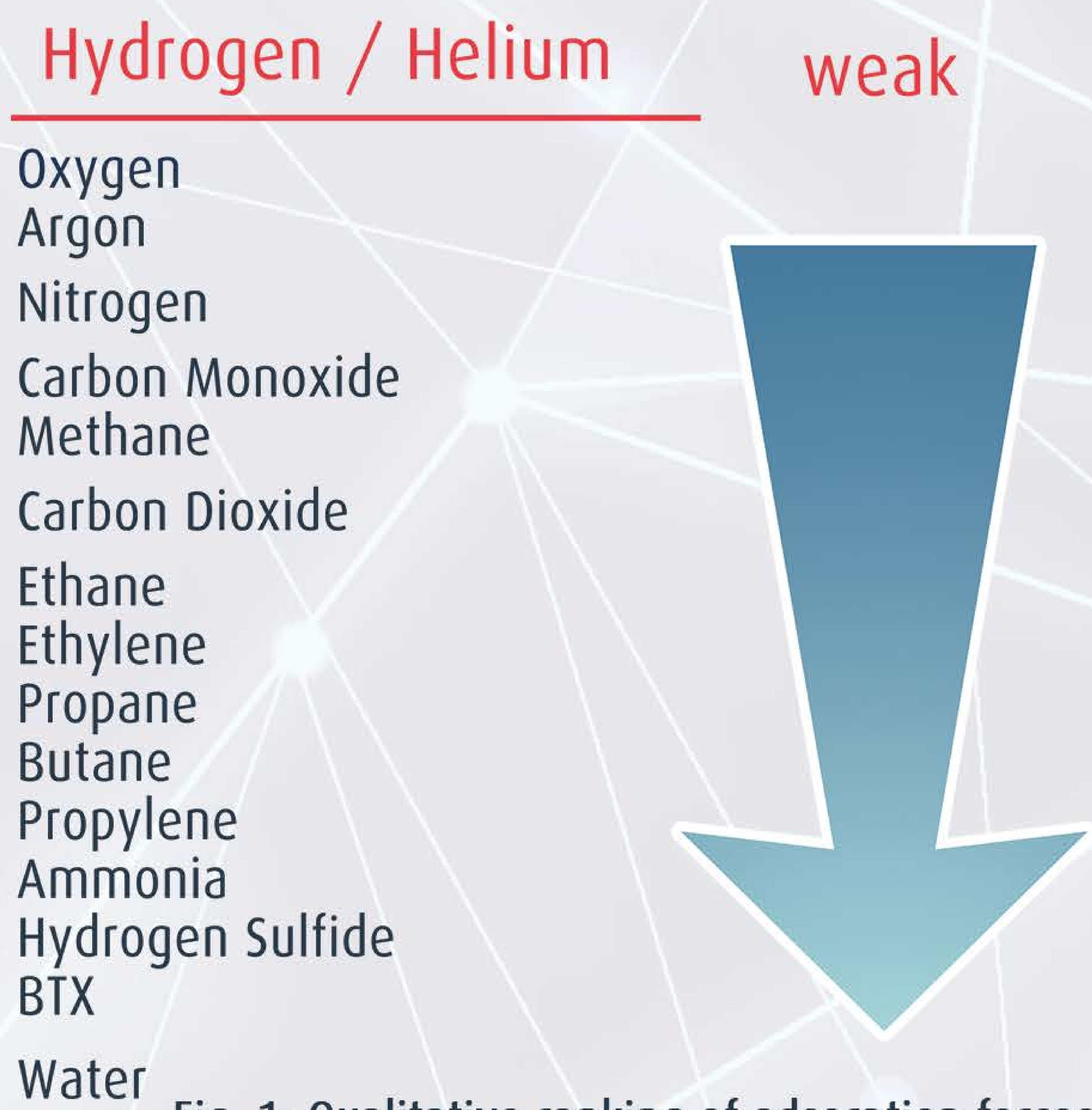


Fig. 1: Qualitative ranking of adsorption forces

Adsorption and regeneration

The PSA process works at basically constant temperature and uses the effect of alternating pressure and partial pressure to perform adsorption and desorption. Since heating or cooling is not required, short cycles within the range of minutes are achieved. The PSA process consequently allows the economical removal of large amounts of impurities.
The figure 2 illustrates the pressure swing adsorption process. It shows the adsorption isotherms describing the relation between partial pressure of a component and its equilibrium loading on the adsorbent material for a given temperature.
Adsorption is carried out at high pressure (and hence high respective partial pressure) typically in the range of 10 to 40 bar until the equilibrium loading is reached. At this point in time, no further adsorption capacity is available and the adsorbent material must be regenerated. This regeneration is done by lowering the pressure to slightly above atmospheric pressure resulting in a respective decrease in equilibrium loading. As a result, the impurities on the adsorbent material are desorbed and the adsorbent material is regenerated. The amount of impurities re-moved from a gas stream within one cycle corresponds to the difference of adsorption to desorption loading.
After termination of regeneration, pressure is increased back to adsorption pressure level and the process starts again from the beginning.

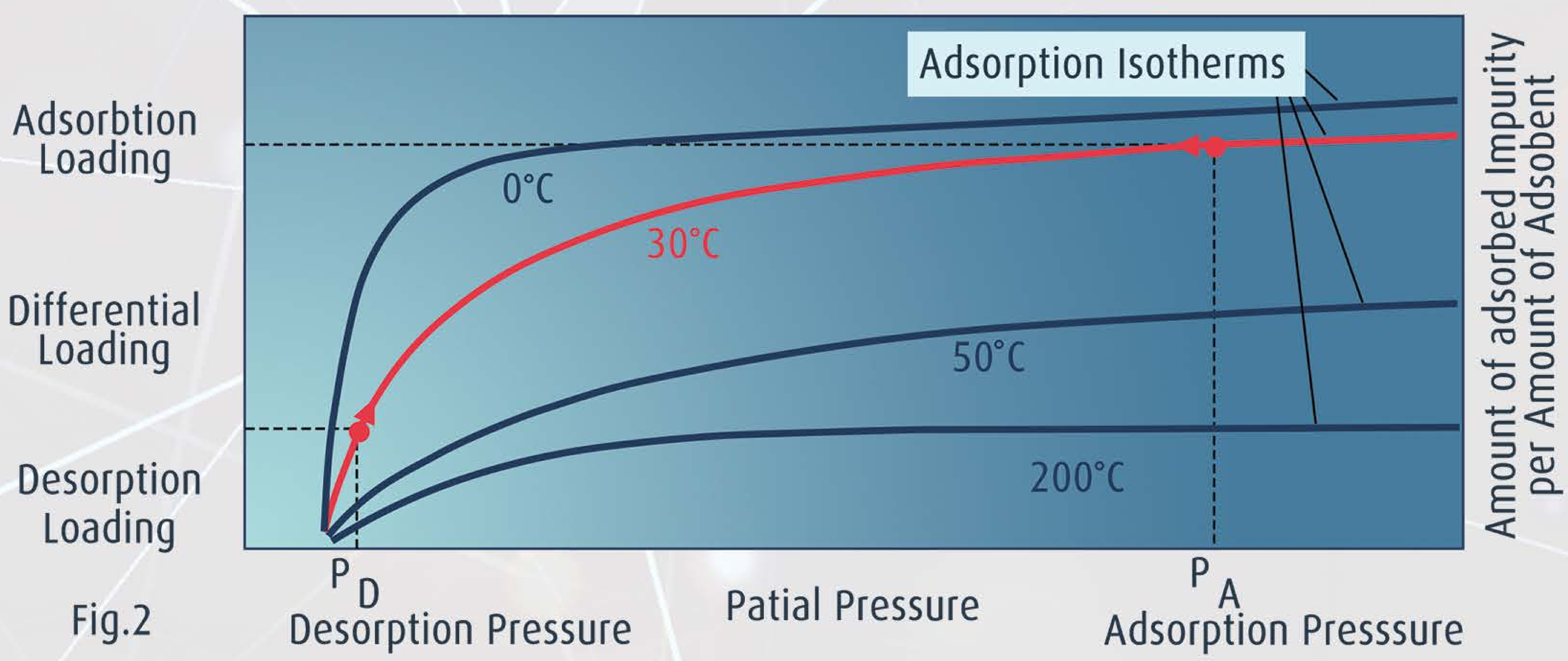


Fig.2

The PSA sequence:

A PSA plant consists basically of the adsorber vessels containing the adsorbent material, tail gas drum(s), valve skid(s) with interconnecting piping, control valves and instrumentation and a control system for control of the unit.
A look at Figure 3 shows that to provide continuous hydrogen supply, minimum 4 adsorber vessels are required.

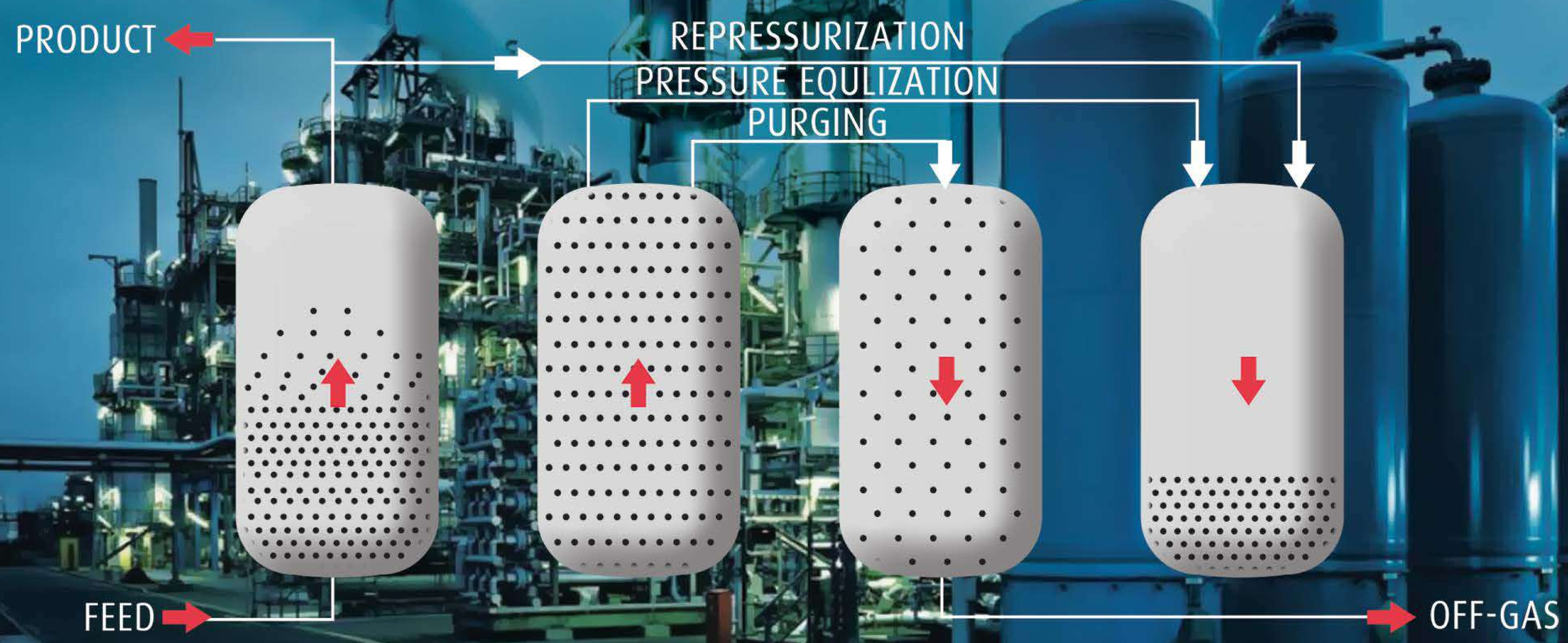
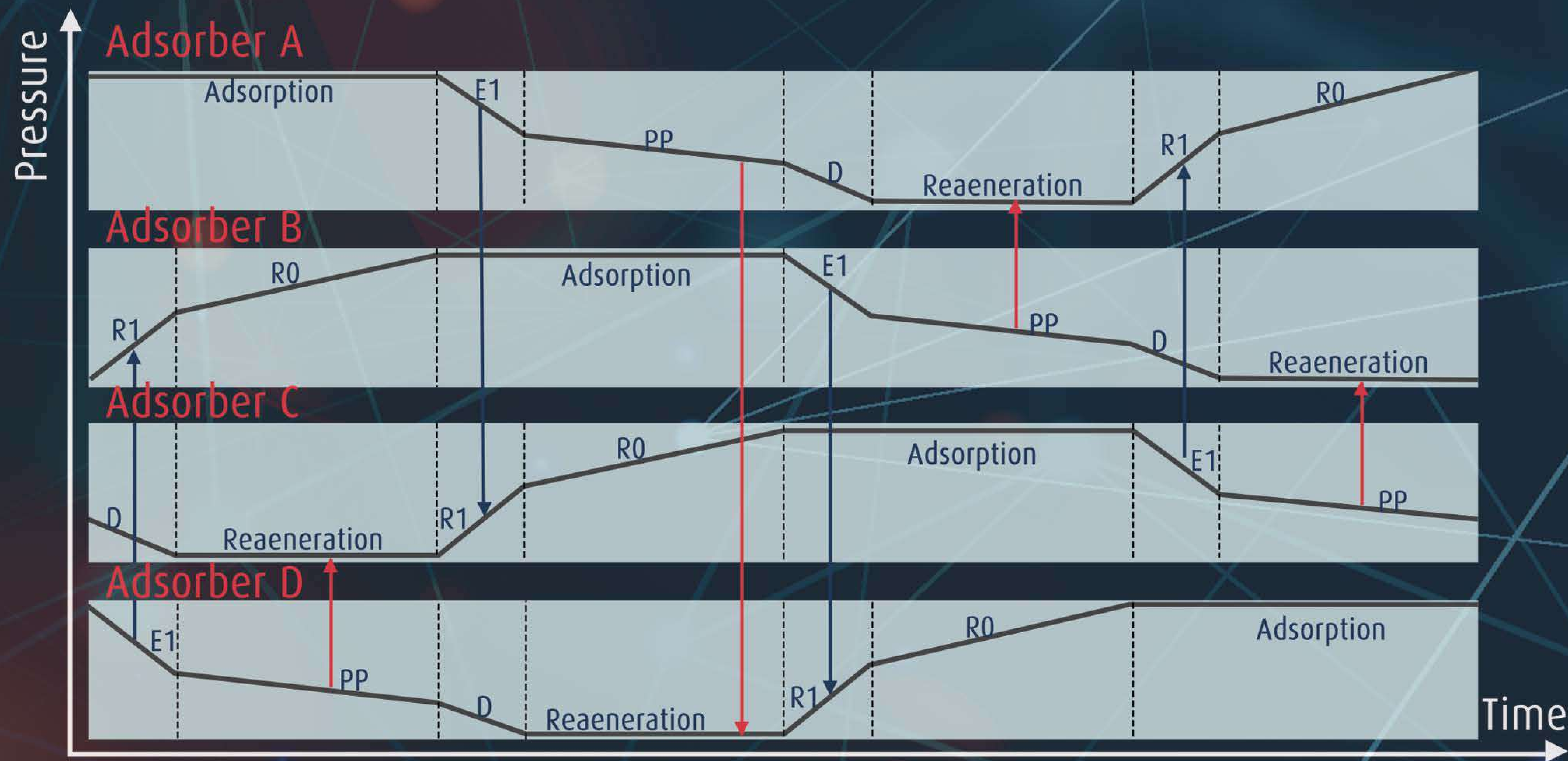


Fig. 3: Min. H2 PSA Adsorbers Configuration

The pressure swing adsorption process has four basic process steps:

- Adsorption
- Depressurization
- Regeneration
- Re pressurization



The figure 4 shows the combination of the sequences of four adsorber vessels as a pressure time

Adsorption;

Adsorption of impurities is carried out at high pressure being determined by the pressure of the feed gas. The feed gas flows through the adsorber vessels in an upward direction. Impurities such as water, heavy hydrocarbons, light hydrocarbons, CO_2, CO and nitrogen are selectively adsorbed on the surface of the adsorbent material. Highly pure hydrogen exits the adsorber vessel at top. After a defined time, the adsorption phase of this vessel stops and regeneration starts. Another adsorber takes over the task of adsorption to ensure continuous hydrogen supply.

Regeneration;

The regeneration phase consists of basically five consecutive steps:

- Pressure equalization
- Provide purge
- Dump
- Purging
- Repressurization

The steps are combined so as to minimize hydrogen losses and consequently to maximize the hydrogen recovery rate of the PSA system.

Pressure equalization (step E1) Depressurization starts in the co-current direction from bottom to top. The hydrogen still stored in the void space of the adsorbent material is used to pressurize another adsorber having just terminated its regeneration. Depending on the total number of adsorbers and the process conditions, one to four of these so-called pressure equalization steps are performed. Each additional pressure equalization step minimizes hydrogen losses and increases the hydrogen recovery rate.

Provide purge (step PP)

This is the final depressurization step in co- current direction providing pure hydrogen to purge or regenerate another adsorber.

Dump (step D)

At a certain point of time, the remaining pressure must be released in counter-current direction to prevent break-through of impurities at the top of the adsorber. This is the first step of the regeneration phase when desorbed impurities leave the adsorber at the bottom and flow to the tail gas system of the PSA plant.

Purging (regeneration)

Final desorption and regeneration is performed at the lowest pressure of the PSA sequence. Highly pure hydrogen obtained from an adsorber in the provide purge step, is used to purge the desorbed impurities into the tail gas system. The residual loading on the adsorbent material is reduced to a minimum to achieve high efficiency of the PSA cycle.

Repressurization (steps R1/R0)

Before restarting adsorption, the regenerated adsorber must be pressurized again. This is accomplished in the pressure equalization step by using pure hydrogen from adsorbers presently under depressurization. Since final adsorption pressure cannot be reached with pressure equalization steps, repressurization to adsorption pressure is carried out with a split stream from the hydrogen product line.
Having reached the required pressure level again, this regenerated adsorber takes over the task of adsorption from another vessel having just terminated its adsorption phase.

HATCO
Compression & Separation
Building 114, Kajabadi St,
Africa Ave, Tehran, Iran
Postal Code:19669913175
Tel: +98 21 28 11 10 19
Fax:+98 21 22 66 41 16
info@hatco.ir
www.hatco.ir

TÜV AUSTRIA CERTIFIED EN ISO 9001 Certificate No. 20100203007466 TÜV AUSTRIA CERT GMBH

TÜV AUSTRIA CERTIFIED ISO 45001 Certificate No. 20116213010456 TÜV AUSTRIA CERT GMBH

TÜV AUSTRIA CERTIFIED EN ISO 14001 Certificate No. 20104203007468 TÜV AUSTRIA CERT GMBH

TÜV AUSTRIA CERTIFIED HSE Certificate No. TA130203007581 TÜV AUSTRIA CERT GMBH