
**Safety of pressure swing adsorption
systems for hydrogen separation and
purification**

*Système d'adsorption modulée en pression pour la séparation et la
purification de l'hydrogène*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Safety of pressure swing adsorption systems for hydrogen separation and purification

1 Scope

This document identifies safety measures and applicable design features that are used in the design, commissioning, and operation of pressure swing adsorption systems for hydrogen separation and purification. It applies to hydrogen pressure swing adsorption systems that process all kinds of impure hydrogen streams as feed, including both stationary and skid-mounted pressure swing adsorption systems for hydrogen separation and purification in commercial or industrial use. This document also applies to small-scale PSA hydrogen system installed within containers, where allowed by local regulations.

The scope of this document includes the equipment depicted within the dashed lines in [Figure 1](#).

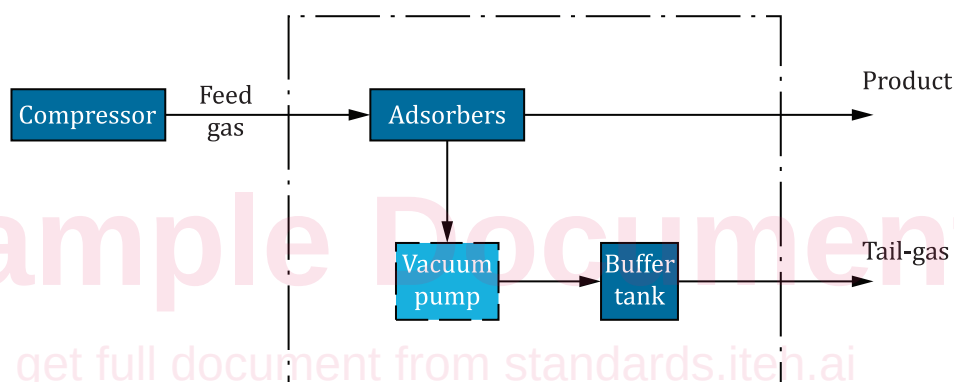


Figure 1 — Example of typical equipment in PSA system for hydrogen separation and purification

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 11114-1, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials*

ISO 11114-2, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials*

ISO 11114-4, *Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement*

IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60364-4, *Low-voltage electrical installations — Part 4: Protection for safety*

NFPA 56, *Standard for Fire and Explosion Prevention during Cleaning and Purging of Flammable Gas Piping Systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 pressure swing adsorption method PSA method

gas separation method that takes advantage of the selective adsorption of a solid *adsorbent* (3.5) for different gases and the ability of solid adsorbents to adsorb more impurities at high pressure and to reject impurities at low pressure

Note 1 to entry: PSA, as practiced commercially, is a batch process utilizing multiple adsorbent-loaded vessels for the continuous purification of a gas stream.

3.2 vacuum pressure swing adsorption

system for hydrogen separation and purification that relies on desorption at sub-atmospheric pressure (achieved with vacuum pumps) to improve the performance of the system

3.3 pressure swing adsorption system for hydrogen separation and purification

hydrogen generation system that separates and purifies hydrogen from an impure hydrogen stream through the pressure swing adsorption process

3.4 adsorber

vessel in which the *adsorbent* (3.5) used for hydrogen separation and purification is contained, which can be vertical vessels

3.5 adsorbent

solid materials used to adsorb gas impurities from the impure hydrogen streams, thereby realizing the separation of the hydrogen from the other gases

3.6 process control valves

operational devices that can open or close to regulate flow in response to a signal from the *control system* (3.7)

3.7 control system

system that performs operations such as opening and closing *process control valves* (3.6), system troubleshooting, product quality control, or optimization of process parameters

3.8**tail gas**

gas remaining after the impure hydrogen mixture is purified through the PSA system

Note 1 to entry: Other names for tail gas are desorbed gas, purge gas, or off gas.

3.9**stationary PSA system for hydrogen separation and purification**

PSA system in which all equipment and piping are permanently mounted to the equipment foundation(s) and piping support structure

3.10**skid-mounted PSA system for hydrogen separation and purification**

PSA system in which some or all of the equipment and piping are affixed to one or more skids, or moveable bases

3.11**fire separation distance**

distance between the PSA system and nearby *buildings* (3.15) that is required in order to prevent fire from spreading from a PSA system to nearby buildings

3.12**buffer tank**

vessel that receives the desorbed gas from the *adsorbers* (3.4) (PSA system) or from the *vacuum pumps* (3.13) (VSA system) and minimizes the composition and pressure variation of the desorbed gas

Note 1 to entry: A buffer tank may also be referred to as a surge drum.

3.13**vacuum pump**

device used for evacuating the *adsorbers* (3.4) during the desorption stage, allowing the *adsorbents* (3.5) to be desorbed and regenerated at sub-atmospheric pressure to improve performance of a PSA system

3.14**container**

enclosed construction or bracing structure fabricated to avoid the effects of specific environmental and climatic conditions, or protect personnel and livestock from accidental contact with the dangerous components of a small hydrogen PSA system

3.15**building**

structure that has a roof and walls, with the similar function as a *container* (3.14) for a hydrogen PSA system or the components of a hydrogen PSA system

3.16**hydrogen embrittlement**

degradation of metal material properties due to the presence of a hydrogen environment

4 Basic specification**4.1 Feed stream pressure**

PSA systems for hydrogen generation and purification typically have feed gas pressures ranging from 0,3 MPa to 6,0 MPa. The operating pressure cycles from full feed gas pressure during adsorption to near atmospheric pressure (0,03 MPa) or vacuum (−0,09 MPa) during desorption.