Molecular Sieve Adsorbents

BASF
We create chemistry

Trust BASF Adsorbents

BASF has been a leading supplier of adsorbents to a wide range of industries for over 50 years. By thinking differently, we help companies meet and exceed demanding quality, environmental and government standards. All aspects of product development, from design to packaging and quality control, are closely monitored and maintained. We provide customized solutions to companies' specific production requirements. Customers rely on our dependable technical services that incorporate the knowledge and skills found throughout BASF.

The BASF Difference

The BASF difference comes from thinking differently in order to make our adsorbents differently. BASF is the leader in providing a variety of superior and unique alumina, desiccant, molecular sieve and adsorbent technologies that allow companies and organizations to meet and exceed stringent product quality standards. What sets us apart is BASF's well-earned reputation for delivering ingenious answers to complicated challenges. Customers trust us to provide solutions for their adsorption needs.

BASF Molecular Sieve Adsorbents

The strength of BASF - The Chemical Company is combined with the experience and expertise of our chemists and engineers to produce BASF Molecular Sieve Adsorbents. Our products and services meet and exceed our customers' expectations and requirements due to our complete commitment to quality. Trust BASF Molecular Sieve Adsorbents to make a difference because we make adsorbents differently.

BASF's Broad Zeolite Molecular Sieves Product Range Offers

- High adsorption of water at low partial pressures
- Separation of compounds with similar polarity
- Selective adsorption or separation based on molecular size
- Polar compound drying
- Uniform ball size for consistent pressure drop

The Adsorbents with a Special Crystalline Structure

BASF Molecular Sieve Adsorbents are crystalline aluminosilicates with frameworks that contain monovalent or multivalent cations from the alkali or alkaline earth group, as well as water in its as-synthesized form. This crystal water can be removed by thermal treatment without damaging the crystalline structure to create the conditions for a reversible process such as water adsorption/desorption.

BASF offers two crystalline structures, zeolite A and zeolite X. The as-synthesized zeolite A exhibits the following unit cell composition:

$$Na_{12}[(AlO_2)_{12}(SiO_2)_{12}] \cdot 27\ H_2O$$

Zeolite X is typically synthesized as a sodium containing product:

$$Na_{86}[(AlO_2)_{86}(SiO_2)_{106}] \cdot 276\ H_2O$$

The crystalline structure of the characteristic units is shown in the drawings of Figure 1. Zeolite A has a relatively simple cube-like structure composed of four truncated octahedrons. In zeolite X, the truncated octahedrons are interconnected in a way which results in a different spatial structure.

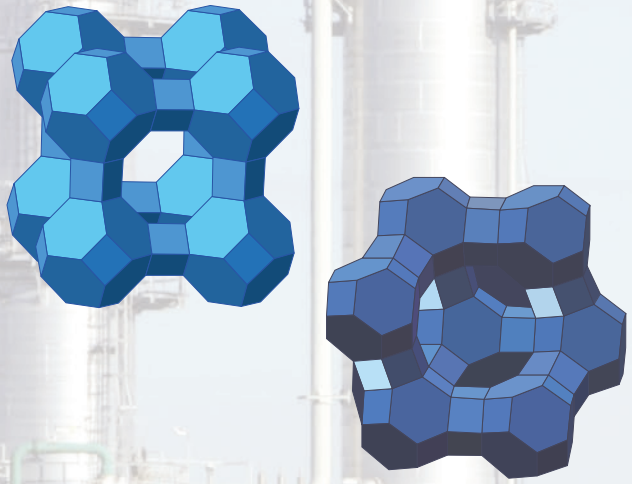


Figure 1: Characteristic cavity structure of zeolite A (left) and zeolite X (right)

Figure 1 shows the characteristic pore structure of these two zeolite types. The pores lead to a cavity with an adsorption surface. The pore diameter is defined precisely by the synthesis of the zeolite. A change of the pore opening diameter is achieved by replacing some of the sodium ions of the zeolite A by other monovalent and multivalent alkali or alkaline earth ions.

Molecular Sieve Adsorbents are Available in the Following Forms

3A K-Na zeolite A with a nominal pore opening of 3 Å (0.3 nm)

4A (as-synthesized) Na zeolite A with a nominal pore opening of 4 Å (0.4 nm)

5A Ca-Na zeolite A with a nominal pore opening of 5 Å (0.5 nm)

13X Na zeolite X with a nominal pore opening of 10 Å (1.0 nm)

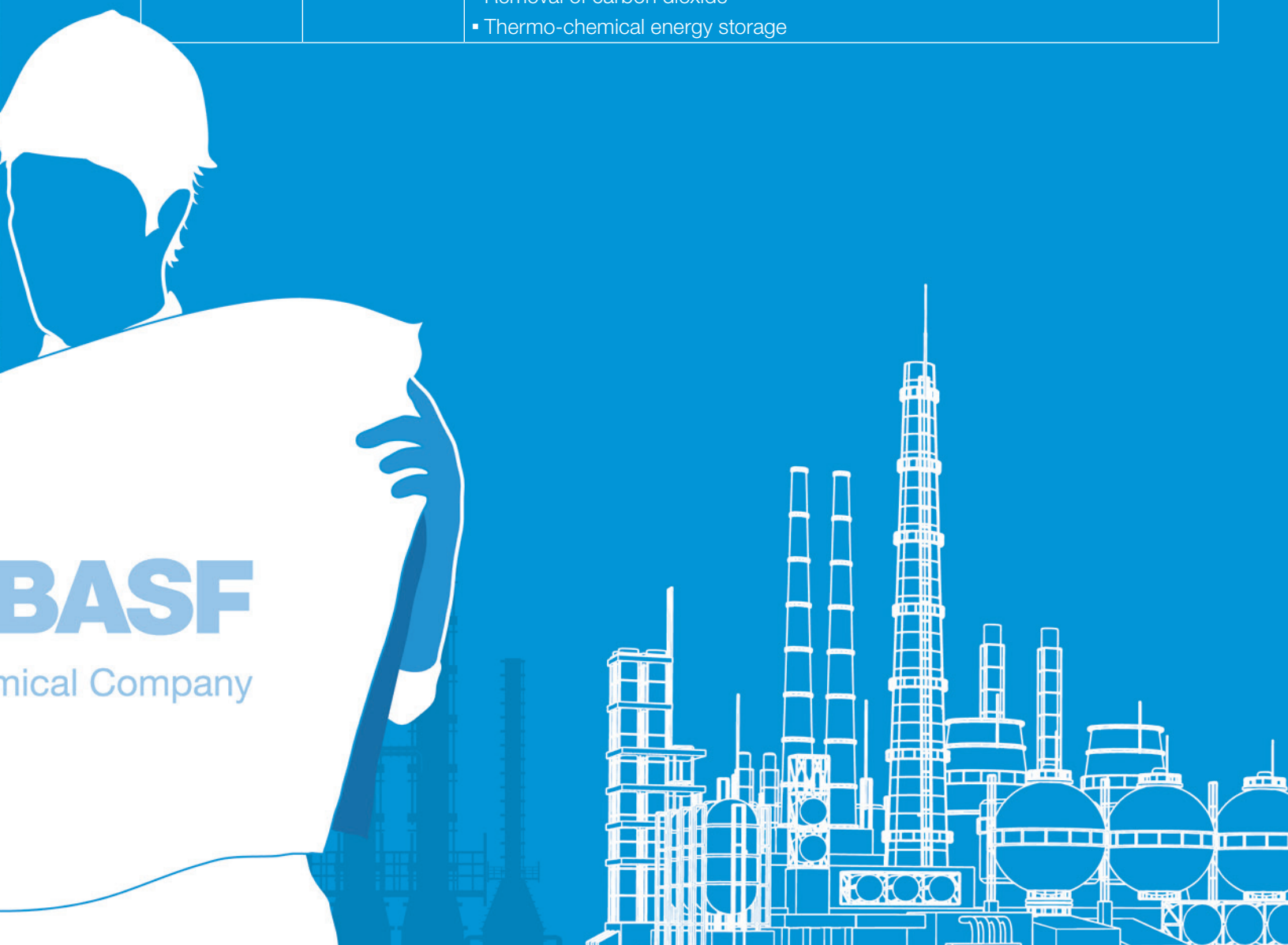
Properties of BASF Molecular Sieve Adsorbents

- The adsorption surface area of a zeolite is around 800–900 m^2/g.
- The specific (cavity) volume is approximately 0.3 cm^3/g for zeolite A and 0.35 cm^3/g for zeolite X. This provides sufficient space for holding a wide range of atoms or molecules with a high capacity.
- Polar and polarizable molecules and non-saturated hydrocarbons are preferably adsorbed as a result of the existence and accessibility of freely moving cations that act as adsorption sites within the zeolite framework.
- The precisely defined pore openings of 3 Å, 4 Å, 5 Å, or 10 Å make it possible to separate substances with different molecular diameters.

For more information on BASF Molecular Sieve Adsorbents, please see Table 1.

Table 1: BASF Molecular Sieve Adsorbents Overview

Product	Bead Size	Main Application Areas
3A	1.6–2.5 mm 2.5–5.0 mm	▪ Drying of gases and polar liquids (methanol, ethanol) and easily polymerizing substances, such as unsaturated hydrocarbons (ethylene, propylene, acetylene and butadiene)
4A	1.2–2.0 mm 1.6–2.5 mm 2.5–5.0 mm	▪ Drying of organic liquids (solvents, oils, gasoline and other saturated hydrocarbons), air, liquid gases (propane, butane), as well as technical and noble gases (H_2, N_2, He, Ar, etc.) ▪ Thermo-chemical energy storage
5A	1.6–2.5 mm 2.5–3.5 mm 2.5–5.0 mm	▪ Drying and desulfurization (removal of H_2S) of natural gas ▪ Purification of technical hydrogen ▪ Separation of n-paraffins from branched and cyclic hydrocarbons ▪ Removal of carbon dioxide ▪ Non-cryogenic oxygen enrichment
13X	1.2–2.0 mm 1.6–2.5 mm 2.5–3.5 mm 2.5–5.0 mm	▪ High performance purification of air and other gases (removal of trace contaminants) ▪ Desulfurization (sweetening) of natural gas and other fluids ▪ Non-cryogenic oxygen enrichment ▪ Removal of carbon dioxide ▪ Thermo-chemical energy storage



BASF Molecular Sieve Adsorbents Cover a Wide Range of Applications

BASF Molecular Sieve Adsorbents are successfully utilized in gas and fluid purification, separation and drying processes by

- Drying gases and fluids to water levels significantly below 1 ppm
- Removing
  - CO_2
  - NH_3
  - Alcohols
  - H_2S and other polar sulfur compounds
  - Nitrogen

Application examples include:

- The treatment of feed air to cryogenic air separation systems
- The treatment of mineral oil components before their catalytic conversion
- Separation of *n*- and *iso*- paraffins or aromatic substances
- Removal of CO and N_2 from hydrogen reformer gas
- Direct extraction of oxygen from air

Additional application examples can be found in Table 2.

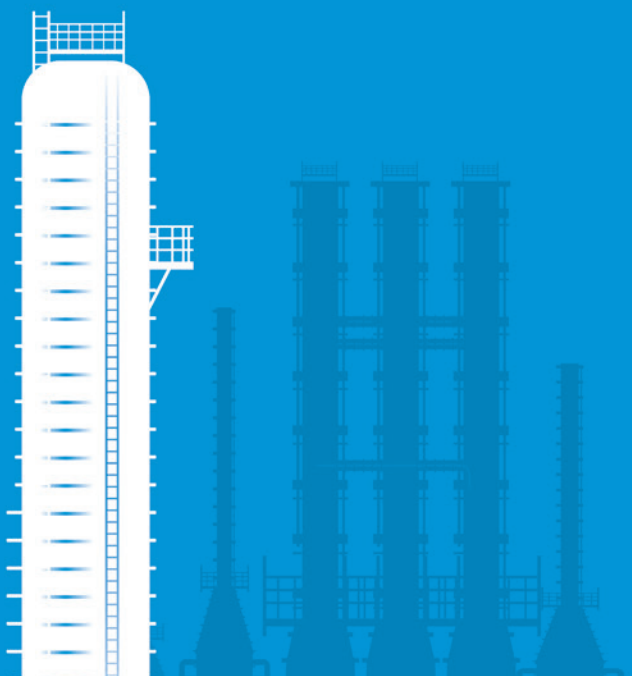


Table 2: BASF Molecular Sieve Adsorbent Applications

Industry	Application	Process Step	Adsorption Process	BASF Molecular Sieve Adsorbent
Petrochemical and Chemical Refining	Ethylene production drying	Cracked gas	TSA	3A
		Acetylene		
		Liquid propylene		
		Hydrogen		
	Treating other products in refineries	Drying and sweetening LPG	TSA	4A, 5A, 13X
		Removal of CO_2 from ethylene	TSA	4A, 13X
	Treating synthesis gases	Removal of CH_3OH after methanol washing	TSA	4A, 5A, 13X
		Extraction of high purity hydrogen from reformer gases and residual gases with a high hydrogen content	PSA	5A, 13X
	Production of paraffins and aromatic substances	Separation of n-/iso- paraffins	DDA/PSA	5A
		Separation of aromatic substances	DDA	13X
		Separation of olefins and paraffins	DDA	5A, 13X
	Olefins Treating		TSA	5A, 13X
Natural Gas Treatment	Drying and purifying natural gas before liquefaction		TSA	4A, 5A, 13X
	Drying and sweetening LPG		TSA	4A, 13X
	Drying and purifying natural gas for automotive use		TSA	3A, 4A, 13X
Technical Gases	Purifying intake air in cryogenic air separation systems		TSA/PSA	13X
	Drying technical gases such as N_2, O_2, CO_2, H_2		TSA/PSA	4A, 13X
	Extraction of CO from CO rich reformer gases		PSA	5A, 13X
	O_2 enrichment of air using PSA and VPSA technology [examples: glass furnaces or manual welding (PSA)]		PSA	5A, 13X
Environmental Protection Technologies and Processes	O_2 enrichment of air using PSA and VPSA processes	Cellulose bleaching with O_2 or ozone	PSA	5A, 13X
		Waste water treatment with O_2 or ozone		
	Purifying biogas		PSA	13X
Energy Technologies and Processes	Heat pumps with H_2O adsorption and desorption		TSA	4A, 13X
	Use as a cooler by means of H_2O desorption			

Abbreviations:

TSA Adsorption processes with thermal regeneration
PSA Pressure swing adsorption
DDA Adsorption process applying desorption by displacement
VPSA Vacuum pressure swing adsorption
LPG Liquefied petroleum gas

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About Us

BASF's Catalysts division is the world's leading supplier of environmental and process catalysts. The group offers exceptional expertise in the development of technologies that protect the air we breathe, produce the fuels that power our world and ensure efficient production of a wide variety of chemicals, plastics and other products, including advanced battery materials. By leveraging our industry-leading R&D platforms, passion for innovation and deep knowledge of precious and base metals, BASF's Catalysts division develops unique, proprietary solutions that drive customer success.

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