MOLECULAR SIEVES - A SHORT SUMMARY-

Molecular sieves are crystalline metal aluminosilicates having a three dimensional interconnecting network of silica and alumina tetrahedra. Natural water of hydration is removed from this network by heating to produce uniform cavities which selectively adsorb molecules of a specific size.

A 2.5-5 mm (4 x 8-mesh) sieve is normally used in gas phase applications, while the 1.6-2.6 mm (8 x 12-mesh) or even smaller type is common in liquid phase applications. The powder forms of the 3A, 4A, 5A and 13X sieves are suitable for specialized applications.

Long known for their drying capacity (even to 90°C), molecular sieves have recently demonstrated utility in synthetic organic procedures, frequently allowing isolation of desired products from condensation reactions that are governed by generally unfavorable equilibria. These synthetic zeolites have been shown to remove water, alcohols (including methanol and ethanol), and HCl from such systems as ketimine and enamine syntheses, ester condensations, and the conversion of unsaturated aldehydes to polyphenals.

Type 3A

Composition 0.6 K_2O: 0.40 Na_2O : 1 Al_2O_3 : 2.0 ± 0.1SiO_2 : x H_2O

Description The 3A form is made by substituting potassium cations for the inherent sodium ions of the 4A structure, reducing the effective pore size to ~3Å, excluding diameter >3Å, e.g., ethane.

Major Applications Commercial dehydration of unsaturated hydrocarbon streams, including cracked gas, propylene, butadiene, acetylene; drying polar liquids such as methanol and ethanol. Adsorption of molecules such as NH_3 and H_2O from a N_2/H_2 flow. Considered a general-purpose drying agent in polar and non polar media.

Type 4A

Composition 1 Na_2O: 1 Al_2O_3: 2.0 ± 0.1 SiO_2 : x H_2O

Description This sodium form represents the type A family of molecular sieves. Effective pore opening is 4Å, thus excluding molecules of effective diameter >4Å, e.g., propane.

Major Application Preferred for static dehydration in closed liquid or gas systems, e.g., in packaging of drugs, electric components and perishable chemicals; water scavenging in printing and plastics systems and drying saturated hydrocarbon streams. Adsorbed species include SO_2, CO_2, H_2S, C_2H_4, C_2H_6, and C_3H_6. Generally considered a universal drying agent in polar and non polar media.

Type 5A

Composition 0.80 CaO : 0.20 Na_2O : 1 Al_2O_3: 2.0 ± 0.1 SiO_2: x H_2O

Description Divalent calcium ions in place of sodium cations give apertures of ~5Å which exclude molecules of effective diameter >5Å, e.g., all 4-carbon rings, and iso-compounds.

Major Application Separation of normal paraffins from branched-chain and cyclic hydrocarbons; removal of H_2S, CO_2 and mercaptans from natural gas. Molecules adsorbed include nC_4H_{10}, nC_4H_9OH, C_3H_8 to $C_{22}H_{46}$, and dichlorodifluoro-methane (Freon 12®).

Type 13X

Composition 1 Na_2O: 1 Al_2O_3 : 2.8 ± 0.2 SiO_2 : xH_2O

Description The sodium form represents the basic structure of the type X family, with an effective pore opening in the 910¼ range. Will not adsorb $(C_4F_9)_3N$, for example.

Major Application Commercial gas drying, air plant feed purification (simultaneous H_2O and CO_2 removal) and liquid hydrocarbon/natural gas sweetening (H_2S and mercaptan removal).