SCIENCE NEWS Online
THE WEEKLY NEWSMAGAZINE OF SCIENCE

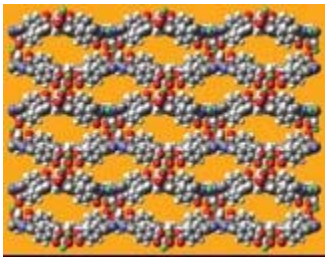
Week of Oct. 5, 2002; Vol. 162, No. 14

Molecular Separations: New artificial sieve traps molecules

Jessica Gorman

Just as a fishing net can catch big fish while letting small ones through, natural, porous minerals called zeolites can ensnare certain molecules while letting others swim free. Now, researchers have created a metal-laced organic solid that they say mimics zeolites and could outperform them for certain industrial and laboratory uses.

Zeolites can soak up liquid or gas molecules and also catalyze chemical reactions. They're used in petroleum refining, removal of water from organic solvents, and other industrial processes. These minerals sometimes appear in far more visible roles, such as in a small packet of desiccant that reduces humidity inside a shoebox.



MOLECULE TRAP. A porous network of porphyrin molecules made of carbon, oxygen, nitrogen, and two types of cobalt. Suslick and M.E. Kosal/UIUC

The natural zeolitic minerals, composed of aluminum and silicon, are a billion-dollar-a-year industry. Nonetheless, there aren't many ways that researchers can alter the size, shape, or reactivity of zeolites' pores, says Kenneth S. Suslick of the University of Illinois at Urbana-Champaign. To improve on nature's molecular sieves, many researchers are developing synthetic varieties whose properties they can tailor (SN: 6/23/01, p. 398: http://www.sciencenews.org/20010623/bob18.asp).

Suslick and his coworkers at the University of Illinois turned to organic, doughnut-shape molecules called porphyrins, which often contain metal ions at their centers. Well-known porphyrins include blood hemoglobin and leaf chlorophyll. By heating a mixture of a porphyrin precursor and cobalt chloride to 200°C, the researchers produced sturdy, pore-riddled networks of porphyrin molecules glued together by cobalt-containing linkages. Suslick and his colleagues describe their molecular sieve in the October *Nature Materials*.

In laboratory experiments, the material adsorbed molecules—such as water, ethanol, and methanol—that fit inside its half-nanometer-wide pores, but the network didn't take up slightly larger molecules. The new material also readily adsorbed water from common laboratory solvents such as benzene and toluene, removing more water in 1 hour than a zeolite material does in a day, the researchers report.

The new material "seems to be a very nice, working example of the

application of clever molecular design to one of the most challenging problems in materials chemistry—an organic analog of zeolites," says chemist Andrew D. Hamilton of Yale University.

Suslick suggests that the porphyrin networks might do more than just recognize and trap molecules—they could potentially catalyze a wide variety of chemical reactions, depending on what metal ions lie within the sieve's porphyrin components. Suslick says that he can envision using one of his synthetic zeolites for, say, turning gasoline into a precursor of nylon.

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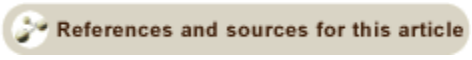

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Further Readings:

Gorman, J. 2001. Perfecting porosity. *Science News* 159(June 23):398-399. Available at http://www.sciencenews.org/20010623/bob18.asp.

Sources:

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From *Science News*, Vol. 162, No. 14, Oct. 5, 2002, p. 213.