Chemical weapons treaty sets deadline

On April 29, an international treaty banning chemical weapons went into effect. Ratified by 75 nations, including the United States but not Russia, the Chemical Weapons Convention stipulates that members must destroy all chemical stockpiles by 2007.

The U.S. Army began incinerating the U.S. stockpile in 1990 and plans to complete the purge by 2004. However, citizens' groups opposed to incineration hope that the treaty deadline will allow time for development of alternative disposal technologies.

The United States has about 30,000 tons of chemical weapons stored, including World War II–era mustard gas and the lethal nerve agents sarin and VX. Incinerators are now operating at two of the nine U.S. storage sites: on Johnston Atoll, about 800 miles south of Hawaii, and in Tooele, Utah (SN: 12/10/94, p. 394).

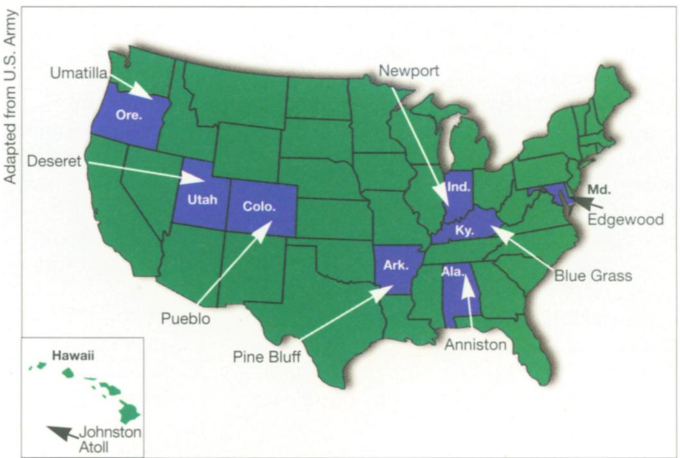
Because some of the chemicals are loaded into weapons, such as rockets, bombs, and mines, the problem of disposal is complicated. Of the available technologies, incineration most efficiently destroys contaminated metal and plastic parts, says Mickey Morales of the Army's Aberdeen (Md.) Proving Ground. After the weapons are disassembled robotically and drained of their contents, the chemicals and the tainted components are burned in separate furnaces. Exhaust gases are captured and treated to remove toxic substances.

Careful monitoring of emissions and numerous safety features make the design "the Rolls Royce of incinerators, compared to the ones that are normally permitted to operate in this country," says Amy E. Smithson of the Henry L. Stimson Center, a public policy research institute in Washington, D.C.

Some groups believe incineration of chemical weapons is unsafe. In ratifying the treaty, the U.S. Senate added a provision to extend the deadline 5 years if an alternative method is found. These extra years should provide sufficient time for development, says Craig Williams of the Chemical Weapons Working Group in Berea, Ky., an advocacy group opposed to incineration.

The risk of storing the weapons for that additional time is greater than the minimal risk of burning them, says Donald L. Siebenaler, director of a National Research Council committee that evaluates the Army's disposal program. For example, some nerve agents are loaded onto M55 rockets, which are potentially unstable and could blow up, Smithson says.

The Army is currently studying alternative disposal methods, says Morales, but getting permits for any new technologies will take years. The Army plans eventually to neutralize mustard gas and VX stored in bulk at two sites (SN: 10/5/96, p. 218). Destroying chemicals in bulk with alternative methods is not hard, says Smithson, but once the chemical is part of a weapon, "you're dealing with a deadly agent next to propellants and explosive agents." — *C. Wu*



Adapted from U.S. Army

The United States stores chemical weapons at nine sites.

Tying physical theory into stable knots

In the late 19th century, British scientist Lord Kelvin hypothesized that atoms could be described as vortices in the ether, an intangible fluid then thought to fill all space. He proposed that different elements would correspond to vortices bent into different types of knotted tubes forming closed loops.

Lord Kelvin's formulation of atomic theory in terms of knots never panned out. Nonetheless, the mathematics of knots has proved useful in recent years for describing knotted polymer strands (SN: 11/16/96, p. 310) and in various esoteric aspects of theoretical physics (SN: 5/21/88, p. 328).

Now, theorists have for the first time discovered a way to generate stable knotlike structures as solutions of the equations of field theory, which is widely used to describe many kinds of physical systems. Ludwig Faddeev of the Steklov Mathematical Institute in St. Petersburg, Russia, and Antti J. Niemi of Uppsala University in Sweden report their findings in the May 1 Nature.

"Until now, no one has been able to construct a knot in field theory, which means that testing theories for knot production has been impossible," says Warren B. Perkins of the University of Wales at Swansea.

"Our results point to several experimental and theoretical situations where such structures may be relevant, ranging from defects in liquid crystals and vortices in superfluid helium to the structure-forming role of cosmic strings in the early universe," Niemi and Faddeev say.

Cosmologists have postulated the existence of cosmic strings to account for the pattern of galaxies in the universe (SN: 12/7/96, p. 364).

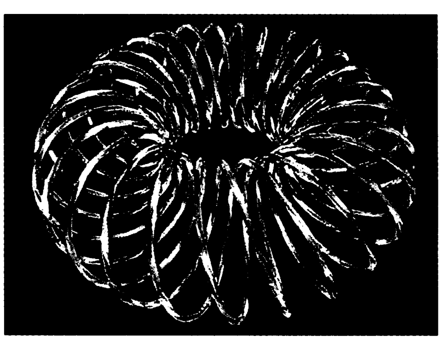
A field theory consists of equations expressing how objects—whether electrons, photons, molecules, or magnets—influence each other. One can picture the resulting field as an array of arrows, with the length of each arrow representing the field's strength at a given point.

Using computers, Faddeev and Niemi found numerical solutions of the equations describing a specific type of field. Their investigations yielded two stable patterns of arrows in the field, one of which could be interpreted as a twisted, doughnut-shaped loop and the other as a trefoil knot.

The trefoil is the simplest example of a torus knot. Torus knots can be described as a loop wrapping around the surface of a doughnut a number of times. The theorists note that their results suggest that other torus knots should also appear as solutions of their equations.

"Now that these knot configurations have been constructed, their properties can be investigated in detail," Perkins says. For example, researchers can examine how knots would arise among random string configurations in physical systems.

Niemi and Faddeev are now studying the applicability of their model to liquid crystals, in which rodlike molecules tend to align themselves in parallel rows, and to vortex structures in superfluid helium-3. — *I. Peterson*


David P. Dobkin/Princeton Univ.

Example of a complex torus knot.