Energy

Binary-cycle geothermal energy

Engineers know how to convert high-temperature hot water to electricity, but converting moderately hot water from geothermal wells is not so easy. Now, San Diego Gas and Electric Co. and other concerns have begun building a geothermal demonstration plant in Heber, Calif. It will generate power from geothermal fluids 150°C to 200°C, temperatures once thought too low to be useful in generating electricity.

The plant, located 10 miles north of the U.S.-Mexico border in the Imperial Valley, is in a rich geothermal source area whose underground fluids also power the nearby high-temperature Salton Sea and Brawley geothermal plants. Moderately hot sources in the United States are estimated to outnumber the high-temperature sources (hotter than 200°C).

At Heber, moderately hot water will be brought up under pressure from 4 feet to 8,000 feet deep and circulated in a closed loop. Heat from the loop converts a hydrocarbon solution of mostly isobutane into steam in a second closed loop. That steam then turns the turbine of a generator to produce electricity, after which it recondenses into fluid and starts the cycle over. The solutions in the two loops never mix; the energy is transferred from one loop to the other in a heat exchanger. Used geothermal water in the first loop is ultimately reinjected into the ground.

One-half of the plant's $122 million cost is being footed by the Department of Energy, while the remainder is being shared by San Diego Gas and Electric and the Electric Power Research Institute (the two major private participants), along with the State of California and several other utilities. The plant will produce 45 megawatts net, or about enough to supply the needs of 45,000 people, according to Maurice Luque, a spokesman for SDG&E. The plant's designers claim this will be the largest plant of its type to use binary-cycle technology so far. Interest in the facility is running high, says Luque, and the energy industry will be watching its performance during the two-year trial period with an eye to building more stations in the future. The Heber project is scheduled for completion in 1985. The plant was designed by Fluor Corp., and the geothermal source is jointly owned by Union Oil Co. and Chevron USA Inc.

Petroleum expulsion from shale rocks

The first oil well was drilled to a little under 70 feet in 1859 in Pennsylvania, and by 1970 there were almost 600,000 producing wells in the world. But in the 124 years since the first well, no one has ever satisfactorily explained how petroleum gets from its source rocks, organic-rich shales, to reservoir rocks, such as porous sandstone, which the drilling rigs tap. The problem is still unsolved, but a team of researchers in West Germany and Norway has begun to understand petroleum migration by studying 150- and 250-meter-long samples from drill cores in Spitsbergen, Norway.

A. S. Mackenzie and colleagues at the Institute of Petroleum and Organic Geochemistry in West Germany and the Continental Shelf Institute in Norway report that lighter fractions of petroleum (hydrocarbons with 15 to 19 carbons) are preferentially expelled into overlying sandstones from thin shale layers, about 60 meters thick, and from the edges of thicker units, up to 127 m, than from the interior of thick units. The lower-molecular-weight components of petroleum are preferentially expelled over heavier hydrocarbons, those with more than 19 carbons. In the Feb. 10 NATURE the researchers suggest that the amount of compaction of the shale is what may control how much petroleum is expelled from the shale. Earlier explanations of migration had relied only on the chemistry and age of the shales' organics. The ability of a shale to expel its petroleum into a reservoir determines its potential as a source rock. Understanding this mechanism will make the evaluation of promising oil reservoirs easier, they say.

Physical Sciences

The extent of a neutron's presence

It is a basic principle of modern physics that objects are both particles and waves. This wave-particle duality applies to everything from photons and electrons to the sun and the moon, but experimentally, wave properties are technically demonstrable only for the lightest particles. An experiment that measured the length of the "wave packets" associated with neutrons is reported in the Feb. 21 PHYSICAL REVIEW LETTERS by H. Kaiser, S. A. Werner and E. A. George of the University of Missouri at Columbia.

According to a formula worked out 60 years ago by physicist Louis de Broglie, the wavelength associated with a given particle depends on the momentum of that particle. However, by another basic principle of physics, the Heisenberg uncertainty principle, the momentum can never be precisely determined. All that can be known is that it lies within a certain short range. To represent a real particle, therefore, waves with lengths corresponding to all the momenta in the range must be added together. When this is done, the waves reinforce each other over a small stretch, the "wave packet," and effectively cancel each other everywhere else. According to the uncertainty principle again, the particle's location in space can never be precisely known. All that can be known is that it is somewhere within the extent of the wave packet.

The experiment takes a beam of neutrons, splits it in two, runs the two beams over paths of different lengths and recombines them. In the recombination, the waves of the neutrons will interfere, either reinforce or cancel each other according to the relationship between their phases, which depends on the lengths of the two paths. The first demonstration of this interference was an important piece of evidence for the wave properties of neutrons (SN: 4/24/76, p. 268).

In the present work, the experimenters inserted slabs of aluminum in the path of one of the beams to slow it down. If the slab slows the beam enough that its wave packets no longer overlap with those of the other beam at the recombination point, then they will not interact with each other, and the interference effects disappear. From the thickness of the slab that caused the disappearance, the experimenters were able to calculate the length of the wave packet, which, for the neutrons of average wavelength 1.268 angstroms that they were using, comes to 19.9 Å.

Anomalons—quirky but not quarky

When a highly energetic atomic nucleus strikes a solid target, the nucleus is likely to shatter. The fragments fly on into the target and strike other nuclei in their turn. Six percent of them make such hits much sooner than the ordinary properties of nuclei would lead one to expect. These are called anomalons (SN: 10/30/82, p. 284). The existence of anomalons could mean that some nuclei come in strange shapes or that internally they are mysterious new states of matter, behaving like bundles of quarks, instead of collections of neutrons and protons.

One proposed explanation was that the original collision not only breaks up the incoming nucleus, but breaks up some of the neutrons or protons into their constituent quarks, leaving nuclear fragments with unbalanced quarks on them. Unbalanced quarks have a much stronger attraction for other nuclear matter than integral neutrons and protons, and so such fragments would be likely to interact sooner.

Fragments with unbalanced quarks should exhibit electric charge in fractions of the normal units. P. B. Price and five others of the University of California at Berkeley studied the charges of a few hundred such fragments (determined by the damage they did in a plastic detector) and report in the Feb. 21 PHYSICAL REVIEW LETTERS that there is essentially no evidence for fractional charge, at least in the energy range they studied.