ENERGY

Coal mixers for oily thirsts

Several commercial programs are developing coal-based chasers to slake America's costly and gluttonous thirst for petroleum. One effort, dedicated last month near Houston, is a $116 million pilot plant to test the Exxon Donor Solvent Coal-liquefaction process. During the next 30 months, bituminous and subbituminous coals will be fed through the Baytown, Tex., facility in a slurry of hydrogenated solvent. Pulverized coal will enter the plant's reactor via the oil-based slurry and be transformed into a liquid-petroleum substitute under temperatures in excess of 800°F, pressures of around 2,000 pounds per square inch, and an atmosphere spiked with gaseous hydrogen.

Although the Baytown plant will produce only about 700 barrels of liquids per day (from 250 tons of coal), commercial-scale progeny — perhaps costing $1.5 billion each (1979 dollars) — might deliver fuel streams totaling 30,000 barrels or more of fuel daily. Emissions from such a plant would be similar to those produced by today's coal-fired powerplants and oil refineries.

Like an oil refinery, a commercial liquefaction plant would probably produce a range of products that could substitute for gasoline-blending stocks, boiler fuel, stationary gas-turbine fuel and petrochemical feedstocks. Combustion tests by Exxon of its synthetic boiler fuel showed that it burned cleaner than petroleum equivalents with regard to ash, total particulates and sulfur. Nitrous-oxide levels ran higher than those from comparable fuel oils because of the nitrogen-rich liquefaction process; the levels can be lowered, however, by modifying combustion conditions or by adding a step to the liquefaction process.

Samples from waste-water streams will be collected at the Baytown plant and analyzed elsewhere for characterization of necessary cleanup schemes. A related experimental 70-ton-per-day "flexicoking" plant, also in Baytown, will be fed unburned coal-slurry particulates, ash and wastes to produce a low-Btu flue gas (around 100 Btu per cubic foot). Furnaces used to preheat the coal-oil slurry could be powered by this gas.

The $340 million price tag for developing this program, begun in 1976, is being paid for by the U.S. Department of Energy, Exxon Coal USA, the Electric Power Research Institute, Japan Coal Liquefaction Development Co., Phillips Petroleum Co., Atlantic Richfield Co. and Ruhrkohle A. G. (a West German firm).

New solar alloy

A highly plastic, inexpensive and ductile aluminum alloy that can be shaped into complex configurations will be used in 40 solar-collector panels installed for testing at the Kirkcaldy College of Technology in Scotland. Heated to 450°C, the Tube Investments Ltd. alloy can withstand strains 100 times greater than those that cripple ordinary aluminum, according to the Feb. 18 Energy Research Reports, a newsletter out of Newton, Mass.

Arabian shale oil

Hoping to cut its fuel budget, Jordan is turning its attention to extracting oil from shale, instead of OPEC — the Mideast-dominated oil cartel. The oil-short Arab nation found an estimated 10 billion tons of oil-saturated rock in 1968. While samples suggested it was "pretty good stuff (estimated 14- to 36- gallons-per-ton-yield)," according to a Jordanian newsletter, Alia Report, it proved much more economical at the time simply to forget about the shale and import Saudi oil.

No more. Jordan recently budgeted more than $2.6 million for shale exploration and for analysis of rock samples by foreign experts. The water-short nation hopes to harness direct combustion of shale rock for power generation since most concepts, which instead first squeeze out the oil, are water intensive.

PHYSICAL SCIENCES

Clearing up noble metal crystals

Nature sometimes refuses to conform to plausible theory. As C. S. G. Cousins of Exeter University in England points out in the Feb. 21 NATURE, the noble metals (copper, silver and gold) insist on forming crystals of the face-centered cubic configuration although theoretical calculation says that the hexagonal close packed configuration possesses the least energy for their case, and therefore should be the stablest crystal form.

There are a lot of factors to be added in to determine which form has the least energy. Cousins lists the Ewald energy, the core overlap energy, the kinetic, exchange and correlation energies of free electrons and a band structure energy. Thinking there might be still another factor that had not been brought in, he adopted a "three-ion interaction" that had been found by W. A. Harrison.

This is the energy generated by the forces among three ions lying on the same straight line. Cousins observes that each ion in an f.c.c. structure is the central atom of six such triads of collinear ions. In an h.c.p. structure each ion is the center of three such triads. This makes a difference in the energies contributed to the two configurations by the three-ion interaction. When that difference is added in, the face-centered structure becomes stabler for noble metals, and Cousins expresses a belief that that is why they naturally fall into it.

The how of muon conservation

Conservation laws in physics tend to arise empirically. Experimenters observe the radioactive decays of the particles called muons and find that certain combinations of particles are produced and certain others are not produced. Sorting out common factors in the permitted decays and common differences with the forbidden ones, they conclude that there is a property of muonness or muon number and that it is conserved in these interactions. That is, counting a muon or a muon neutrino as $+1$ and their antiparticles as -1, the net muon number at the end of a process must be the same as the muon number that went in at the beginning.

Empirical conservation laws must be taken into theory. Sometimes a theory that starts from grand principles requires a change in such a law, and then experimenters have to retest to check the theory. Such is the case with the recent suggestion that muon conservation may not be additive, as described above, but multiplicative. In an additive law the net muon number stays constant. In a multiplicative law the base number -1 is multiplied by itself the number of times indicated by the net muon number. The product will be either -1 or $+1$, depending on whether the number of multiplications is odd or even. The product is what counts, and the net muon number can change so long as it preserves the evenness or oddness.

The two kinds of laws permit different modes of muon decay, and the difference is important to physicists who are trying to determine what kind of mathematical symmetry principles underlie particle physics. A group of physicists from the United States, France, Switzerland and Canada (S. E. Willis et al.) set up an experiment at the Clinton P. Anderson Meson Physics Facility at the Los Alamos Scientific Laboratory to look for evidence of effects of the multiplicative law.

What they tried to measure was electron antineutrinos coming from the decay of a positive muon into a positron, an electron antineutrino and a muon neutrino (permitted by multiplicative but not additive law) and electron neutrinos from decay of a positive muon into a positron, an electron neutrino and a muon antineutrino (permitted by both laws). In the Feb. 25 PHYSICAL REVIEW LETTERS they report the evidence "in excellent agreement with the additive law."