PHYSICS

Reactor Ashes Precious

Atomic plants do not pose the "disposal" problem that many laymen often think. The problem is really how to save the highly valuable "ashes" or fission products for use.

See Front Cover

By WATSON and HELEN DAVIS

➤ FIRE which mankind has used for at least 25,000 years, has unfitted people for understanding the problems of atomic energy.

Fire produces heat, and so does fission, but the results of the two process beyond that do not correspond. Nuclear fuels do not burn out as coal does. Fission products have nothing in common with ashes.

Radioactive elements withdrawn from atomic reactors are materials of perhaps as great value as the atomic fuel producing them. Disposal by burying them in the ground or throwing them into the sea just to get rid of them would be economically disastrous.

Fear of the health hazard from radiation has so far created a demand by people unacquainted with the specific problems of radioactive waste disposal that such wastes be eliminated at all costs.

To the men who have tamed the atom during the past ten years, the lifetime of the new atomic age, the problem of waste disposal appears only as that of finding enough unused space in the world to set aside the most dangerous of these products until they can be safely mined for the useful elements they contain. Fifty years would perhaps be the right time to let the hottest radiations die away.

Remove Vicious Elements

One scheme for successive steps in making use of high energy fission products was offered the International Conference on the Peaceful Uses of Atomic Energy in Geneva by Dr. E. Glueckauf of the British Atomic Energy Research Establishment, Harwell. First step in this scheme. after reducing the bulk of the fission product solution by evaporation, is to remove chemically the two most vicious radioactive elements, strontium and cesium isotopes.

Strontium is a chemical relative of calcium, the clay-forming element, and cesium is a heavier and more active relative of sodium and potassium, the universally occuring salt-formers. These two elements lend themselves to disposal by incorporating them into baked clay products.

The liquid left over after removal of strontium and cesium would be stored for 13 years, according to Dr. Glueckauf's scheme, while the clay products containing the highly radioactive material would be useful for the energy they give off.

Strontium would go into these hot bricks at once, and be used as a source of heat for 50 years. Its radiations are such that a great deal of shielding is not required to protect people working near such a source of heat.

Cesium, on the other hand, would be kept in another form for 50 years, to make use of the active rays it would give off. Only after these had died away at the end of that time, would it be given the baked clay treatment, in order that it might safely be thrown away.

After 13 years, the solution from which strontium and cesium had been extracted would again be processed for recovery of other elements, this time the rare metals ruthenium, rhodium and palladium. These are junior members of the platinum family, and find use because they are hard and not easily corroded.

Ruthenium is at present giving difficulty to researchers because its chemical properties make it troublesome to separate and its radioactive properties dangerous to handle. These difficulties are expected to be solved as more experience is gained.

An aged solution of debris from atomic reactors would also be a source of technetium, an element that does not occur in nature, but is known only in its radioactive forms, one of which is produced in the fission of uranium 235 and plutonium.

Substantial quantities of neptunium and americium from atomic reactors could also probably be used. Both neptunium and americium are artificially produced elements, heavier than uranium, not found in nature.

Value received from these semi-precious metals plus the energy used as heat and radiation from the hot products first separated will pay the costs of fission product processing, according to estimates by Dr. Glueckauf.

Figuring the Cost

Differences in ways of counting costs in nuclear energy operations were stressed by Drs. Abel Wolman and A. E. Gorman of the U.S. Atomic Energy Commission at the conference. While cost of storage of fission products may be high compared to the storage of innocuous liquids in more familiar processes, the actual money outlay for this necessary part of the atomic industrial cycle may be only a small fraction of the cost per kilowatt of electric current produced.

In counting costs, it must not be forgotten that the greater part of most industrial processes consists of obtaining usable energy in the form of heat.

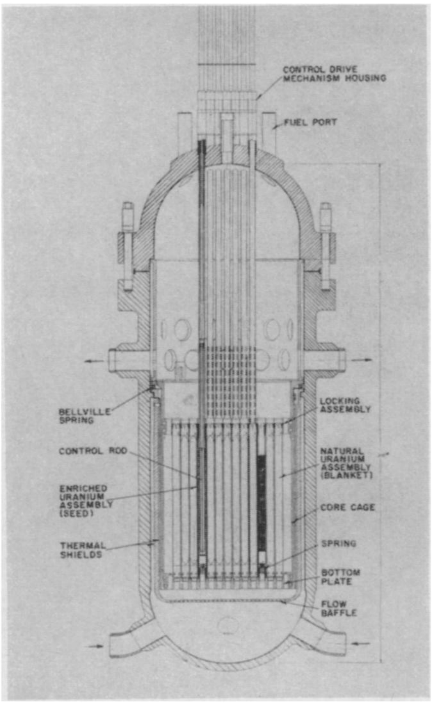
Until discovery of radioactive processes, this was the only form of energy generally used to change the form of materials to make useful products. But the radiations given off by atomic reactions can also be used in manufacturing processes.

Great advantage of the new types of reactors using circulating liquid fuel is that they allow access to the high radioactivity of the very short-lived fission products.

Energy from such radioactivity can produce new kinds of chemical reactions. One such reaction is the polymerization of plastics by irradiation, producing materials of much greater strength than the original had. Prospects of opening whole new fields of chemical research are foreseen by manufacturers alert to the possibilities of the atomic age.

Although new technologies will have to deal with new difficulties, Dr. Glueckauf is optimistic about man's abilities to deal with them.

When plutonium abandons its role as the bomb element and joins its parent uranium in peaceful industry, for example, the amount of americium that will appear in the fission products will create a serious disposal problem for the future. This



REACTOR VESSEL—The "atomic furnace" for the first U.S. atomic-powered electric generating station to be installed at Shippingport, Pa., is shown in this cutaway drawing.

deadly man-made element, No. 95 on the chemist's list, has a half-life of 470 years and will be difficult to store until it decays to a level at which it may be given final burial. However, Dr. Glueckauf stated that these problems of the future "will be solved by only a small fraction of the ingenuity that created them."

Shorter Time Slices

➤ TIME IS being sliced thinly to parts of a billionth of a second in the latest sort of atomic counters, Dr. G. A. Morton of the Radio Corporation of America laboratories, Camden, N. J., told the conference.

Scintilation counters have been developed into rugged and reliable tools for uranium prospecting and for following the course of tell-tale radioisotope tracers in biological, medical and industrial processes. The device is useful in detecting and measuring with high accuracy all forms of nuclear radiation.

When a particle is absorbed in a transparent phosphor material, a flash of light proportional to the energy of the particle is produced. This light goes into a photomultiplier tube and produces a pulse of electrical current that can be measured and recorded.

Sensitive detection devices for atomic radiation will allow keeping tab on great masses of industrial materials.

Dr. W. H. Johnson, Purdue University chemist, suggested that new measurement techniques will allow tagging vast quantities of oil in underground storage to tell of any leaks.

All the world's sugar could be labeled with such a small amount of radioactive carbon that it could be traced and yet not raise the level of the world's natural radioactive carbon activity by more than a tenth of a percent. This would allow tracking all sugar in medical experiments, but would not cause worry about sweetening food.

See Simpler Universe

➤ SIMPLIFICATION of the structure of the universe was forecast by Dr. Hans Bethe of Cornell University, Ithaca, N. Y.

Dr. Bethe said it was likely that an entirely satisfactory theory of nuclear forces could be built based only on pi mesons. Dr. Bethe, a theoretical physicist who was instrumental in the Los Alamos atomic bomb work, worked out in pre-A-bomb days the equations for the famous "carbon-cycle" by which the sun is stoked.

He said scientists do not now understand what role the mu meson plays in cementing together the hard core, or nucleus, of atoms. Although this atomic particle, found with either a positive or negative charge, has been known since 1937, it is not clear why such a particle should exist at all.

On the basis of scientists' present understanding of nuclear forces, a satisfactory theory of nuclear structure can be constructed using only protons, neutrons, electrons, neutrinos and pi mesons. There seems to be no spot for mu mesons, yet they exist.

Both mu and pi mesons are relatively lightweight, sub-atomic particles having masses lying between electrons and protons. Pi mesons are somewhat heavier than mu mesons.

Physicists who are now struggling to make sense out of about 20 atomic particles, called fundamental even though they exist for only fleeting microseconds (see SNL, May 21, p. 330), welcomed Dr. Bethe's forecast of simplification in nuclear theory.

One of the sessions of the United Nations International Conference on the Peaceful Uses of Atomic Energy which closed on Aug. 20 at Geneva is shown on the cover of this week's SCIENCE NEWS LETTER. The U.S. delegation is seated in the lower left in the photograph.

Atomic Ore From Granite

➤ IMMENSE QUANTITIES of uranium and thorium, the two chief natural elements from which atomic energy is derived, are dispersed in the ordinary granites of the earth's crust.

They can be extracted "extremely easily" according to a paper reporting the work of a team of scientists directed by Dr. Harrison Brown, professor of geochemistry at the California Institute of Technology and a technical adviser to the conference.

Although thorium and uranium are present in average granite to the extent of only a few parts per million, it has been found they are present in such a way as to make their extraction quite simple.

Average granite, found in all parts of the world, contains about four parts per million of thorium. If all the uranium and thorium could be extracted from one ton of granite and converted into fissionable material and "burned" in a nuclear reactor, the energy released would be equal to that obtained from burning about 50 tons of coal, according to the estimates of the researchers.

Experiments indicate that an average of only about 25% of the thorium and uranium in granite rock is "leachable." One ton of granite would, therefore, produce releasable energy equivalent to 10 to 15 tons of coal.

The authors point out that world-wide demand for uranium and thorium may eventually amount to "millions of tons," and they ask, "is it within the realm of technological and economic feasibility for a nation which is devoid of high-grade deposits to obtain uranium from substances which exist abundantly on the earth's surface?"

The authors show that the energy costs required to process a ton of granite, leaching uranium and thorium, would lie "within the range of 25 to 48 pounds of coal." This, they say, "is clearly very much smaller than the equivalents of 20,000 pounds of coal which could be extracted from a ton of average rock."

The authors conclude that from "solely an energetic point of view" granite rocks in the earth's crust can be processed for a net energy profit" and this means, they go on to say, that "reserves of uranium and thorium available to man can be considered for all practical purposes as infinite."

But from the economical aspect, the dollar cost of extracting uranium and thorium from granite is prohibitive at the present time. For the future, however, "there is ample uranium and thorium in igneous rocks to power a highly industrialized world economy for a very long period."

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