CHEMISTRY

Atomic Bomb Chemistry

Background you will need in connection with the Bikini test.

➤ STARTING with the knowledge that one kind of uranium could be split or fissioned with release of energy while another and most common sort of uranium could not, separation of the two kinds of uranium was a major task in the early stages of the atomic energy researches.

In order to make the fission reaction in uranium 235 self-sustaining, it was found necessary to separate uranium 235 (less than ½% in any uranium sample) from the more abundant isotope uranium 238 (more than 99%). The more common kind prevents the chain reaction by absorbing neutrons.

An enormous isotope separation plant, using gaseous diffusion methods, was erected at Oak Ridge, Tenn. Much of the experimental work for the whole project was done there.

Research on uranium 235 fission, using heavy water (D_2O) as the moderator, slowing down the neutrons, was under way in both England and Germany in 1939. American scientists substituted specially purified graphite for heavy water.

Two new elements, heavier than uranium 92, both of which were "made to order" and neither of which was known to exist in nature, played an important part in the atomic bomb researches and manufacture. These were elements 93 and 94.

Formation of element 94 from uranium 238 by neutron capture was effected in the Radiation Laboratory of the University of California in 1941. The new element was found to undergo slow neutron fission like uranium 235. It was named plutonium (Pu).

Plutonium, radioative but approximately as stable as radium, was obtained from uranium 238, element 92, by way of the intermediate short-lived element 93, named neptunium (Np) discovered in 1940. Uranium 238 changes to neptunium and neptunium to plutonium by beta-ray transformation.

Manufacture of plutonium from uranium 238 allowed utilization of the inert uranium isotope for atomic power purposes. It allowed the advantage of sharp chemical separation of different elements instead of the tedious diffusion methods of isotope separation.

Thus transmutation, for centuries the alchemists' goal, became the method of choice of the group of scientists who worked out the chemistry of the atomic bomb.

Here the knowledge and skill of chemists who had studied the behavior of radium and other radioactive elements were put to good advantage.

It had been found in work with such elements that their weight and their chemical nature depend on two kinds of minute particles which make up the hearts of their atoms.

The number of one kind of particle, the proton, in the atom heart is responsible for the nature of the element. One proton makes hydrogen, 26 protons make iron, 92 protons make uranium. The other kind of particle in the atom heart is the neutron. Uranium 235 has a net result of 92 protons and 143 neutrons, adding up to 235, according to the chemists' calculations, while uranium 238 has three more neutrons than its lighter isotope.

The two uraniums had to be separated, because only uranium 235 would split up the way the scientists wanted it to for use in the atomic bomb. Uranium 238 would not. By lucky chance, the very property of uranium 238 which made it useless for the purposes of the bomb provided the clue which was the best solution of the separation problem.

The more plentiful form of uranium could be made to undergo transformation into another kind of element by first adding to the nucleus of its atom a neutron, to make it so heavy that it would become unstable, then by allowing this heaviest uranium atom to shoot an electron out of its structure. This loss of electrons from the total quantity of uranium showed itself as a phenomenon familiar to scientists as the beta ray. It is the peculiar nature of radioactive elements to change into something else when they emit beta rays, and that something else is, oddly enough, not a lighter but a heavier element.

Accordingly, when uranium 239, formerly the heaviest known element, emitted its beta ray, it changed into a still heavier element, neptunium. Neptunium proved to be a rather unstable element, and emitted a beta ray in its turn. This change in the atom turned neptunium into another new element, plutonium. The names of these three elements are taken from the three farthest planets of our solar system.

Plutonium turned out to be a fairly stable element, about whose chemical properties enough was soon learned to prove that chemical separation of this new material from its parent uranium would be a relatively easy task. Plutonium does not readily follow the pattern by which it was formed, but makes the opposite transformation by which it gives off an alpha ray and becomes uranium 235. This, however, happens so slowly that there is plenty of time for the atom-splitting reaction of plutonium to do its work.

In the course of the researches it was also possible to make for the first time two heavier transuranium elements, numbers 95 named americium and 96 named curium, by bombardment with high-energy helium nuclei or alpha particles.

Production of materials for atomic bombs was at first planned to be located at the Clinton Engineer Works at Oak Ridge, Tenn. Later the plant for full scale manufacture of plutonium was built at Hanford, Wash., and the bomb laboratory was located at Los Alamos, N. M.

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MEDICINE

Vaccination Protects Against Tuberculosis

➤ B.C.G. VACCINATION against tuberculosis is protecting a large proportion of nurses and tuberculosis sanatorium employees in Saskatchewan, Can., from getting the disease from patients, Dr. R. G. Ferguson, director of medical services and general superintendent of the Saskatchewan Anti-Tuberculosis Association, reported at the meeting of the National Tuberculosis Association.

Tuberculosis cases among nurses were reduced to one-fourth and among employees to one-fifth the number that had occurred before the vaccination was instituted in 1938.

B.C.G. is made from living tuberculosis germs which have been greatly weakened in their disease producing capacity. It does not give 100% protection but has been found safe by the Canadian users and even when it did not prevent tuberculosis, it reduced its severity.

A serious situation which had been developing with regard to excessive tuberculosis among nurses and sanatorium employees no longer exists.

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