Uranium Photoaccumulator

Anton N. Yegorov, Russia

St.Petersburg Institute of Nuclear Physics, Russian Academy of Sciences, Gatchina, 188350, Leningrad region, Russia
http://www.pnpi.spb.ru, Email: bti@isppd.pnpi.nw.ru

Photoaccumulators are galvanic elements consisting of two communicating vessels, one of which is exposed to light and another is kept in darkness. Ionic composition of electrolyte, which fills these vessels, depends on intensity of illumination. If an inexpensive electrode is placed in each vessel, then a potential difference will appear. If the electrodes are closed at external working resistance the electron stream will begin to equalize ionic composition and the difference in illumination intensity will tend to disbalance it. As a result, a certain working mode will be established which will allow to utilize the photoaccumulator for production of industrial electrical energy. As distinct from the solar battery, which works while exposed to the light, the photoaccumulator stores some part of solar energy in its electrolyte which is supplied with electrical energy after sunset too.

The idea of photoaccumulator is not a new one. It was established in the end of 19th century that it is feasible to create a photoaccumulator containing electrolyte made of the following mixture: $Fe^{2+} + Hg^{2+} = Fe^{3+} + Hg^{+}$.

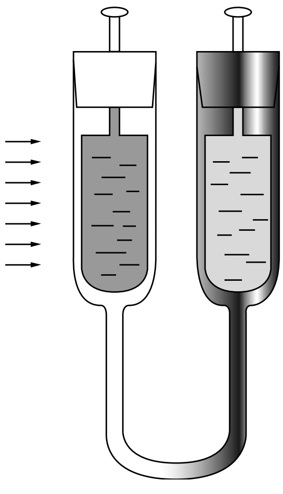
This photoaccumulator was not adopted in practice because of high toxicity of the electrolyte and very low EMF (approximately 0.018). Development of technology is accompanied by a widening range of materials and matters which can be used in large scale production and power industry. Among such materials are, in particular, titanium, depleted uranium and rare-earth elements. Nuclear power industry uses U235 isotope only. Naturally occurring compound contains only 0.72% of U235. Hundreds of thousands of U238 from which U235 has been extracted are kept as useless stock.

In the end of sixties in one of radiochemical laboratories of LINP (Leningrad Institute of Nuclear Physics) P.N. Moskalyov repeated the same experiment over a long period of time. In the morning he placed a tightly closed retort filled with uranyl-chloride soluted in compound of water, spirit and hydrochloric acid on the window-sill. The solution in the retort changed its color from yellow to emerald-green. Before leaving the laboratory Moskalyov removed the retort with green solution from the windowsill to a closed chest. In the morning Moskalyov retrieved the retort with the solution (which was already yellow) from the chest and placed it on the sill. The solution became green again and the whole process repeated daily.

Chemical processes in uranium electrolyte are rather complicated: first, under the light influence the uranyl ion oxidizes ethyl alcohol, which is then transformed to aldehyde: $UO_2^{+2} + C_2H_5OH^+ = U^{iv}(OH)_2 + C_2H_4O$.

In the dark ions of urany-4 interact with aldehyde and are transformed to UO_2 uranyl ion and spirit again. Thus, **this cyclic process can take place over a significant period of time being supported by the energy provided by light quanta of visible light which are transformed into the heat.**

The idea of utilizing this process in order to obtain electrical energy emerged in the late nineties. The mechanism of uranium photoaccumulator is very simple (Fig. 1): two glass vessels, one made of transparent glass and another of non-transparent glass, are connected with a black acid-proof rubber tube. The communicating vessels are filled with aqueous electrolyte containing 40% of spirit, 80-100 g/l UO_2Cl_2 and 0.2 m HCL. The electrolyte is previously activated by multiple cycles of exposing it to light and then placing it in darkness in order to obtain a significant volume of aldehydic fraction. The major difficulty of designing uranium photoaccumulator is connected with the choice of the material for electrodes. In galvanic elements carbonized platinum electrodes are usually used. For practical use platinized titanium gives the best fit. Titanium foil covered with superfine layer of platinum is currently widely used in electrochemical industry and is procurable.



In the transparent vessel the titanium petal-shaped electrodes are parallel the light flow, so the light quanta move freely through the solution.

In working condition each photoaccumulator produces 10 mA of current at 0.3 volt voltage, so they are to be connected in large batteries, both in series and in parallel.

It is also necessary to consider the aspect of safety. Until now, the depleted uranium has been used for one purpose only, namely, for manufacturing of cores for armor-piercing shells. When used in this manner, the uranium is pulverized, which leads to environmental damage. The battery of photoaccumulators is placed in hermetic metal chest; the front panel of the latter must be made of solid safety glass. Such a system will protect the photoaccumulator battery from malicious intent and the security staff from weak uranium radioactivity.