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Preparation of Enriched Nickel- 63 for nuclear β-voltaic batteries

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Modern technology in the field of microsystem technology allows producing subminiature and reliable devices for engineering and medicine. Energy for these devices should be also supplied from miniature and reliable power sources with a long service life. Atomic batteries (AB) on the β-voltaic effect (the analog of the photovoltaic effect) most fully meet these requirements. Among possible β- emitting radionuclides nickel- 63 has most optimal characteristics. It is characterized by rather long half-life (100 years), soft β- radiation (17 keV), high specific power (~ 100 mkW/Ci) and chemical resistance.
The efficiency of the energy conversion of β-radiation depends on both the construction features of the atomic battery and the degree of nickel -63 enrichment. The current technology of nickel -63 production are based on irradiation highly enriched nickel - 62 in super high neutron flux (1x1015 n/cm2s). The degree of enrichment really attained by this technology is about 20%. However, theoretical calculations and experimental studies show that for the AB production it is desirable to use nickel- 63 with enrichment no less than 80 %. This will allow nearly tenfold increase in the AB efficiency (from 0.3-1.0 to 20-25%).
For large-scale production of highly enriched nickel -63 (more than 80%) we developed a procedure, which is based on irradiation of nickel -62 with mid-level enrichment in industrial nuclear reactors with “conventional” thermal neutron flux (5x1013 –1x1014 n/cm2s). In the course of subsequent reprocessing we obtain intermediate product of nickel -63 with enrichment of about 6%, which is then subjected to the centrifugal separation for preparing Ni-63 with 80% enrichment.
Secondary product (Nickel -62) remaining after enrichment of Ni- 63 can be reused. As a result, a virtually waste-free closed cycle of production is realized, which allows irradiation of the large volumes of raw materials without violation of the nuclear reactor operation.
This technology allows the large-scale commercial production of nickel- 63 for nuclear batteries with reasonable cost for commercial use.

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