

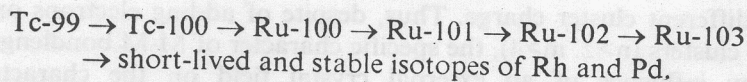
## Tc-99 transmutation as the new source of stable ruthenium

A.A. Kozar, V.F. Peretroukhin

Institute of Physical Chemistry, Russian Academy of Sciences,  
31 Leninsky prosp., 117915 Moscow, Russia

The world production of Tc-99 in power reactors is 7.5 t/year but its requirements in world market are below a few hundreds g/year. Many nuclear countries plan to isolate Tc-99 from radioactive wastes for long-term controlled storage or liquidation. Tc-99 transmutation to short-lived and stable nuclides is the only radical method of this long-lived radionuclide liquidation. High Tc-99 capture cross sections with thermal and intermediate neutrons are a base of this strategy.

In this work we develop our early publication [1] about production of stable and applicable ruthenium by Tc-99 transmutation in reactors with thermal neutrons. Natural Ru is noble metal, its price is about 10 \$/g, its world stocks are about 3100 t and its world requirements are 7.4 t/year, that could be satisfied completely by Tc-99 transmutation. Stable isotopes Ru-100, Ru-101, Ru-102 are the main products of Tc-99 transmutation with thermal and intermediate neutrons:



Transmutation Ru could be applicable in non-nuclear industry if it will contain the quantity of radioactive nuclides which is lower than permissible level.

We have calculated Tc-99 transmutation and Ru production dynamics during Tc-99 point-target irradiation by thermal neutrons with spectrum hardness of  $\gamma=0.3$  (fig.1,2). Stable ruthenium yield achieves maximum with thermal neutron fluence of about  $5 \cdot 10^{22} \text{ cm}^{-2}$  ( $\gamma=0.3$ ) and equals about 99% of all nuclei, 0.1 - 0.2% are nonburnt Tc-99 and after 1 year of target keeping the rest are stable isotopes of Rh and Pd. The analysis of all possible reactions of Tc-99 with thermal neutrons shows that there are no long-lived radioactive isotopes among transmutation products.

Ru activity after irradiation will be result of a presence of nonburnt Tc-99 and fission products produced from actinides impurities in Tc-99 target. About 99-99.5% of nonburnt Tc-99 must be separated from transmutation products to achieve the concentration of less than  $10^{-5}$  g of Tc-99/g of Ru which is lower than the permissible level for a surface and an equipment in nuclear industry. Probably it will require full dissolution of targets because of production of Ru-Tc solid solutions under irradiation (for example, in the case of completely metallic Tc targets). In the opposite case Tc-99 before irradiation must contain less than  $5 \cdot (10^{-11} - 10^{-10})$  g of actinides/g of Tc-99 in order to produced fission products activity will be less than  $10^2$  Bq/g for use of Ru in industry (latter value in brackets relates to target keeping during 10 years after irradiation). But if Tc-99 rest separation from Ru after 1 year keeping will lead to extraction of about 90% of all fission products activity except Ru-106, then Tc-99 target must contain less than  $2 \cdot 10^{-10}$  g of actinides/g of Tc-99 before irradiation for immediate use of Ru.