Chemical processing and waste management following neutron activation

Engeniy Nesterov,
research associate of the Lab №31
Research Nuclear Reactor IRT-T
Toms

Vienna-2017

The necessity of regeneration of enriched mo-98

- In process of irradiation of enriched Mo-98 by neutrons **only $2 \cdot 10^{-3}$ %** undergoes a transition to ^{99}Mo. Therefore following regeneration is required
- **Regeneration** is desorption of Mo-98 from spent columns and rinse water and following production of MoO_3 for repetitive use

Desorption of Mo-98 from spent columns

Main idea in approach was to use as few stages as possible and decrease volumes of used chemicals.

The following processes were investigated:

- Thermal desorption from surface of Al_2O_3 in vacuum and in airflow
- Direct sublimation of MoO_3 in gaseous forms of hydrochloric acid
- Desorption of Mo by solutions of ammonia, acids and caustics

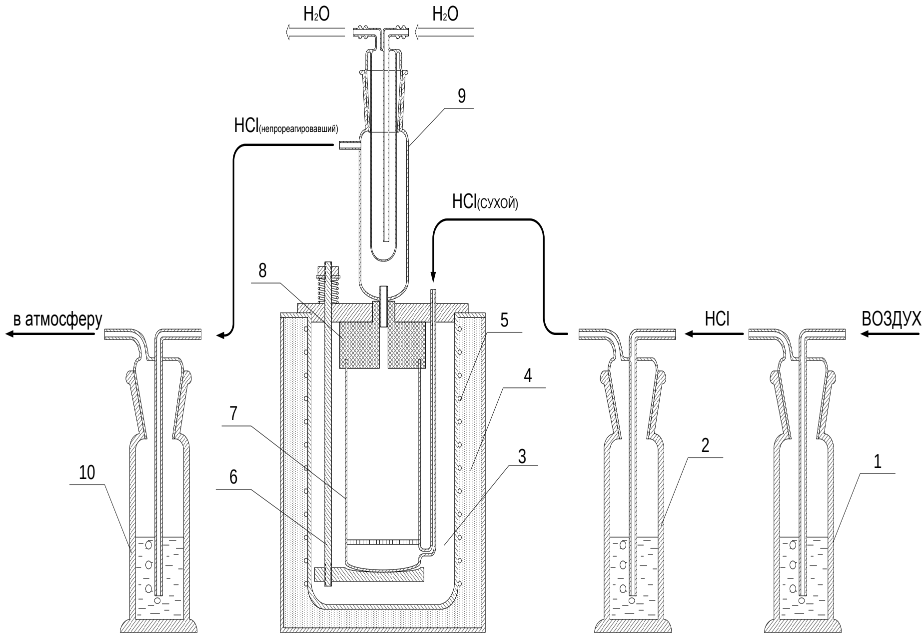
Thermal desorption of MoO_3 from the surface of Al_2O_3 in vacuum

The stripping was performed in tube heater with a temperature 1000 – 1500 ^{0}C for 2,5 hours. Yield of MoO_3 is approximately 97,5 %

Technical issues:

- «Smearing» of MoO_3 sublimate on the surface of heater
- The necessity of washing sublimate out with solutions of acids and following evaporation, which leads to increased level of losses

Sublimation of MoO_3 in hydrochloric acid



Desorption of Mo by solutions of ammonia

Desorption solution	Efficiency, %
2 M H_2SO_4	90,5
10 M HNO_3	67,1
2 M NH_4OH	92,3
4 M NH_4OH	**96,4**
6 M NH_4OH	95,6
8 M NH_4OH	94,8
10 M NH_4OH	94,2

Settlement of MoO_3 (VI) from liquid wastes

- 10 half-life periods
- Alcoholic solution of α-benzoinoxim
- Molybdenum yield is approximately 93,8 %

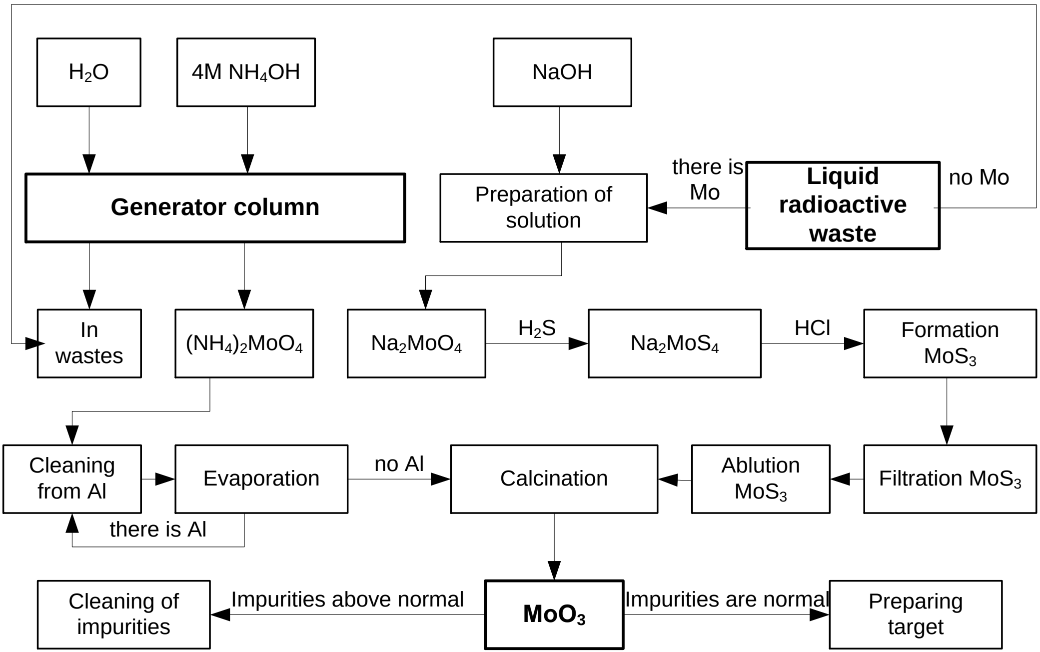
Sulphide method:

- Caustic soda and hydrogen sulfide
- Thioate residuas is being heated up to 600^0
- Molybdenum yield is approximately 99 %

Purity control of regeneration product

- Impurities with Al and Na produce ^{24}Na
- Allowed concentrations in product should be less than $2 \cdot 10^{-6}$ g and $1{,}8 \cdot 10^{-3}$ g per 1 g of oxide respectively
- Actual concentration may be 2 orders higher due to 0,9 % solution of NaCl, that is used for washing

Technological scheme of Mo-98 regeneration



Characteristics of radioactive wastes

Liquid and solid RW are being produced.

Solids 47 kg per 1000 generators a year:

- Aluminium penals, qurtz glass ampoules
- Chromatographic columns of used generators

Liquids 40 l per 1000 generators a year:

- Rinse waters after washing generators

Radioactive waste of production of 1000 Tc-99 generators a year

№	Technological operation	State	Activity, Ci	Volume
1	Irradiation of $^{98}MoO_3$ target	Solid: penals, ampoules	0,7	40 kg
2	Refueling of sorption columns	Liquid	$1 \cdot 10^{-3}$	40 l
3	Regeneration of Mo-98	Solid: sorbent	$4{,}3 \cdot 10^{-6}$	7 kg

Overall level of waste is $2 \cdot 10^{-4}$ % of ^{99}Mo activity.