PURIFICATION OF WASTE EFFLUENTS FROM URANIUM MINES AND MILLS IN UKRAINE

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Abstract. Development of Nuclear Energy Industry, which is foundation for energy supplying and economic independence of the country, based on increasing our own uranium resources. Reserves of uranium ore have explored by SGS Kirovgeology show the possibility to supply the nuclear fuel on the Atomic Power Stations for many years. From other side, mining of uranium ore and producing the uranium concentrate have a range of environmental problems. Successful solution of those problems can make the Atomic Energy Industry one of the environmentally safe producer of electric energy. Mining of uranium ore creates large volume of radioactive waste effluents. Presents of the uranium and natural radioactive elements (NRE) in concentration that is higher than in the hydrographic net, require effective treatment technologies to separate the radio-elements from waste effluents. During the last years specialists from VOSTGOK (Zholty Wody), Chemistry Institute (Kiev), Institute of Industrial Technology (Zholty Wody) and SGS Kirovgeology designed a reliable and simple technology for purification of mining water. This technology is based on the process of co-precipitation uranium, natural radio-elements, beryllium and heavy metals with mixed collector by hydroxide magnesium and carbonate calcium. Advantage of this technology is the possibility to extend its by second stage - desalting of effluents up to necessary concentration. Second stage does not require essential changes of the process. All sediments which are created after purification are the material for secondary extraction of uranium. The technology was tested at one of the VOSTGOK mines. The achieved results have shown that effluents can be purified from radio-elements up to necessary requirements. According to proposed technology, treatment of radioactive contaminated mining water allows to exclude negative influents of uranium mining on the environment.

1. PURIFICATION SYSTEM: GENERAL CHARACTERISTICS

Mining water that is pumped from uranium mines of VOSTGOK belongs to calcium-magnesium, sulphate-hydrocarbonate class. Average contents of calcium and magnesium are 200 and 100 mg/l accordingly, and average contents of sulfate and carbonate are 600 and 250 mg/l.

As a principal technology, the proposed method was to purify waste effluents based on the separation of uranium, natural radio-elements, beryllium and heave metals with mixed collector by hydroxide magnesium and carbonate calcium. As calcium and magnesium are the usual part of mining water it does not require additional materials for creating the collector. Calcic is used as a precipitant.

Working control after the technological scheme is made by gauges for the parameter as follows:

- consumption of mining water coming for purification, consumption of calcic solution,
- dosing of calcic solution,
- controlling of pumps, vacuum filters and settling tanks,
- control of purified water by pH meters.

The productivity of the purification system is 500 m^3 of water per hour.

2. DESCRIPTION OF TECHNOLOGICAL PROCESS

Please see principal equipment and technological schemes in Figures 1 and 2.

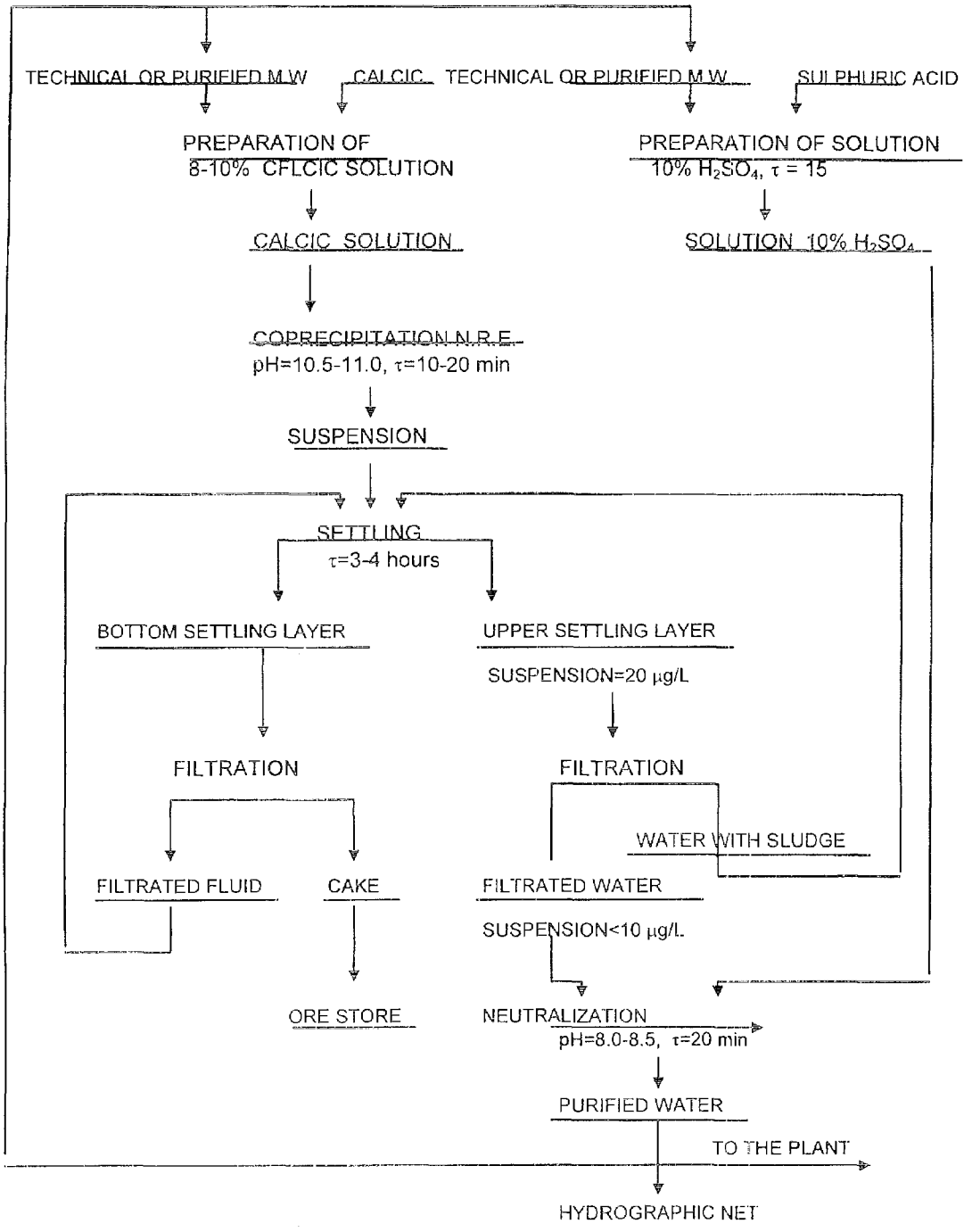

FIG. 1. Technological scheme for purification of mining water.

Technological process of purification mining water has a operations as follows:

- preparation of 8-10% calcic solution,
- preparation of 10% sulfuric acid solution,
- co-precipitation of uranium and natural radio-elements by calcic treatment of mining water until pH = 10.5 - 11.0.
- separation from water the creating sediments and suspended material by settling,
- filtration of bottom settling layer - thickened sediments,
- filtration of upper settling layer - light water,
- neutralization of purified mining water until pH = 8.0 - 8.5.

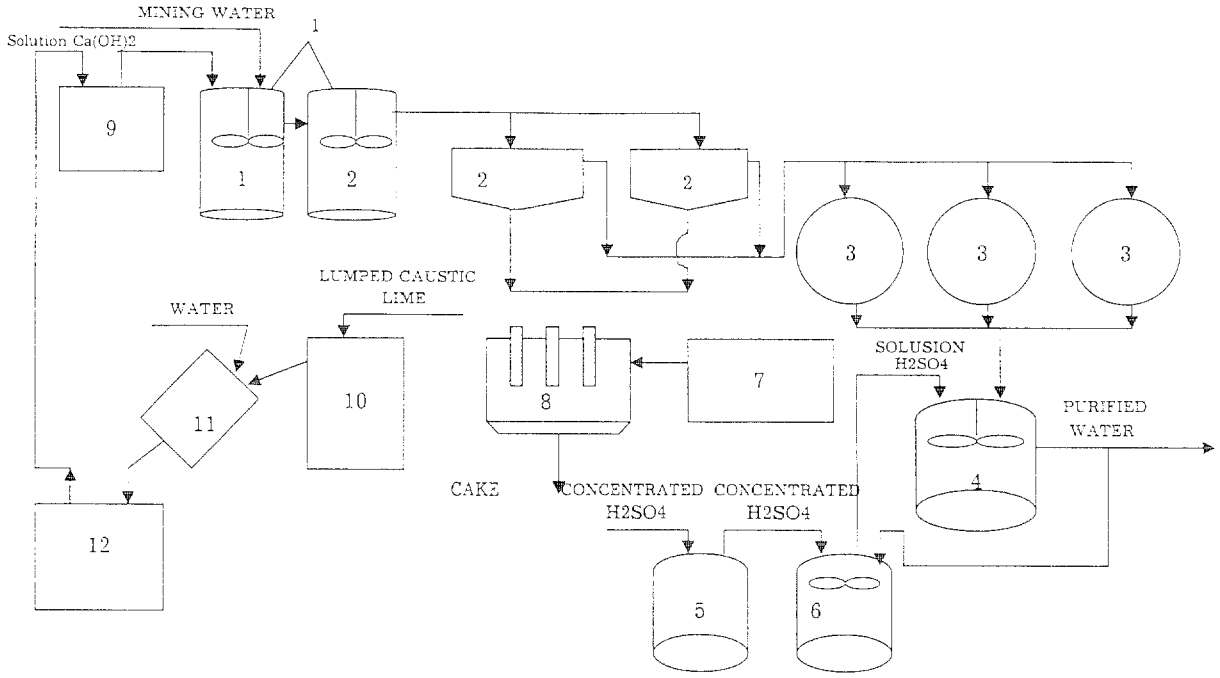

FIG. 2. Principal equipment scheme for purification of mining water.
1) mixers for co-precipitation of uranium and NRE; 2) settling tanks; 3) sand filters; 4) neutralization tank; 5) tank for storing H_2SO_4 concentrated; 6) tank for preparation 10% H_2SO_4 solution; 7) tank for accumulating heavy sediments; 8) disc filter; 9) tank for calcic solution; 10) tank for slaking of calcic; 11) classificator; 12) tank for preparation of 10% calcic solution.

3. STORING AND PREPARATION OF WORKING SOLUTIONS AND REAGENTS

Sulfuric acid is transported to the unit into the stainless still tank. Volume of the tank is 2 - 6 m^3. Acid has a concentration 92.5 - 94.0%. Acid is discharged into the stainless still tank (5) (see Figure 2). From tank (5) acid is going into the tank (6) which is filled, by technical water or purified mining water. After the mixing by mixer or air jets during the 10 - 15 minutes the solution is ready for using. From tank (6) solution is going into the tank (4) for correction pH of purified mining water.

Calcic solution. Lumped caustic lime is transported to the unit by railway or trucks. Depends on the type of calcic, calcium- and magnesium oxide contents are not less than 85.0%; 70.0%; 60.0% if the calculations are done on the dry material. Discharging of calcic is made into the storing tanks by water jets. Slaking of lime and preparation of calcic solution are made in the tank (10) and classificator (11). After that solution goes into the concrete tank (12) for finding till concentration 8 - 10%. For mixing of lime milk circular pumps are used, same pumps are pumping the ready product to the distribution tank (9). Tank (9) has air jets for mixing and equipped by airlift for supplying calcic solution to the mixers (1). While the mixture is consumed from tank (12) it refills from storing tank.

4. MIXING

Mixing of mining water and calcic solution is made in the mixers (1). Mining water is pumped into the mixer (1 (1)) and 10% lime milk is pumped from tank (9). From the mixer (1(1)) solution comes into the mixer (1(2)). It must be equal distribution of calcic solution in the treated water. That gains by mechanical mixing. Volume of mixers calculated to obtain the proper blending of water and lime milk during 10 - 20 minutes. From the mixer (1(2)) treated water comes into the settling tanks(2).

5. SETTLING

Separation of sludge and sediments of mineral salts created after reagent treatment are made by precipitation of mining water in the settling tanks (2).

Suspensions which appeared during the treatment of mining water are not homogenous and have different density. Therefore the time of settling in the tanks must be not less than 3-4 hours.

Upper settling layer - light water, with content of suspended particles not more than 20 mg/l, goes for filtration.

Bottom settling layer is pumped into the tank (7).

6. FILTRATION OF BOTTOM SETTLING LAYER

Bottom sediments are the thickened sludge and settlings of mineral salts are filtrated on the disk vacuum filter (8).

Filtration is made when the sediments accumulated but not less than once per day. Cake of filtration goes into the special container and transported to the ore store.

7. FILTRATION OF UPPER SETTLING LAYER

Purification of upper settling layer is made by filtration through sand filters (3). From the three filters two of them are working one in reserve. Sand filters are formed from washed river sand fraction 0.8 - 1.8 mm and the bottom layer from gravel fraction 2 - 40 mm. Water coming for filtration must not content suspension more than 20 mg/l and after filtration content of suspension must be 8-10 mg/l. After filtration water goes for neutralization.

Time to time during filtration sand is blocked by suspended material that decrease the effectiveness of filtration. Therefore sand filters periodically (once per day) are regenerated by return water-air flow. Time of washing 5-6 minutes. After regeneration washing fluid with suspension (concentration up to 10 mg/l) are pumped into the settling tanks (2).

8. NEUTRALIZATION OF WATER AFTER SAND FILTERING

Water, purified on the sand filters, contents suspended material max 10.0 mg/l. This water pumps into the tank (4). Solution of sulfuric acid, with concentration 10.0%, pumps into the same tank from tank (6). After mixing during 10 - 20 minutes purified water goes to the plant for using and rest goes to the hydrographic net.