IMC Invest

Kamushanovskoye U deposit - Hydro-Metallurgy and Technology of U extraction

Details of the pilot testwork at Kamushanovskoye

In the summer of 2015, a programme of detailed testwork was carried out to assess the possibility of in-situ recovery or in -situ leaching of uranium (ISR) with subsequent sorption operations for ion exchange, desorption and the production of “yellow cake”. Preliminary hydrogeological studies performed on two boreholes showed satisfactory filtration properties of uranium-bearing peat: the average filtration factor K was 1.76 m/day with fluctuations from 0.30 to 2.18 m/day. As a result of laboratory studies on percolation leaching of uranium by solutions of sulfuric acid, carbonates and bicarbonates of sodium and ammonium, the carbonate leaching regime was selected, viz. (Na2CO3) via chloride-carbonate solutions (soda). In choosing the location of the site for conducting experiments to determine the main filtration parameters of ore-bearing peat bogs and the experimental cell for carrying out field experiments on leaching, the main criteria were the lithological structure of the section and its thickness, the average content of the extracted useful component and the expected filtration properties of the ore-bearing sediments. The southern zone of uranium-bearing peatlands at Kamushanovskoye was chosen as the main one, being the most studied, where the resources are estimated according to the Measured category (2012). It is from this part of the deposit that first production is planned.

The leaching process

The process of uranium in situ leaching included:

The leaching solutions of soda are delivered at a given concentration to the peat deposit through a solution delivery system comprising trenches and boreholes. The system includes methods for subsoil saturation, control of solution movement and subsequent recovery of pregnant (uranium-containing) solutions to the surface, based on the hydrogeological features of the deposit; leaching of uranium occurs as the leaching solutions move from the delivery system to the recovery system by pumping; recovery to the surface of pregnant solutions is achieved through a system of pumps (trenches and boreholes); extraction of uranium from the pregnant solutions to the sorbent; making up of the leaching liquors with soda and returning them to the deposit for further leaching.

The experimental cell was a closed isolated rectangle with dimensions of 8x15 m. On the perimeter of the cell, an excavator traversed an annular trench with a depth of 2.5-2.6 m and a width of 280 mm. The depth of the trench was determined by the thickness of the peat. The trench was excavated across the peat strictly to the surface of the underlying alluvial sediments (clay, sand, gravel). To control the depth of the excavation, boreholes were drilled at the corners of the trench to accurately measure thickness of peat. After excavation, the outer wall and the bottom of the trench were insulated by a 0.1- 0.2mm thick, polyethylene film. To lower the insulation into the trench, steel bolts were attached to the film to prevent it from floating and to increase its weight. The film was held in place at the outer side of the trench by the peat recovered from the trench during excavation. After draping the outer wall of the trench with the film, perforated pipes with of 110 mm diameter were installed at the corners and in the middle of the long sides of the trench, to act as recovery wells. In the center of the cell, a delivery well was constructed.

Before the tests, all wells were flushed to clean water. The pumped water was discharged into the nearest drainage channel. When flushing was finished and after the water level became static in all wells, a submersible pump was turned on at the maximum flow at the central (recovery) well to fill the buffer tank and tanks (IBC containers) for mixing of solutions. The pumping continued until the water level in the central well dropped to the bottom of the peat deposit. At the same time, excess water was also discharged to a nearest drainage channel. The flow rate (flow) of water from the central well was adjusted so that the dynamic water level in the well stabilized at the level of the bottom of the peat deposit - 2.7 m. The discharge rate was 0.8 m3/h, while the pH = 7.60, measured by the ionomer Hanna HI 8314 with a temperature compensator.

During the tests, the delivery of leach solutions into cell was carried out through 6 injection wells. The injection rate was measured by a calibrated vessel and a stopwatch for each well by summing of partial measurements. Leaching solutions were evenly distributed along the wells by valves. The injection rate was held at 0.8 m3/ h, i.e. delivery and recovery systems were in balance. Concentration of soda in the leaching solution was maintained at 30 kg/m3. The injection and recovery of leaching and pregnant solutions continued non-stop. The pH was measured in the pregnant solutions every 3 hours. In addition, twice a day, at 9:00 and 21:00, samples of the pregnant solutions were collected to measure the residual concentration of soda as well as the concentration of uranium. The pregnant solutions were sent to a sorption column loaded with ion-exchange resin AB-17-8. The sorbent was in a swollen and saturated state. The weight of the ion-exchange resin loaded into the column was 42kg, or 21kg of dry weight. The pregnant solution moved from the bottom to the top of the column.

After 24 hours of testing, concentrations of uranium of 4.13mg/dm3 were detected, the concentration of soda was 8.5mg/dm3, pH = 9.5.

Subsequently, the concentration of uranium rose steadily and reached 11.81mg /dm3 on day 3 of the test. At the same time, the hydrogen index of the solution reached 10.2. In total, 168m3 of pregnant solutions (PR) with an average uranium content of 13.66mg/dm3 were recovered to the sorption column during the experiment. In total, 1.9kg of uranium was recovered onto sorbent at a rate of 0.19 kg/day. The content of uranium in the sorbent was 58.3 kg/t (dry) or 42 kg/m3 (wet). These data are close to the total dynamic exchange capacity (PDOE) of the anionite AB-17-8.

Desorption of uranium was carried out with a solution of ammonium nitrate at a concentration of 2M. The generated strippant had a content of uranium 4.6 g/dm3 . The recovery of uranium into the strippant was 98.1%. To produce the "yellow cake", peroxide precipitation was chosen, because the solubility of ammonium-uranyl tricarbonate is about 13 g/dm3 (6 g/dm3 for uranium), and uranium peroxide is practically insoluble.

As a result, the following concentrate was produced: the uranium content - 60%; Fe <170ppm; Cu<60 ppm; Zn <250ppm. Other elements were not detected.

Conclusion:

The principal possibility of using this method for mining deposits of this type is demonstrated and proven. The method of in situ leaching of U from ore of the Kamyshanovskoye U deposit is considered the most economical.

Extensive and detailed research of the U extraction from peat was carried by numerous scientists in USA, Europe and Russia.

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