TECHNIQUE AND TECHNOLOGY OF THE MAIN IN-SITU LEACHING METHODS AND TECHNIQUES

Gulnoza Azamatovna Makhmudova
Doctoral student at Tashkent State Technical University

ABSTRACT

The paper presents the technique and technology of in-situ leaching mining, as well as the basic technological scheme of in-situ leaching. The technological parameters of uranium mining are calculated. Three variants of calculation of technological parameters of in-situ leaching development are proposed.

Key words: mineral, in-situ leaching, technology, technique, uranium, ore, geotechnological wells.

INTRODUCTION

The essence of in-situ leaching (ISL) of a mineral resource is the selective conversion of a mineral component to the liquid phase by controlled movement of the solvent through the ore in its natural state or through the solution prepared for dissolution and lifting of the metal-saturated solution to the surface. To this end, a chemical reagent is injected through holes drilled from the surface into the ISL formation, capable of converting minerals of the mineral resource to a soluble form. The solution, having passed through part of the ore body, is brought to the surface through other boreholes and then piped to the processing facilities [1-4]. A schematic diagram of underground metal leaching is shown in Figure 1.

MATERIAL AND METHODS

Mining (geotechnological) complex - combines technical means, facilities and technological processes associated with the extraction of uranium productive solutions from the subsurface.

It includes:

- operating fields, sections, cells;
- technological, observation and control wells;
- internal technological pipelines and pumping stations;
- sumps and mixers;
- local sorption units (LSU);
- equipment for lifting solutions;
- control and process automation equipment;

- internal reagent facilities;
- external communications.

Processing facility - combines equipment, facilities and technological processes associated with the processing of productive solutions to produce final commercial products for a given enterprise.

It includes:

- technological (sorption-desorption) unit (SDU);
- compressor;
- reagent facilities;
- instrumentation and automation service;
- internal energy networks, roads.

In the case of monolithic, impermeable ores, leaching is carried out from the mine workings that have penetrated the PI formation. The rock mass that has been broken up by drilling and blasting is sprayed with solvent, which flows down and dissolves the minerals. Productive solutions are collected at the lower horizon and then pumped to the surface for processing [4,5].

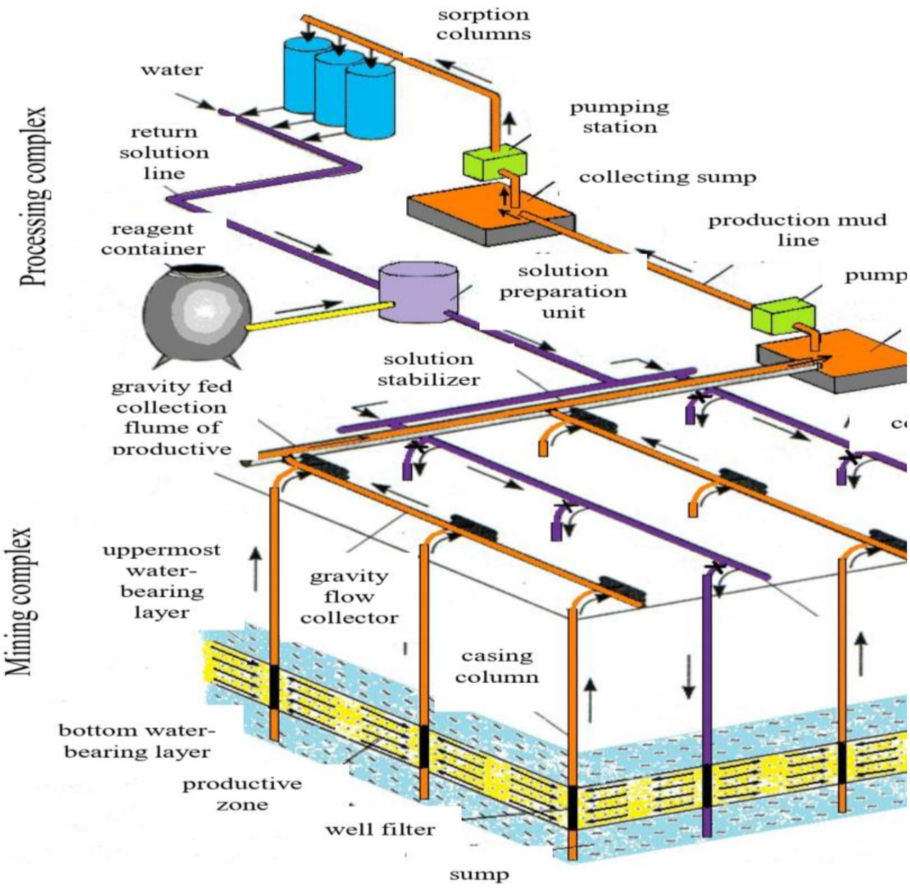

Figure 1. Schematic flow diagram of in-situ leaching

The most important natural prerequisites for in-situ leaching (ISL) are the ability of PI and its compounds to be converted into solution when the ore formation is exposed to a water solution of a leaching agent, and the ability of leaching solutions to filter into the rocks of the payzone.

The choice of solvent for ISL depends on the composition of the ores. The most widely used are aqueous solutions of acids (sulphuric, hydrochloric, nitric) or soda.

Ore-forming mineralization is located both on the surface of clastic grains and particles and also inside them. In this regard, depending on the composition of the host rocks, one or another method of uranium extraction from the subsurface is used.

ISL is used in the extraction of uranium ores, non-ferrous and rare metals (copper, nickel, lead, zinc, gold, etc.). There are prerequisites for using it in extraction of phosphates, borates etc.

The important factor for increasing the efficiency of mining by ISL method is the correct choice of a scheme of allocation of technological boreholes and distances between them. In the practice of field operation, a linear scheme of wells' arrangement is mainly applied, which represents an alternation of rows of injection and pumping wells. The distance between rows and wells in a row varies in a wide range (15-50 m and more). The most widespread scheme is 25x50 m. When ore is exposed to acidic, alkaline and bacterial solvents, the diameter of the borehole is determined by the size of the solvent lifting equipment (airlifts, submersible pumps, etc.) [6,7].

he choice of solvent for ISL depends on the composition of the ores. The most widely used are aqueous solutions of acids (sulphuric, hydrochloric, nitric) or soda.

Ore-forming mineralisation is found both on the surface of the clastic grains and particles and also within them. In this regard, depending on the composition of the host rocks, one method or another is used to extract uranium from the subsurface.

ISL is used in the extraction of uranium ores, non-ferrous and rare metals (copper, nickel, lead, zinc, gold, etc.). There are prerequisites for its use in extraction of phosphates, borates etc [8,9].

The important factor of increasing extraction efficiency using ISL method is the correct choice of process borehole pattern and distance between boreholes. In field operation practice, a linear scheme of well arrangement is mainly applied, which represents an alternation of rows of injection and extraction wells. The distance between rows and wells in a row varies in a wide range (15-50 m and more). The most widespread is the scheme of 25x50 m. At ISL ores by exposure to acidic, alkaline and bacterial solvents, the diameter of the borehole is determined by the size of the solvent lifting equipment (airlifts, submersible pumps, etc.) [9].

Depending on existing extraction unit designs, the final diameters of geotechnical wells range from 150 to 400 mm.

It should be noted that wellbore diameters of geotechnical wells should be determined taking into account the costs of drilling and production of the useful component.

It is known that with the decrease of wellbore diameter all the technical-economical indices of drilling increase - mechanical and running speeds increase, power inputs and working intensity of round-trip operations decrease, the cost of 1 m of drilling and borehole equipment decreases.

On the other hand, when production and hoisting equipment size increases, well productivity and production efficiency go up. Therefore, the criterion for the choice of borehole diameter is ultimately the cost of the ore extracted. It is necessary to strive for smaller sizes of mining equipment to be used for the same production capacity. This will reduce well diameters, drilling costs and, as a result, production costs.

CALCULATION OF TECHNOLOGICAL PARAMETERS FOR ISL DEVELOPMENT

For the calculations, we select an ore deposit located in the central area of the deposit - 11-2.

According to geological exploration on exploration line 100-4-1, the depth of the deposit is 450m, metal reserves of 55 tonnes, area productivity of 5.5kg/m^2, the area occupied by the deposit F=53525m^2.

Variant - I.

With the arrangement of injection and injection wells in a row (longitudinal rows), (Fig.2.2).

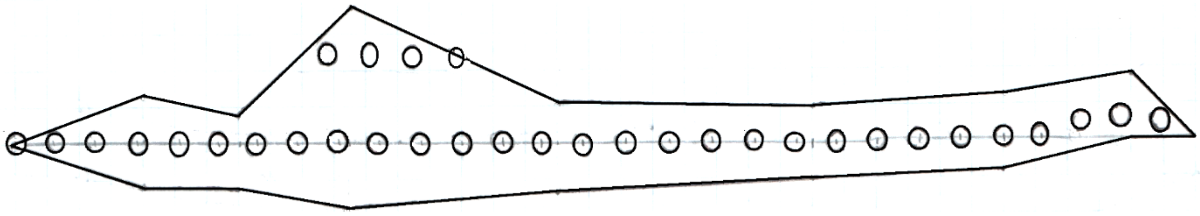

Figure 2. Diagram of the arrangement of the pumping and injection wells in a row.

1. Average metal concentration in productive solutions C_a (g/l).

$C_a=E \cdot P \cdot 10^3/W$;

$\beta=0.2$; $\upsilon_f=K_f \cdot I$; $I=0.24$

$\upsilon_f = 5m/d \cdot 0,24 = 1,2\ m/d.$

$Y_v = \upsilon_f \cdot \beta = 1,2m/d \cdot 0,2 = 0,24\ m/d.$

Solution to ore weight ratio

L:H $f = 0,6/\ \beta = 0,6/0,2 = \beta$

$W = W_m/\ d$ – solution volume m^3.

$W_m = f \cdot \rho \cdot F \cdot M$ – solution weight t

$W_m = 3 \cdot 1,6\text{т}/\text{м}^3 \cdot 53525\text{м}^2 \cdot 3,2\text{м} = 822144\ t.$

$W = 822144\text{т}/(1\text{т}/\text{м}^3) = 822144\ m^3.$

$C_a = 0,8 \cdot 55\text{т} \cdot 10^3/822144 = 0,054\ g/l.$

2) Total flow rate of pumped wells

$Q_e = (Me \cdot 10^3)/(C_a \cdot T)\ m^3/d$ T= 300 days

$Q_e = (55\text{т} \cdot 10^3)\ /\ (0,054 \cdot 300) = 3395\ m^3/d.$

3) The flow rate of one well pumped out.

$q = H \cdot b \cdot \upsilon_f\ m^3/d.$

The width of the flow of the boreholes moving to the pumping well is equal to the average width of the ore body b = 55m.

$q = 3,2 \cdot 55 \cdot 1,2 = 212\ m^3/d.$

4) Number of pumping wells working simultaneously N = (3395 m^3/d)/(212 m^3/d) = 16.

5) The distance between holes is determined by dividing the distance of the ore body by the number of all holes. N = 32 .

G = 1120m/32 = 35 m.

6) Duration of area worked per pumping well:

$t_o = (3 \cdot 1,6t/m^3 \cdot 3,2m \cdot 3345m^2)/1t/m^3 \cdot 212m^3/d = 242\ d.$

$F_o = 3345m^2$ area coming in per pumping well.

7) Time of occurrence of productive fluids in the wells.

$t_n = M \cdot n \cdot l \cdot b/q$ n = 0,3

$t_n = 3,2m \cdot 0,3 \cdot 35m \cdot 55m/212m^3/d = 8,75d = 9d.$

8) Total flow rate of unproductive solutions.

$Q_n = Q_e\ tn\ /\ t_o = (3395m^3/d\ \cdot 8,75d)/242d = 125m^3/d.$

9) Medium concentration (increased after diversion of unproductive solutions).

$C = Q_e\ C_a\ /\ (Q_e - Q_n) = [(3395m^3/d\ \cdot 0,054)/(3395m^3/d - 125m^3/d)] =$ 183,3/3270 = 0,056 g/l.

10) Solvent consumption.

$P_r = [((0.8 \cdot 55t)/55t) \cdot (3395m^3/d - 125m^3/d)(25g/l - 20g/l)]$ = 13080t.

11) The length of time the area to be assessed has been in operation.

$t = (3 \cdot 1.6t/m^3 \cdot 53525m^2 \cdot 3,2m)/3395m^3/d = 242d.$

Variant – II.

With injection wells along the contour and disposal wells along the axis of the orebody. (Figure 3)

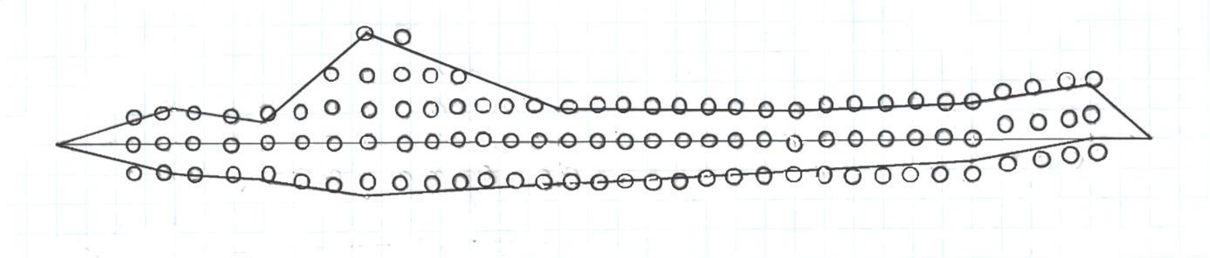

Figure 3. Layout of injection wells along the contour and disposal wells along the axis of the orebody

1) Flow rate per well pumped out.

$q = 3,2m \cdot 25m \cdot 1,2m/d = 96m^3/d.$

2) Number of pumping wells working simultaneously.

$N = (3395m^3/d)/(96m^3/d) = 36.$

3) Duration of area worked per pumping well: $F_0 = 1487m^2$;

$t_0 = (3 \cdot 1.6t/m^3 \cdot 3,2m \cdot 1487m^2)/(1t/m^3 \cdot 96m^3/d) = 238$ d.

4) Time of occurrence of productive fluids in the wells.

$t_n = (3,2m \cdot 0,3 \cdot 30m \cdot 25m)/96m^3/d = 7,5$ d.

5) The distance between holes is determined by dividing the distance of the ore body by the number of pumping holes. N = 36.

G = 1120m/36 = 30m.

6) Total flow rate of unproductive solutions.

$Q_n = Q_e t_n / t_o = (3395m^3/d \cdot 7,5d)/238d = 107\ m^3/d.$

7) Medium concentration (increased after diversion of unproductive solutions).

$C = Q_e C_a/(Q_e - Q_n) = [(3395m^3/d \cdot 0,054)/(3395m^3/d – 107m^3/d)] =$ 183,3/3288=0,056 g/l.

8) Solvent consumption.

$P_r = [((0.8 \cdot 55t)/55t) \cdot (3395m^3/d – 107m^3/d)(25g/l – 20g/l)] = 13152$ t.

Variant – III.

With the boreholes positioned in a cross formation along the strike of the ore body.

1) Flow rate of one well pumped out. (Figure 4)

$q = 3,2m \cdot 50m \cdot 1,2m/d = 192\ m^3/d.$

2) Number of pumping wells working simultaneously.

$N = (3395m^3/d)/(192m^3/d) = 18.$

3) Duration of area worked per pumping well: $F_0 = 2974m^2$;

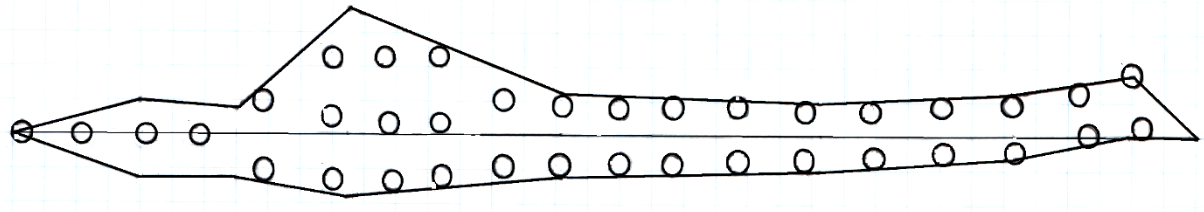

Figure 4. Cross-hole pattern along the strike of the ore body

$t_0 = (3 \cdot 1.6t/m^3 \cdot 3{,}2m \cdot 2974m^2)/(1t/m^3 \cdot 192m^3/d) = 238$ d.

4) The timing of the appearance of productive fluids in the wells.

$t_n = (3{,}2m \cdot 0{,}3 \cdot 30m \cdot 50m)/192m^3/d = 7{,}5$ d.

5) The distance between holes is determined by dividing the distance of the ore body by the number of all holes. N = 37.

G = 1120m/37 = 30m.

6) Total flow rate of unproductive solutions.

$Q_n = Q_e\, t_n / t_o = (3395m^3/d \cdot 7{,}5d)/238d = 107\ m^3/d$.

7) Medium concentration (increased after diversion of unproductive solutions).

$C = Q_e\, C_a/(Q_e - Q_n) = [(3395m^3/d \cdot 0{,}054)/(3395m^3/d - 107m^3/d)] = 183{,}3/3288 = 0{,}056$ g/l.

8) Solvent consumption.

$P_r = [((0.8 \cdot 55t)/55t) \cdot (3395m^3/d - 107m^3/d)(25g/l - 20g/l)] = 13152$ t.

Table.1

Geotechnological indicators

№	Name	designation	measurements	V_1	V_2	V_3
1	Metal concentrations in productive solutions.	C_a	g/l	0.054	0.054	0.054
2	Total flow rate of the wells.	Q_e	m^3/d	3395	3395	3395
3	Number of pumping wells working simultaneously.	N		16	36	18
4	Block duration per 1 well	t_0	d	242	238	238
5	Time of occurrence of productive solutions.	t_n	d	9	7.5	7.5
6	Solvent consumption and concentration.	V_r/C_r	t/g/l	13080 25	13150 25	13150 25
7	Dimensions of the rise and fall of the water level in the well.	H_Y	m			
8	Spacing of wells and rows.	σ/λ	м / м	35 / 55	25 / 30	30 / 50

CONCLUSION

Qualitative reduction of radioactive metal mining cost is possible only on the base of modern technologies of in-situ leaching well construction. One of the most important stages of the work was a complex technology of construction of in-situ leaching wells. Each in-situ leaching mining option calculated contributes to the individual area of the uranium deposit.

REFERENCES

1. Аренс В.Ж. Скважинная добыча полезных ископаемых (геотехнология). М.: Недра, 1986. –279 с.
2. Хчеян Г. Х., Нафтулин И. С. Геотехнологические процессы добычи полезных ископаемых. М: Недра, 1983. 221 с.
3. Истомин В.П. Особенности минерально-сырьевой базы и перспективы добычи урана в рудоуправлении №5.// Горный вестник Узбекистана. №14, 2003. С. 67-68.
4. Толстов Е.А., Толстов Д.Е. Физико-химические геотехнологии освоения месторождения урана и золота в Кызылкумском регионе. М.: Геоинформцентр, 2002.
5. Скрипко С.В. Простая геотехнология месторождения «Лявлякан». // Горный вестник Узбекистана. № 14, 2003.
6. Мамилов В.А., Петров В.А. и др. Добыча урана методом подземного выщелачивания. М.: Атомиздат, 1980.
7. Махмудов А. М., Худайбердиев Ш. М. Определение основных параметров энергоэффективности работы насосных установок в технологии подземного выщелачивания //Науч.-техн. и произв. журнал «Горный вестник Узбекистана».–Навоий. – 2012. – Т. 3. – С. 73.
8. Махмудов А., Курбонов О. М., Сафарова М. Д. Технические решения по совершенствованию монтажно-демонтажных работ погружных насосных агрегатов в условиях рудников ПВ //Горный вестник Узбекистана»(ISSN 2181-7383) Научно-технический и производственный журнал Выпуск. – №. 3. – С. 9-12.
9. Makhmudov A., Kurbonov O. M., Safarova M. D. Research of the pressure characteristics of the centrifugal water drainage plant of the WCP 25-60G brand //Australian Journal of Science and Technology, ISSN. – №. 2208-6404. – С. 279-282.