STUDYING THE EFFECT OF VARIOUS FACTORS ON THE PROCESS OF DISSOLVING LOW-GRADE SYLVINITE ORES IN TUBEGATAN MINE IN WATER

[1]Mavlyanov M.B., [2]Mansurov T.A., [3]Mansurov O., [4]Baxrullayeva M.O., [5]Shermatov X.Yu.
[1,2,3,4,5]Tashkent Institute of Chemical Technology Yangiyer branch
https://doi.org/10.5281/zenodo.11367725

Abstract. *The purpose of the research: chemical composition of Tubegatan mine potash minerals, norms and control of insoluble parts (adsorption), colloid physical and mechanical physical properties, influence of solvent: sylylvinite ratios, degree of evaporation, crystallization stages and other investigations. Based on the obtained results, the composition of potash minerals, the amount of insoluble parts and calculation (adsorption), colloid physicist and mechanical physical properties, depending on the influence of the solvent: sylvinite ratio, the kura complex was proposed.*

Keywords*: low-grade sylvinite, fraction, strength, anhydride, potassium chloride, sodium chloride, insoluble part, deliming.*

Today, special attention is paid to attracting low-grade potassium ores to the processing industry and creating processing technologies. In this regard, improving the technology of obtaining potassium chloride from low-grade sylvinites is one of the urgent tasks.

In this regard, to study the mineralogical composition of the low-grade potassium ores of the Tubegatan mine in our republic; theoretical analysis of the galurgy method of enrichment and conducting research in laboratory conditions; researching the effect of various technological parameters on product output and finding optimal conditions; study of rheological properties of solutions and solids formed in the process; development of a technological scheme for beneficiation of low-grade sylvinite ores by galurgy method; special attention is being paid to the development and technical-economic evaluation of the technology for obtaining NPK-fertilizers from the products and wastes generated during the enrichment process.

In our scientific work, the water solubility of low-grade sylvinite ores from the Tubegatan deposit was studied depending on the particle size, temperature, S:L ratio, and time. To study the effect of particle size on the kinetics of melting of low-grade sylvinite ores from the Tubegatan mine, the particle size is -10+7 mm; -7+5mm; -5+3mm; -3+1mm; -1+0.5mm sylvinite samples (Sample 1 (9.2% KCl) and Sample 2 (18.3% KCl)) were selected. Dissolution of the samples in water was carried out at a S:L ratio of 1:4 and a temperature of 25 and 80oC. The dissolution kinetics of the samples was investigated. The melting time was 2, 5, 10, 20, 30 minutes. The results of the study are presented in Tables 1 and 2 and Figure 1.

The obtained data show that the dissolution time of sample 1 at a temperature of 25oC is 2 minutes, and as the particle size increases from -1 mm to -10 mm, the solubility decreases from 54.4% to 17.5%, almost 3.1 times (1- table). When the melting time is increased from 2 to 30 minutes and the particle size increases from -1 mm to -10 mm, the solubility of sylvinite increases from 54.4 to 70.1% or from 17.5 to 59.1%, respectively.

The same pattern is observed in the melting of sylvinite sample 2. According to the obtained results, the melting time of sample 2 is 2 minutes, and the solubility decreases from 58.5% to 43.4%, almost 1.35 times, as the particle size increases from -1 mm to -10 mm (Table 1).

As the melting time increases and the particle size decreases, the solubility of sylvinite increases, while it can be seen that the solubility of sample 2 (18.3% KCl) with a higher potassium chloride content is higher than that of sample 1 (9.2% KCl). For example, the solubility of the -1+0.5 mm fraction of sample 1 in 2 minutes was 54.4%, while the solubility of sample 2 was 1.07 times greater under the same conditions.

According to the obtained results, as the temperature increased to 80oC, the solubilities of the samples increased as a result of the reduction of the particle size and the increase of the melting time (Table 3.3.2I). At 25oC, the maximum solubility of sample 1 was 70.1%, and when the temperature was increased to 80oC, this indicator increased to 88.5%, i.e. 1.26 times. The same situation was repeated in the 2nd sample, when the particle size was -1+0.5 mm and the dissolution time was 30 minutes, the solubility was 95.1%, which is 1.33 times greater than the solubility of the same fraction size and time at 25 ^{o}C.

1 - table

Dependence of the kinetics of dissolution of low-grade sylvinite ores at 25 ^{o}C on particle size

№	Particle size, mm	Dissolving time, minutes				
		2	5	10	20	30
		Solubility,%				
Sylvinite (9,2 %KCl)						
1	-10+7	17,5	28,9	31,8	54,3	59,1
2	-7+5	36,2	43,9	48,3	58,5	60,4
3	-5+3	42,6	47,2	52,9	61,5	65,5
4	-3+1	51,2	61,1	64,6	65,8	67,4
5	-1+0,5	54,4	65,5	68,8	69,7	70,1
Sylvinite (18,3 % KCl)						
1	-10+7	43,4	45,9	50,3	55,2	61,5
2	-7+5	45,8	47,3	53,9	60,8	62,1
3	-5+3	49,7	53,8	56,1	63,4	66,6
4	-3+1	54,2	64,2	67,6	69,1	69,4
5	-1+0,5	58,5	67,6	69,7	71,3	72,1
Melting temperature, 25^{o}C						
S:L ratio = 1:4						

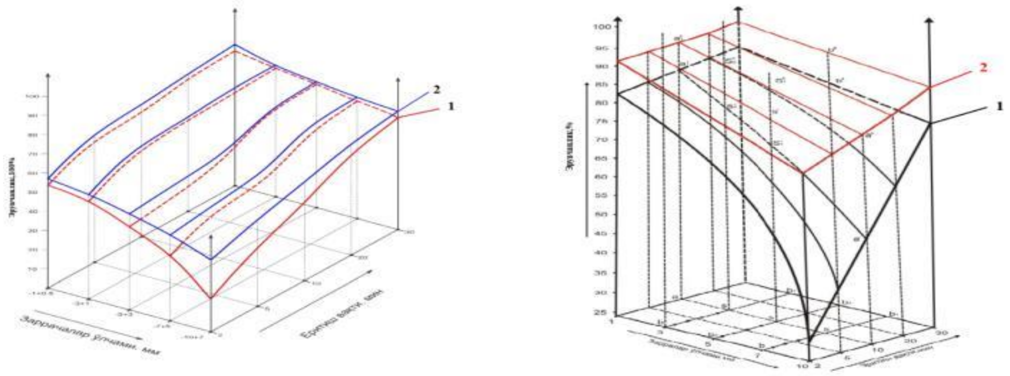
2 – table

The dependence of the kinetics of melting of low-grade sylvinite ores at 80 °C on the particle size

№	Particle size, mm	Dissolving time, minutes				
		2	5	10	20	30
		Solubility, %				
Example 1 (9,2 % KCl)						
1	-10+7	29,2	44,5	47,8	76,3	79,1
2	-7+5	59,4	66,9	73,2	76,5	79,4

3	-5+3	68,7	67,2	78,9	81,5	84,5
4	-3+1	81,1	82,1	83,6	84,8	87,4
5	-1+0,5	83,4	84,4	85,8	86,7	88,5
Example 2 (18,3 %KCl)						
1	-10+7	72,3	73,9	82,3	83,2	89,5
2	-7+5	74,4	75,3	82,9	83,8	90,1
3	-5+3	81,6	82,8	84,1	85,4	91,6
4	-3+1	82,2	84,2	84,6	87,4	92,4
5	-1+0,5	92,5	93,6	93,7	94,3	95,1
Melting temperature, 80°C						
S:L ratio = 1:4						

A nomogram was proposed to ensure that it was convenient to determine the intermediate solubility of technological parameters during technological calculations (Fig. 1). This nomogram makes it possible to predetermine the influence of technological factors on the melting process of sylvinite particles of different sizes.



a) t=25°C ***b) t=80°C***

1- Nomogram. Dependence of the kinetics of dissolution of low-grade sylvinites on particle size: sample 1 (9.2% KCl), sample 2 (18.3% KCl)

Different solubility of raw materials at different temperatures is one of the most important factors in the process of galurgic enrichment, and it is important to study the effect of different Q:S ratio and melting time on the degree of melting in a wide range of parameters. For this purpose, Tubegatan mine low-grade sylvinite samples (Sample 1 (9.2% KCl) and Sample 2 (18.3% KCl)) with water solubility S:L ratio 1:2, 1:4, 1:6 and temperature It was done at 60, 80, 100oC, particle size -5 mm. The melting time was 15, 30, 45, 60 minutes. The results of the study are presented in Table 3.

The nomogram shows the change in dissolution kinetics with increasing S:L ratio, dissolution time, and temperature. As can be seen from the nomogram, the solubility of the samples increases with the increase in temperature, for example, the melting time is 15 minutes, the S:L ratio is 1:2, and as the temperature increases from 60 to 80 °C, the solubility in sample 1 increases from 68.7% to 77.0%, in sample 2 and in the sample it was found that the solubility increases from 80.20% to 81.10%.

Increasing the dissolution time also causes an increase in solubility. In the range of parameter changes, for example, when the S:L ratio is 1:2, the temperature is 100°C, and the melting time is increased from 15 to 60 minutes, the solubility of sample 1 increases from 77.0% to 82%, while the solubility of sample 2 increases from 81.10% to 87%. , increases to 90%.

When the influence of the S:L ratio on solubility was studied, it was found that the solubility also increases with an increase in the proportion of the liquid phase in the system from 1:2 to 1:6, for example, an increase in the proportion of the liquid phase in the system from 1:2 to 1:6 at a temperature of 100 ^{0}C and a melting time of 15 minutes with, the solubility of sample 1 increases from 77% to 90%, i.e. 1.16 times, and the solubility of sample 2 increases from 81.10% to 96.60%, i.e. 1.19 times.

This difference decreases with increasing duration of solubility, after 60 minutes the difference of solubilities at 100 ^{0}C is 1.5% in sample 1, which is 0.11 times smaller than at 15 minutes, and in sample 2 the difference of solubilities is 9.1%. which is 0.61 times smaller than 15 minutes.

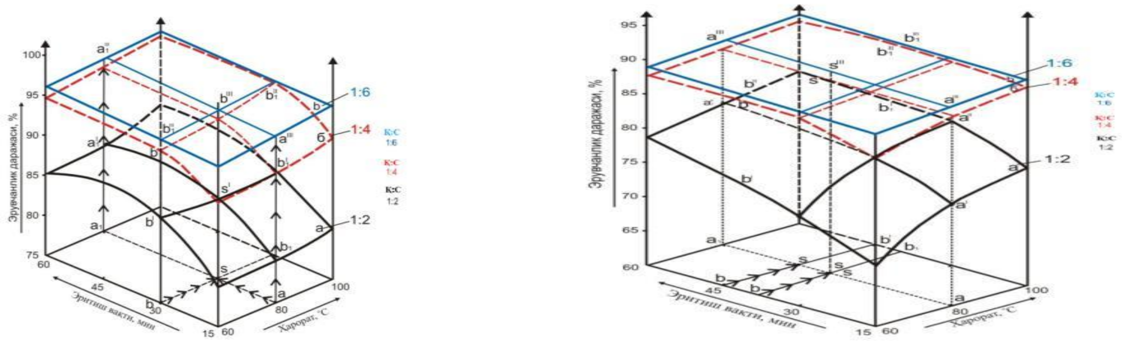
Using these nomograms, it is possible to predict the percent increase in solubility in samples after a certain time at a given temperature and S:L ratio. For this, we draw a parallel line a-a1 from the given temperature to the time axis. We draw a line parallel to the coordinate axis, that is, perpendicular to the temperature axis, from the found points α-α1.

3-table

Effects of S:L ratio, temperature, and melting time on the dissolution kinetics of low-grade sylvinite ores

№	S:L ratio	temperature, °C	Dissolving time, minutes			
			15	30	45	60
			Solubility, %			
Example 1 (9,2 % KCl)						
1	1:2	60	68,7	71,5	73,4	78,7
2		80	75,0	79,5	80	80,5
3		100	77,0	81,0	81,2	82,0
4	1:4	60	84,13	87,1	87,3	87,5
5		80	87,7	88,0	88,2	88,5
6		100	88,8	89,3	89,4	89,5
7	1:6	60	88,0	88,2	88,5	88,8
8		80	89,4	89,9	90	90,2
9		100	90,0	90,2	90,4	90,5
Example 2 (18,3% KCl)						
1	1:2	60	80,20	84,15	84,90	85,00
2		80	80,50	85,00	85,20	85,51
3		100	81,10	85,20	86,10	87,90
4	1:4	60	90,44	94,05	94,20	94,60
5		80	91,26	95,26	95,40	96,00
6		100	92,88	95,60	95,80	96,40
7	1:6	60	95,00	95,44	95,60	96,00
8		80	96,30	96,56	96,65	96,78
9		100	96,60	96,88	96,91	97,00

From the points of intersection of the curves showing the dependence of temperature on the solubility surfaces (1:2, 1:4, 1:6), i.e. a^{1}, a^{11}, a^{111} and, respectively, points a^{11}, a^{111}, a^{1111}, corresponding to the solubility curves over time we connect, that is, we get the curve of the change of the degree of solubility with the change of time at the given temperature.



a) ***b)***

2 - Nomogram. Nomogram for determination of S:L ratio, duration of melting time and temperature effect on the degree of melting of Tubegatan mine low-grade sylvinite samples: a) sample 1; b) Example 2

From the curve at this temperature, we draw a line parallel to the temperature axis from the given time to find the degree of solubility at a certain time interval (b-b1). We draw a line parallel to the solubility coordinate axis from point S, the point of intersection of b-b1 and a-a1 lines. We determine the intersection points of this line with the solubility curve at a certain Q:S ratio and temperature, points S^{1}, S^{11}, S^{111}. The available S-S^{1}, S-S^{11}, S-S^{111} shears indicate the degree of solubility at a given temperature, solubility duration, and S:L ratio, respectively.

Thus, the experiments conducted to study the effect of S:L ratio, melting time, and temperature on the process of dissolving low-grade sylvinite samples in water showed that the S:L ratio is from 1:2 to 1:6, the temperature is from 60 to 100°C, and the melting time is from 15 to 60 minutes. showed an increase in the degree of solubility with the change.

REFERENCES

1. Ибрагимов Г.И.,Эркаев А.У., Якубов Р.Я.,Туробжонов С.М. Калий хлорид технологияси. –Т.; 2010. – 200 б.
2. Sokolovskiy A.A., Unaniants T.P. Kratkiy spravochnik va mineralnym udobreniyam [A short guide to mineral fertilizers]. Moscow, Khimiya Publ., 1987. 120p.
3. Adilova M.SH., Bayrayeva D.A., Erkayev A.YU., Bukhorov SH.B., Mavlyanov M.B. Intensifikatsiya tekhnologii flotatsionnoy kontsentratsii silvinitov tyubegatanskogo mestorozhdeniya [Intensification of flotation concentration technology of sylvinites of the tyubegatan deposit]. Universum: Texnicheskiye nauki,, 2019, no.10, pp. 30-34.
4. Mirzakulov X.Ch., Mamajonova L.A., Isakov A.F., Kalanov G.U. Issledovaniya po intensifikatsii protsessov fil-tratsii kontsentrata chlorida kaliya i galitovyx xvostov silvinitov Tyubegatanskogo mestorojdeniya [Research on the intensification of processes of a filtration of the concentrate of potassium chloride and halite tailings Tubegatan syl-vinite deposits]. Universum: Texnicheskiye nauki ,, 2019, no.7, pp. 30-34.
5. Aleksandrovich K.M. Osnovy primeneniya reagentov pri flotatsii kayliynykh rud [Basics of using reagents in the flotation of potassium ores]. Minsk, Science and technology, Publ, 1993, 78p.

6. Isayeva G.A., Mineralniy-texnologicheskiy svoystva silvinitov Tyubegatanskogo mestorojdeniya [Mineral-technological properties of sylvinites of the Tyubezhatan deposit]. Vestnik Permskogo universiteta. publ., 16.pp 264-274.
7. Turakulov B.B., Erkayev A.U., Kucharov B.X., Toirov Z.K. Physical-chemical and Technological Bases of Producing Pure Potassium Hydroxide in Combined Method. International Journal of Advanced Science and Technology, 2020, vol. 29, no. 6s, pp. 1126–1134. http://sersc.org/journals/index.php/IJAST/article/view/9205/5089
8. Adilova M.SH., Bayrayeva D.A., Erkayev A.YU., Bukhorov SH.B., Mavlyanov M.B. Intensifikatsiya tekhnologii flotatsionnoy kontsentratsii silvinitov tyubegatanskogo mestorozhdeniya [Intensification of flotation concentration technology of sylvinites of the tyubegatan deposit]. Universum: Texnicheskiye nauki,, 2019, no. 10, pp. 30-34.
9. Эркаев А.У., Адилова М.Ш., Мавлянов М.Б. Тюбегатан кони шахтаси ангидридли сильвинитларини қайта ишлаш жараёни тадқиқоти// Композицион материаллар, №4. 2020. 112-115 б.
10. Мавлянов М.Б., Адилова М.Ш., Эркаев А.У. Изучение влияния технологических параметров на процесс кристаллизации хлорида калия // Узбекский химический журнал, 2022. №3. 20-28 б. http://www.uzchemj.uz
11. Мавлянов М.Б., Адилова М.Ш., Эркаев А.У. Изучение процесса получения хлорида калия галургическим способом из сильвинита Тюбегатанского месторождения //«Universum:технические науки» Выпуск:11(104) ноябрь, 2022. С.30-38.