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The Study of the Concentration Process, the Brine Lakes Karaumbet and Barsakelmes

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ABSTRACT: The processes of concentration of brine from lakes Karaumbet and Barsakelmes and the effect of cooling temperature on the composition and properties of pulp and mother liquors have been investigated. The parameters at which it is possible to isolate practically pure sodium chloride without precipitation of other salts and obtain solutions with a content of 15-19.5% magnesium chloride have been determined.

KEY WORDS: Brine, Sodium And Magnesium Chlorides, Concentration, Crystallization, Filtration, Density, Temperature, Sediment.

I. INTRODUCTION

One of the main directions of economic development of the Republic of Uzbekistan is the development of natural resources, their integrated use and the creation of competitive, import-substituting products based on local raw materials with high added value [1-2].
The rapidly developing economy of the Republic consumes more and more mineral resources, including magnesium compounds. Uzbekistan has significant reserves of mineral raw materials for the production of magnesium compounds, such as dolomites, dry mixed salts and brine from lakes Karaumbet and Barsakelmes [3].

II. LITERATURE REVIEW

Despite the great need for magnesium compounds and the presence of a powerful raw material base, they are not produced in the Republic and are imported from abroad. This is primarily due to the lack of an acceptable technology for processing dolomites, dry mixed salts and brine. Therefore, studies aimed at developing a technology for processing brine from lakes Karaumbet and Barsakelmes with the release of the most pure sodium chloride and obtaining concentrated solutions of magnesium salts are an urgent problem that needs to be addressed.
The great need of the Republic for magnesium compounds, the availability of raw materials poses a problem for the country's scientists to involve them in the processing process and create on their basis new industries for the country - sodium and magnesium chlorides.
In previous studies, the results of evaporation and winter cage of brine from lakes Karaumbet and Barsakelmes in natural conditions were presented [4]. The processes of summer evaporation and winter cage of sodium sulfate from brine, in order to obtain more concentrated solutions of sodium and magnesium chlorides, are very long. Therefore, the purpose of further research was to identify the conditions for the concentration of brine from lakes Karaumbet and Barsakelmes in production conditions with the release of the purest possible sodium chloride and obtaining the most concentrated solution of magnesium chloride from natural brines without a stage of their preliminary purification.

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III. RESEARCH METHODOLOGY

The brine of the Karaumbetlake was used for the research. %: Na^+ - 8.01; Mg^{2+} - 3.27; Cl^- - 17.70; SO_4^{2-} - 6.66 and brine from lake Barsakelmes composition, wt. %: Na^+ - 8.90; Mg^{2+} - 2.77; Cl^- - 16.90; SO_4^{2-} - 4.21. In order to identify the regularities of changes in the composition of brine during the concentration, cooling of one stripped off brine and to establish the optimal technological parameters for cleaning brine by precipitation of salts from brines, studies were carried out on the concentration of brine from lakes Karaumbet and Barsakelmes.

The brine was evaporated at a temperature of 90°C under a slight vacuum (40 mer.col.) and constant stirring. Upon reaching the predetermined density of the brine, it was cooled to temperatures of 40 and 20°C, the liquid and solid phases were separated by filtration at a vacuum of 400 mer.col. and analyzed for the content of the main components by known methods of chemical analysis, determining the density of pulps and mother liquors [5-8]. The composition of the solid phase was analyzed after drying at a temperature of 105-110°C for three hours without preliminary washing.

IV. ANALYSIS AND RESULTS

Changes in the composition of brine from lakes Karaumbet and Barsakelmes during concentration depending on the density of the suspension and when cooled to a temperature of 40 and 20°C are shown in tables 1 and 2.

As can be seen from table 1, when the brine of Karaumbet lake is concentrated with an initial density of 1.240 g/sm^3 to a suspension density of 1.550 g/sm^3 and cooling to 40°C, the magnesium chloride content in the liquid phase increases from 7.20% to 28.24%. In this case, the content of sodium ions decreases from 8.01% to 0.91%, SO_4^{-2} from 6.66% to 5.63%, the Na:Mg ratio from 2.45 to 0.13.

Table 1. Influence of the concentration process and cooling temperature on the composition of the brine of Karaumbetlake

№	$\rho_{pulp.}$, g/sm^3	Liquid phase composition, wt. %					Na^+:Mg^+	SO_4^{-2} sol. phasa
		Na^+	Mg^{+2}	Cl^-	SO_4^{-2}	$MgCl_2$,		
Cooling temperature 40°C								
1.	1.240	8.05	3.27	17.72	6.66	7.20	2.45	-
2.	1.295	5.08	3.78	18.45	6.98	15.08	1.37	-
3.	1.340	4.22	4.39	19.17	6.78	18.97	0.96	-
4.	1.360	4.39	4.23	20.56	6.67	19.78	1.04	0.28
5.	1.400	3.01	4,40	21.43	6.17	22.51	0.68	0.56
6.	1.450	1.85	6.42	21,17	5.95	24.51	0.29	1.07
7.	1.510	0.93	7.03	20.25	5.31	27.57	0.13	1.92
8.	1.550	0.91	7.20	20.13	5.63	28.24	0.13	2.67
Cooling temperature 20°C								
1.	1240	8.01	3.27	17.7	6.66	7,20	2,45	-
2.	1.295	5.07	3.54	18.1	6.62	13,51	1,43	-
3.	1.340	4.08	4.26	19.7	7.21	17,20	0,96	сл.
4.	1.360	4.22	4.13	19.1	7.44	19,04	1,02	0.36
5.	1.400	2.88	5.41	20.4	7.93	21,43	0,53	0.71
6.	1.450	1.91	6.39	20.4	6.60	24,78	0,30	1.12
7.	1.510	1.01	6.88	20.2	6.00	27,64	0,15	2.36
8.	1.550	0.96	7.00	19.9	5.72	28,98	0,14	3.54

At a cooling temperature of 20°C, these indicators are, respectively, for magnesium chloride 7.20-28.98%, for sodium ions 8.01-0.96%, for SO_4^{-2} 6.66-5.72% and for the Na:Mg ratio 2.45-0.14.

Table 1 shows that the composition of the brine of lake Karaumbet depends on the degree of its vaporization and does not depend on the temperature of its cooling. Chemical analysis of solid phases isolated from one stripped off brine from lake Karaumbet at a density of 1.51-1.55 g/sm^3 indicates the predominant content of sodium chloride and bischofite in the presence of insignificant amounts of sodium sulfate crystalline hydrates. Hence it follows that, in principle, it is possible to evaporate brine from lakes Karaumbet and Barsakelmes to 26-30% $MgCl_2$. However, in this

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case, in addition to NaCl, other salts precipitate, for example, Na_2SO_4, $CaSO_4$. This is evidenced by the appearance in the sediment of the sulfate ion along with Na^+ and Cl^-. The content of sulfates in the solid phase, with the concentration of brine, increases from 0.28-0.36% at a density of one stripped off pulp of 1.360 g/cm^3 to 2.67-3.54% at a density of 1.550 g/cm^3.

Changes in the composition of the liquid and solid phases of the brine of lake Barsakelmes from the vaporization depth (density of the liquid phase) at a cooling temperature of 40°C are shown in table 2.

The density of the liquid phase varied from the vaporization depth from 1.245 to 1.295 g/sm^3, which corresponds to a pulp density from 1.245 to 1.340-1.345 g/sm^3. The content of magnesium chloride increases from 10.9 to 16.8%, sodium ions decreases from 8.90 to 3.38%, SO_4^{-2} increases from 4.21 to 7.69%, and the Na:Mg ratio decreases from 3.21 to 0.79.

The solid phase isolated from the one stripped off brine sample from lake Barsakelmes when cooled to 40°C corresponds to almost pure sodium chloride. Magnesium chloride is present as an occluded liquid in sodium chloride. Its content does not imply 0.18%. Sulfate ions are completely absent (table 2).

Table 2. Influence of the concentration process on the composition of mother liquors and salt sediment of brine from lake Barsakelmes at a cooling temperature of 40°C

№	$\rho_{liq.ph.}$, g/sm^3	Liquid phase composition, wt. %					Na:Mg	Solid phase composition, wt. %		
		Na^+	Mg^{+2}	Cl^-	SO_4^{-2}	$MgCl_2$		Na^+	Mg^{+2}	Cl^-
1	1.245	8.90	2.77	16.9	4.21	10.9	3.21	38.93	0.13	60.83
2	1.246	6.40	2.97	12.9	4.66	11.6	2.16	42.56	0.15	57.30
3	1.276	6.20	2.97	15.9	4.68	11.6	2.09	43.41	0.11	55.20
4	1.290	5.01	3.72	13.9	6.01	14.6	1.35	43.60	0.15	54.90
5	1.295	4.44	4.46	15.8	7.58	17.5	1.00	43.30	0.18	54.90
6	1.288	3.38	4.29	15.7	7.69	16.8	0.79	38.93	0.13	57.30

Table 3 shows the results of the concentration of brine from Lake Barsakelmes in two stages. At the first stage, the initial brine was stripped to a suspension density of 1.38 and 1.40 g/sm^3, at the second stage, the liquid phase from the first stage, after separation of the precipitate, was evaporated to a density of 1.34-1.35 g/sm^3.

Table 3. Influence of the evaporation process on the composition of mother liquors and salt sediment of brine from lake Barsakelmes

№	$\rho_{susp.}$, g/sm^3	$\rho_{liq.ph.}$, g/sm^3	Liquid phase composition, wt. %					Solid phase composition, wt. %				$m_{sol.ph.}$, g
			Na^+	Mg^{+2}	Cl^-	SO_4^{-2}	$MgCl_2$	Na^+	Mg^{+2}	Cl^-	SO_4^{-2}	
I stage of vaporization												
1	1.245	1.245	8.90	4.60	16.90	4.21	10.62	-	wea.	-	-	-
2	1.345	1.295	6.01	5.24	14.60	6.21	14.95	38.46	wea.	49.72	wea.	7.67
3	1.380	1.27	5.55	6.41	14.97	7.10	15.13	40.17	wea.	50.33	0.94	16.45
4	1.400	1.30	4.12	8.53	15.40	7.15	20.14	42.21	wea.	49.05	1.72	26.70
II stage of vaporization												
5	1.340	1.296	3.90	8.27	16.12	6.87	19.54	39.35	wea.	48,92	wea.	6.70
6	1.350	1.297	3.68	8.18	14.73	7.33	19.35	37.10	wea.	50.63	wea.	2.28

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The results obtained indicate that when the brine is evaporated to a density of 1.34-1.35 g/sm^3, only sodium chloride is present in the sediment. Upon further evaporation of the liquid phase to a density of 1.38-1.40 g/sm^3, sulfates also precipitate. After the second step of evaporation to a brine density of 1.34-1.35 g/sm^3, only sodium chloride precipitates. Since from the technological point of view, the isolation of sodium chloride in the purest possible form is preferable, the concentration limit of brine in the first and second stages must be limited to a suspension density of 1.34-1.35 g/sm^3, which corresponds to the concentration of $MgCl_2$ on the 1st stage - 15-16% and the second - 19-19.5%. In this case, NaCl is released practically without impurities, with the exception of the liquid phase (occluded liquid) entrained by the precipitated NaCl. The amount of this liquid depends on the method of separating the solid phase (centrifugation, filtration, settling) and can be estimated at the stage of pilot testing.

VI. CONCLUSION

Thus, the studies carried out have shown that by concentrating the brine of the Karaumbet and Barsakelmes lakes, it is possible to obtain solutions of magnesium chloride with a content of 15-16% and practically pure technical sodium chloride without preliminary purification.

To obtain pure sodium chloride and more concentrated solutions of magnesium chloride (19-19.5%), brine must be evaporated in two stages. At the first stage, evaporate to a pulp density of 1.34-1.35 g/sm^3, followed by the separation of sodium chloride. The resulting mother liquor with a density of 1.29-1.30 g/sm^3 in the second stage is also evaporated to a pulp density of 1.34-1.35 g/sm^3. This precipitates almost pure sodium chloride. To obtain more concentrated solutions of magnesium chloride, the solutions, after the separation of sodium chloride in the first or second stages of evaporation, must be purified, since the mother liquors are enriched with sulfate ions, the content of which is strictly regulated [9].

Thus, the studies carried out have shown that the process of concentrating brine from lakes Karaumbet and Barsakelmes can be intensified under production conditions, and for this, the brine can be vaporized at temperatures close to boiling under vacuum. At the same time, at the first stage of concentration, sodium chloride with a purity of more than 98% can be isolated. On the basis of the above studies, it can be concluded that in order to accelerate the process of concentrating brine from lakes Karaumbet and Barsakelmes, the original, not purified brine must be vaporized to a concentration of magnesium chloride of 15-16%, separated crystals of sodium chloride, purified mother liquors from sulfate ions and only after This is to continue the evaporation process and obtain a relatively pure concentrated solution of magnesium chloride.

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