STUDY OF THE PROCESS OF EVAPORATION OF WATER IN THE ARAL SEA

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Abstract. *In this study, the rate of evaporation of Aral Sea salt water was studied to extract lithium compounds from the salt water of the Aral Sea. The investigation involved evaporating samples obtained from various concentrations of Aral Sea saltwater and subsequently analyzing each saltwater percentage and result after separating the liquid and solid phases, the contents of the precipitated solid phase and liquid phase were analyzed using an Atomic Absorption Spectrometer (Perkin-Elmer, AAS-30-UCA-690 Elan).*

Keywords: *evaporation, lithium recovery, precipitation, lithium chlorate, the system of salts, sodium chloride.*

INTRODUCTION

An alkali metal called lithium (Li) has a molecular weight of 6.939, a density of 0.534 g/cm^3, a high electrode potential of 3.05, a density of 0.534 g/cm^3, and an electrode weight of 6.939 [1-4]. Lithium compounds are attractive in several industries because of their properties. Not only are lithium and its compounds utilized in the production of glass, ceramics, batteries, and refrigerants, but they are also created during the aluminum manufacturing process and utilized as catalysts in the rubber, air conditioning, pharmaceutical, and drainage sectors [5].

Lithium is a rare element that is found in trace amounts in the crust of the planet [5-7]. The two primary types of lithium deposits are liquid and solid. Salt Lake brines, seawater, geothermal fluids, and secondary raw material deposits, including waste from the electronics sector and lithium-ion battery waste [8]. Around 70-80% of the world's Li deposits are found in the sea, salt lakes, geothermal, and oceanic water [5, 10].

Sea and ocean waters are not thought to be very useful for the industrial production of lithium, even though they contain around 2600 billion tons of lithium due to their low concentration of 0.1-0.2 ppm [13-18].

Lithium levels in geothermal waters range from 1 to 100 parts per million [9, 19]. Lithium processing and manufacture are hampered by the presence of various pollutants and significant levels of other metals in geothermal fluids [20].

Lithium concentrations in saline lakes vary from 100 to 1000 parts per million. Brine treatment is challenging due to the high concentration of contaminants, particularly magnesium [21]. In summary, all of this complicates the process of isolating lithium from natural fluids, particularly in the presence of significant quantities of alkaline and alkaline earth elements [22]. At the moment, mineral concentrates, specifically lithium carbonate and lithium hydroxide, account for 80% of the market [23]. Lithium carbonate is made by extracting and processing spodumene rows and brines from salt lakes [24]. This mineral is found in the rock known as pegmatite. These rocks contain one to four percent lithium, of which sixty to seventy percent has been removed [24]. Lithium carbonate may be made from spodumene as well as from other ores that are present in pegmatite rock [24]. Industrial processing of aqueous lithium solutions requires the depletion of lithium ores. Sea and ocean water, geothermal water, and brine from salt lakes are some of the water sources for lithium.

The republic's great need for lithium compounds and the presence of a powerful raw material base suggest the creation of new production facilities for processing salt water of the Aral Sea. The production of lithium compounds from the waters of the Aral Sea is relatively energy intensive due to the low lithium content. The most acceptable method from an economic point of view is the scheme with the precipitation of the main part of NaCl under natural or industrial conditions.

The paper focuses on the extraction of Li from aqueous solutions to facilitate the expansion of the lithium compound industry, which is distinguished by its cost-effectiveness, superior selectivity, minimal environmental impact, and straightforward technological solutions.

MATERIALS AND METHODS.

The intensity of evaporation of salt water of the Aral Sea was studied in laboratory conditions in a glass with a volume of 1000 ml. The percentage of water evaporation was measured at a temperature of about 100 ℃, after which the composition of the liquid and solid phases was analyzed. For research we used water from the Aral Sea with the following composition (wt. %): LiCl – 0.063%; NaCl – 12.02%; KCl – 0.61%; $CaCl_2$ – 0.19%; $MgCl_2$ – 3.49%; Na_2SO_4 – 3.69%; CC - 130.9; pH - 8.0.

RESULTS AND DISCUSSIONS.

The influence of the duration of the process on the degree of evaporation was studied and it was found that with the evaporation of 700.5 ml of water, the concentration of lithium chloride increased from 0.063% to 0.200%. At the same time, a white salt with a yellowish tint precipitated, and the density of the solution increased from 1.162 g/cm^3 to 1.351 g/cm^3.

Table 1 shows the results of the influence of the degree of water evaporation on the mineral composition of water in evaporated solutions, changes in density and the degree of precipitation of sodium chloride. An increase in the degree of water evaporation contributes to an increase in the content of potassium, calcium, magnesium and sodium chlorides in evaporated solutions. The content of potassium chloride increases from 0.61% to 2.03%, calcium chloride from 0.19% to 0.63%, magnesium chloride from 3.49% to 11.63%, sodium sulfate from 3.69% to 12.30% when the degree of evaporation is 70% of water, and the sodium chloride content increases from 10.27% to 14.67% when the degree of evaporation of 30% of water is achieved.

Table 1

Changes in the composition of Aral Sea water during the evaporation process

Water evaporation rate, %	Composition of the liquid phase (wt. %)						Density gcm^3	Deposition rate, NaCl, %
	LiCl	NaCl	KCl	$CaCl_2$	$MgCl_2$	Na_2SO_4		
0	0.063	10.27	0,61	0.19	3.49	3.69	1.162	-
10	0.065	11.41	0,67	0.21	3.87	4.10	1.170	-
15	0.070	12.08	0,71	0.23	4.10	4.34	1.177	-
20	0.075	12.83	0,76	0.24	4.36	4.61	1.198	-
25	0.080	13.69	0,81	0.25	4.65	4.92	1.201	-

30	0.085	14.67	0,87	0.27	4.98	5.27	1.218	-
35	0.092	14.48	0,93	0.29	5.37	5.67	1.232	1.51
40	0.100	14.31	1,01	0.32	5.82	6.15	1.259	3.22
45	0.109	14.15	1,10	0.34	6.34	6.70	1.267	5.03
50	0.120	14.01	1,22	0.38	7.01	7.38	1.269	7.54
55	0.133	13.89	1,35	0.43	7.76	8.20	1.287	10.32
60	0.150	13.79	1,52	0.47	8.72	9.22	1.305	13.76
65	0.171	13.70	1,74	0.54	9.97	10.54	1.325	18.14
70	0.200	13.63	2,03	0.63	11.63	12.30	1.351	23.93

When 30% of the water evaporates, the solution reaches saturation with sodium chloride and with further evaporation of the saturated solution, sodium chloride begins to precipitate.

When the degree of evaporation reaches 70%, a saturated solution containing 13.63% sodium chloride is formed.

The data obtained indicate that by evaporating water from the Aral Sea and adding sodium chloride, it is possible to increase the content of lithium chloride in the solution to 0.200% with a degree of water evaporation of 70%. In this case, 23.93% of sodium chloride is precipitated, and the solution contains, in addition to lithium chloride, sodium, potassium, calcium and magnesium chlorides.

Figure 1 shows data on the change in the chemical composition of the liquid phase when cooling evaporated solutions from 90 °C to a temperature of 20 °C, from which it can be seen that with decreasing solution temperature the sodium chloride content decreases from 13.63% at 90 °C to 12.98% at 20 °C, the content of other components remains virtually unchanged.

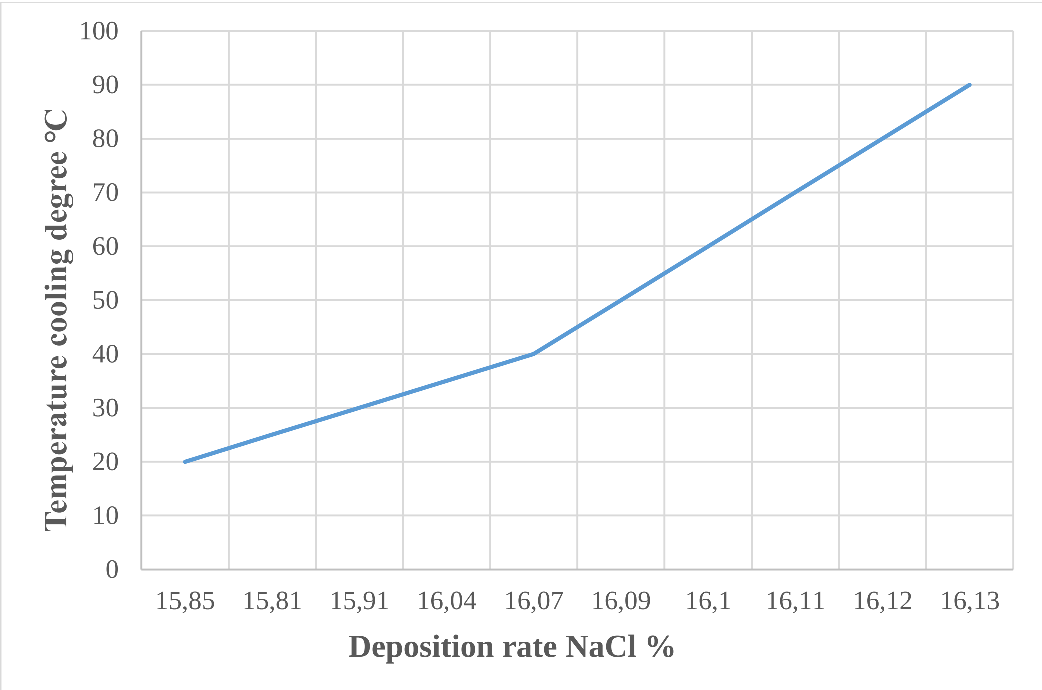

Figure 1. Effect of cooling temperature on the degree of sodium chloride precipitation

To increase the concentration of lithium chloride in the solution, it is necessary to conduct research on the natural evaporation of water from the Aral Sea with the recirculation of evaporated solutions into the initial water evaporation cycle. This will increase the concentration of lithium in the solution until it is saturated with other components of the mixture.

CONCLUSION

As a result of this research, it was determined how the composition of the Aral Sea water changed due to evaporation, and it was observed that the concentration of LiCl, $MgCl_2$, KCl, $CaCl_2$ Na_2SO_4 in the water content increased. The information obtained as a result of the research is of great importance for the extraction of lithium carbonate from the composition of the water of the Aral Sea. In the following places, in the technology of extracting lithium and its compounds from aqueous sources, the necessary technological points are obtained using this information.

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