Recovery of NaCl from a natural brine (South of Tunisia)

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1. INTRODUCTION

South of Tunisia is characterised by the existence of lagunar depressions named Sebkha and Chott. The more important ones are Chott El Jerid, Sebkha El Melah de Zarzis and Sebkha El Adhibate.

Previous geological, hydrogeological and geochemical studies proved that these deposits contain very important reserves of natural brines.

The meteorological conditions in the south of Tunisia and especially at Sebkha El Melah de Zarzis are favourable for the recovery of existing salts by solar evaporation.

The climate at Sebkhat El Melah of Zarzis is characterised by two seasons: a hot season (May - September) and a cold season (October - April).

The composition of Sebkhat El Melah brine is given in table 1. This brine can be assimilated to a quinary system: Na^+, K^+, Mg^{++}, Cl^-, $SO_4^=$ // H_2O. Consequently, the study of the solar evaporation of this raw material can be based on the above-mentioned diagram.

The aim of this study is to calculate, using quinary diagrams, the composition of the salt which is in equilibrium with the end solution when a natural brine coming from « Sebkha El Melah » is evaporated at 25°C. This theoretical result is thereafter compared with those obtained experimentally first on a laboratory scale (25°C isothermal evaporation) and then on a pilot scale at the site.

2. THEORETICAL PATH OF CRYSTALLISATION

For theoretical calculations we use a 25 °C isotherm of the oceanic quinary diagram [2-11] partially represented in figure 1.

We determine the chemical composition of point z' { z' = Bz ∩ [JXYK]} figure 1. The coordinates of J, X, Y and K points are taken from the literature. For our calculations, we approximate the area JXYK with a plane and the borders with straight lines. By interpolation we determine the concentration rates in $MgCl_2$ and NaCl for point z'. In order to do that we calculate the concentrations of point O, such as O∈[JX]∩[zY], then we proceed by interpolation between J and X. The results of these calculations are shown in table 2.

Table 1
Sebkha El Melah de Zarzis natural Brine composition (g/l)

S. ZARZIS	$SO_4^=$	Ca^{++}	Mg^{++}	K^+	Na^+	Br^-	Cl^-	H_2O	density
Natural brine	30.74	0.72	54.37	7.36	41.95	3.20	208.70	892.26	1.2393

Table 2
composition of the brines at the NaCl pan outlet (mol/1000 mol H_2O)

	Na_2Cl_2	K_2Cl_2	$MgCl_2$	$MgSO_4$	H_2O
SN (z)	18.02	2.00	38.38	6.13	1000
z'	3.35	3.76	72.18	11.53	1000
25°C evaporation	6.32	3.19	62.02	9.59	1000
Solar evaporation	6.96	3.15	60.57	9.53	1000

3. EXPERIMENTAL PATH OF CRYSTALLISATION

To make the comparison between theoretical and experimental results feasible, we performed two experimental evaporations. Firstly at the laboratory scale at 25°C and secondly on the site at the ambient temperature. The cutting densities for the two tests are determined experimentally. The composition of the brines at the NaCl pan outlet are given in table 2.

The obtained results are used to perform a mass balance for each evaporation method and for the theoretical sequence calculated from the quinary diagram.

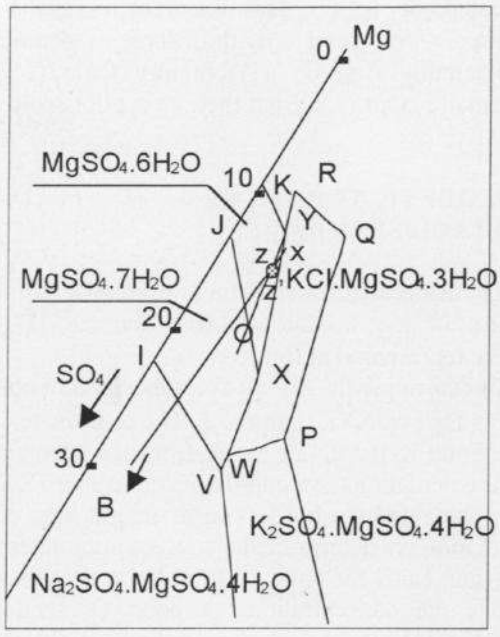

Figure 1 : 25 °C isotherm of the oceanic quinary diagram (theoretical composition of z').

4. CALCULATED AND EXPERIMENTAL RESULTS

The mass balance permits to calculate the percentage of evaporated water, the ratio of crystallised NaCl, and the purity of recovered salt. All these results are shown in table 3.

With regard to this table, we remark that the experimental results are different from the calculated ones, the evaporated water and the recovery ratios are less than the foreseeable ones. It has olso been found that the laboratory scale results were better than those of the pilot scale pan. The purity of the recovered salts is acceptable

Table 3
NaCl sequence mass balance

Designation	% Evap H_2O	% cryst. salt	% purity
Theoretical	46.82	89.58	100
Lab scale	38.12	78.32	97.16
Pilot scale	36.64	75.55	98.68

5. CONCLUSION

We conclude that the experimental crystallisation paths are different from the theoretical one, however, the recovered salts are similar to the foreseeable ones. Over saturated solutions and metastable equilibrium may be the origin of the established gap.

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