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Compare on Characteristic of Different Chemical Type Salt Lake Brines from Tibet During Evaporating

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1 Introduction

China is a country which has many salt lakes. Tibet is the area where have numerous salt lake, because the sources of water have multiple chemical type, resulting in Tibet salt lake brine also presents the characteristics of chemical-type diversity. From 2009 to 2012, the author of this article run experiments of 5℃-isothermal evaporation–precipitation salt law for four salt lake brines (Lake C, D, E and F). These brines belong to three of kinds of chemical type—Carbonate, $MgSO_4$ and Na_2SO_4, their physical and chemical index, such as mineralization, are also not the same. In this paper, authors intend discuss the change of density, pH and the relative viscosity (η) of the brines during evaporating-precipitating salt, combining published literatures (see table 1).

2 Materials and Method

The raw brines used for these experiments were made up in lab, on the basis of the chemical composition of the brines in situ. Their analytical data is list in Table 1. (They are the Lake C, D, E and F). First, the experiment brine was boiling by heating to evaporate to a pre-determinate concentration; then, equilibrate the brine (may be include some salt) by water bath at 5℃ for 6 hours; final, sampling the liquid sample (no precipitating salt) or separating solid and liquid sample.

It is worth pointing out that the indexes of the brines in different seasons was very likely to change, as the change of the temperature, evaporation and rainfall, water source supply. In another hand, the residence time of the lake water for leave in lab also produces a surprise change of the indexes. Sang et al. found that the density change from 1.2609 to 1.1253 g.cm^{-3} (25℃), the brine (appear small amounts of crystals in the container) leave for one year. This significant drop should be attributed to the some kinds of salt precipitation, which environmental temperature comes to ups and downs during leave.

3 Result and Discuss

3.1 The change of density during salt lake brine evaporating

In this paper, the evaporation ratio e（wt%）is given by $e = (w_e/w_0)\times100\%$, where w_0 is the mass of the origin brine for evaporation and w_e is the mass of water loss in

Table 1 The physical and chemical index of the brine of six salt lakes in Tibet

Item	Unit	Lake A[2]	Lake B[3]	Lake C	Lake D	Lake E	Lake F
Density	g.cm^{-3}	1.290	1.110	1.080	1.138	1.101	1.048
pH		9.55	9.36	9.00	8.30	7.77	9.46
Mineralization	g.l^{-1}	422	143	112	184	137	59
Cl^-	wt%	12.06	6.21	5.80	9.49	7.51	1.41
K^+	wt%	3.16	0.80	0.22	0.96	0.309	0.25
SO_4^{2-}	wt%	2.98	0.64	0.32	1.159	0.601	1.99
Mg^{2+}	wt%			0.02	0.36	1.071	
Ca^{2+}	wt%			0.02	0.003	0.117	
CO_3^{2-}	wt%	3.41	0.99	0.24			0.22
HCO_3^-	wt%		0.23	0.00	0.026		0.002
$B_4O_7^{2-}$	wt%	0.84	0.25	0.08	0.103	0.078	0.25
Li^+	wt%	0.08	0.03	0.03	0.01	0.013	0.03
Na^+	wt%	10.01	3.72	3.92	5.437	2.914	1.73
H_2O	wt%	67.42	86.00	89.67	82.36	87.53	94.41
Chemical Type			Carbonate		$MgSO_4$		Na_2SO_4

Evaporation process: Lake A—25℃-Isothermal evaporation；Lake B—Natural evaporation in winter；Others—5℃-Isothermal evaporation

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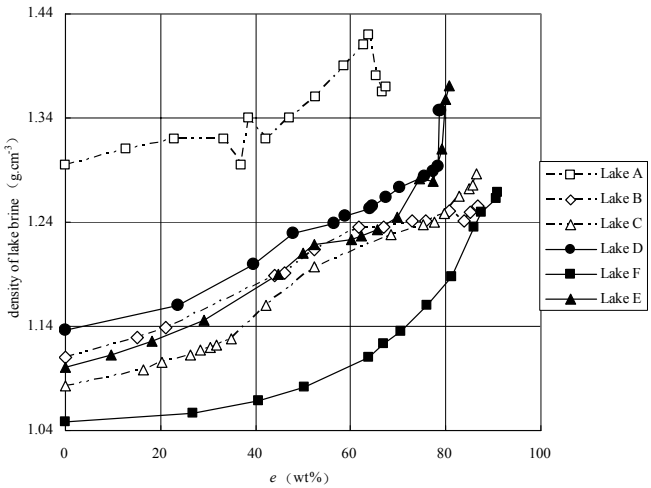

Fig.1 The change of the density of the brines by evaporation ratio (*e*)

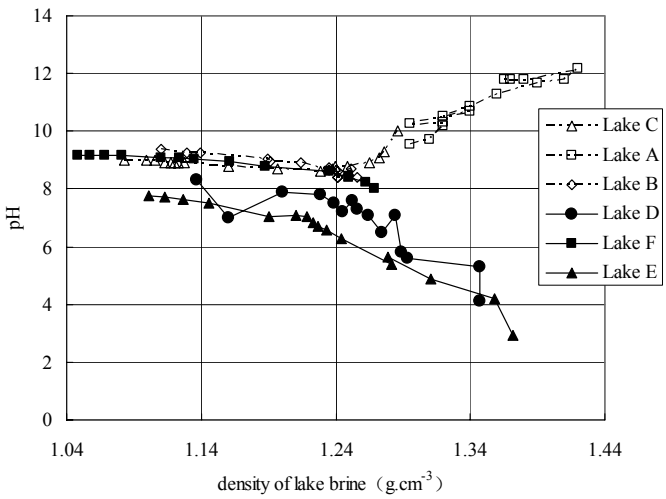

Fig.2 The change of the pH by density during salt lake brines evaporation

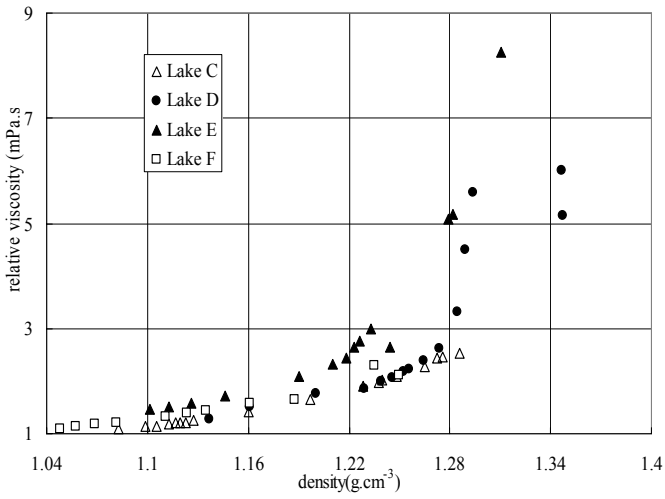

Fig.3 The change of the relative viscosity by density during salt lake brines evaporation

evaporation process.

The results show that in normal temperature environment, the maximum density which we can achieve seemingly was control by original density, no matter natural evaporation or indoor isothermal. If the original density is small, the maximum density also will be small. Otherwise the opposite.

3.2 The change of the pH by density during salt lake brines evaporation

The mineralization of brines discussed by this paper have very large different. So the of density of the brines obtained by evaporation also have very large different.

To compare the change of the acidity during these brines were evaporated; we plotted the pH as the function of the density. See the Figure 2. From the figure we can find an interesting change: 1) before 1.25 g.cm^{-3}, the pH of all brines drop by density of the brine on evaporating; 2) after 1.25 g.cm^{-3}, the curves appear different, the pH of carbonate type brines turn into increase as its density increase, but sulfate type continue drop, and appear a tend to accelerate. 3) in another hand, some scholar pointed out, because the native soda may precipitation at low temperature, the pH is likely to present sustained decrease for whole evaporating process.

3.3 The change of the relative viscosity (η) by density during salt lake brines evaporation

Fig. 3 shows, at the end of evaporation, the viscosity of $MgSO_4$ type brines rapidly increase as carbonate and Na_2SO_4 type brines seemly were to tend to stabilization. This is directly related to the concentration of Mg^{2+} in brines.

The relationship of the η and [Mg^{2+}] is given by η= 0.6186 [Mg^{2+}] + 1.1135 (R^2 = 0.8374) for η＜6 mPa.s.

4 Conclusions

The maximum density of salt lake brine can be able to achieve seemingly also was controlled by original density, no matter natural evaporation or indoor isothermal evaporation.

In the evaporation process, the pH of $MgSO_4$ type brines continuously drop by the increase of density; after 1.25 g.cm^{-3}, the pH of carbonate type brines, different from $MgSO_4$ type, turn into increase by its density increase.

The relative viscosity of the brine is directly related to the concentration of Mg^{2+} in brines.

Key words: Tibet; salt lake brine; evaporation - precipitation; density; pH; chemical type; relative viscosity.

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