



# **Study on Recycled Salt and Glauber' Salt Precipitation Rules of Yabulai Salt Lake Brine**

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# Background

**Yabulai Salt Lake**, located in the southwest edge of Alashan Town, is one of the largest salt lakes in Inner Mongolia of China.

**NaCl deposit:**  
50 million tons

**Na<sub>2</sub>SO<sub>4</sub>·H<sub>2</sub>O deposit:**  
16.5 million tons

**KCl deposit:**  
0.05 million tons

**MgCl<sub>2</sub> deposit:**  
0.3 million tons



**Yabulai Salt Lake**

**22.6 km<sup>2</sup>**

**NaCl purity:**  
Over 97%

**Average deposit thickness:**  
2.71m

**Now becomes history!**

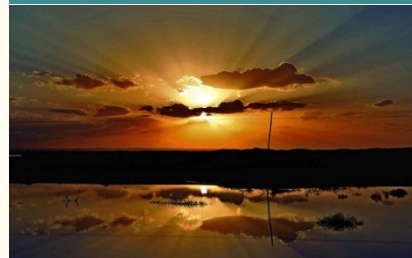
# Background

## Disadvantages

- Only extract  $\text{NaCl}$ , no utilization of  $\text{MgCl}_2$  and  $\text{Na}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ , leading in the waste of resource and environment pollution.
- Decline of the salt deposit and lake brine level.
- Enrichment of  $\text{Mg}^{2+}$  and  $\text{SO}_4^{2-}$ , which makes the brine complicated and aging fast.
- Decline of salt yield and quality.



**Yabulai  
Salt Lake**



## Advantages

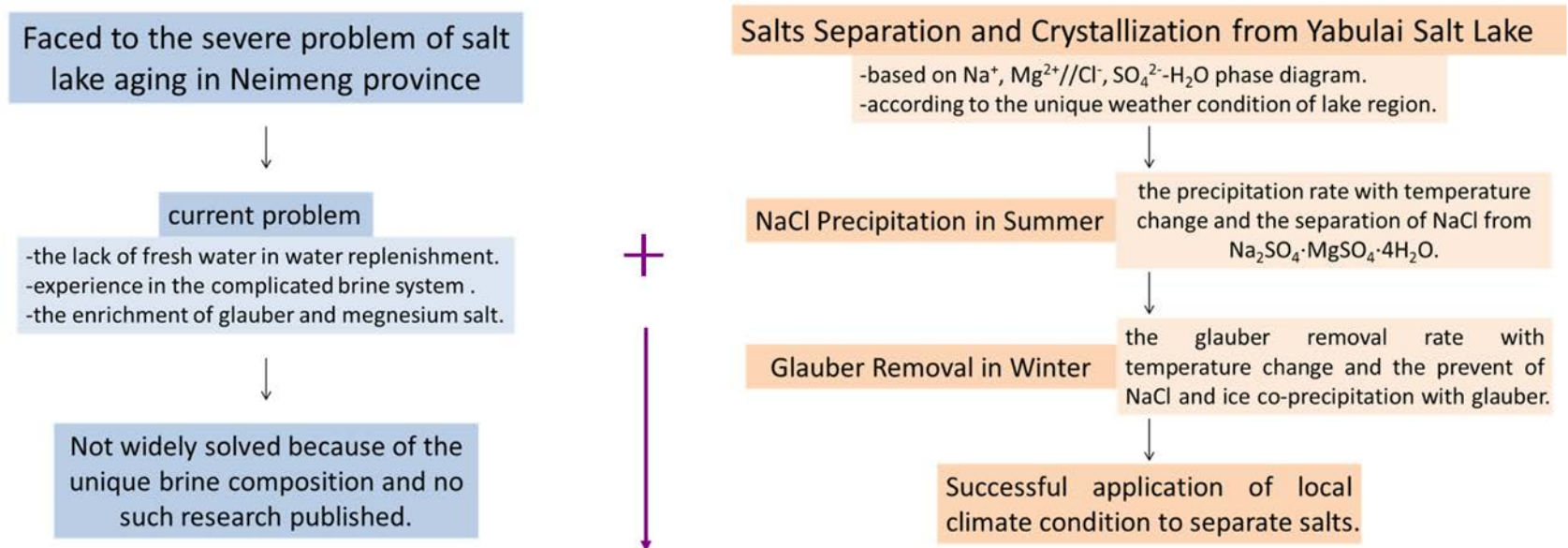
- ✓ High evaporation capacity.
- ✓ Low rainfall capacity.
- ✓ Four distinctive seasons.
- ✓ Huge temperature difference.



**Salt field construction  
and salt crystallization  
according to the content.**

# Project Objective

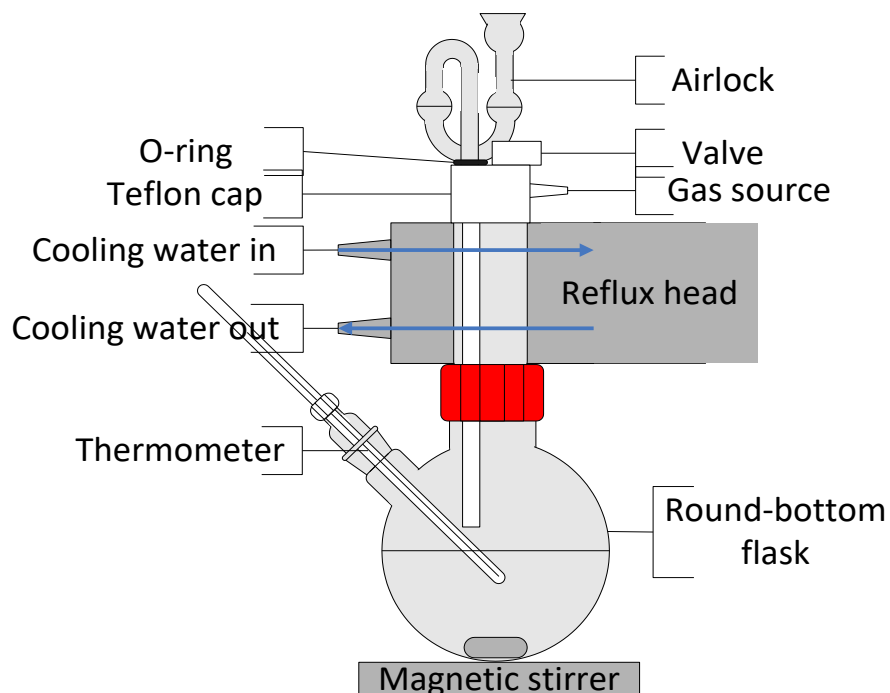
To investigate the feasibility of NaCl precipitation in Summer and glauber removal in Winter on the basis of huge local climate difference in different seasons and to find an efficient route to separate different kinds of salt in complex brine system .



**Aim** to find an efficient salt separation and crystallization route.

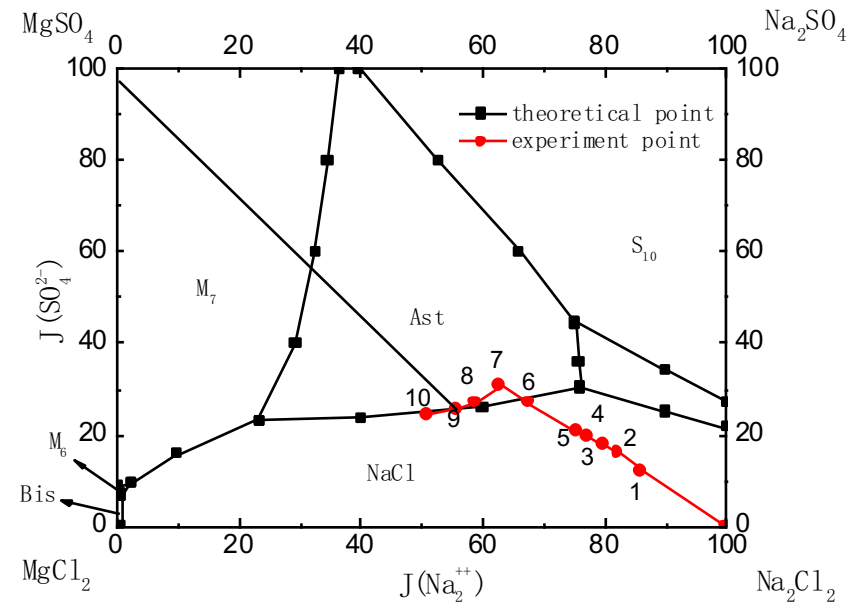
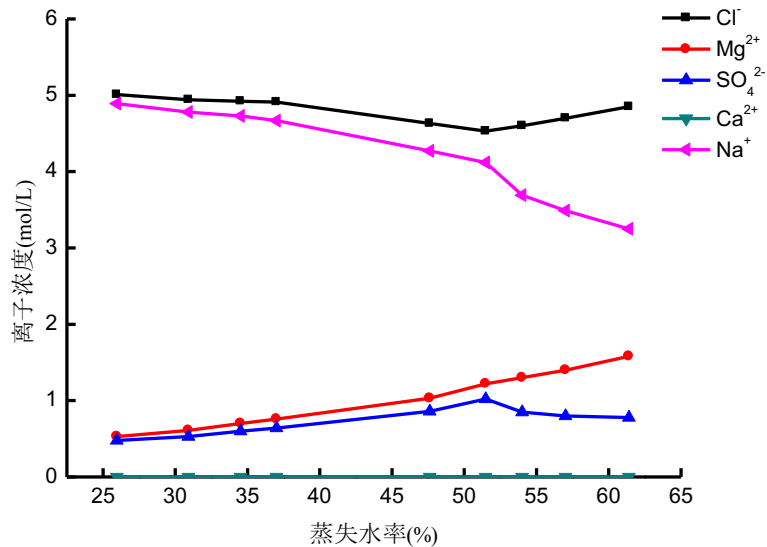
# Recycled Salt Precipitation Rules

Brine composition in April (g/L)						Other items	
Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Mg <sup>2+</sup>	Ca <sup>2+</sup>	Na <sup>+</sup>	H <sub>2</sub> O	Brine temp. (°C)	Brine density (g/L)
185.16	35.74	12.71	trace	112.70	878.69	12	1.225



# Recycled Salt Precipitation Rules

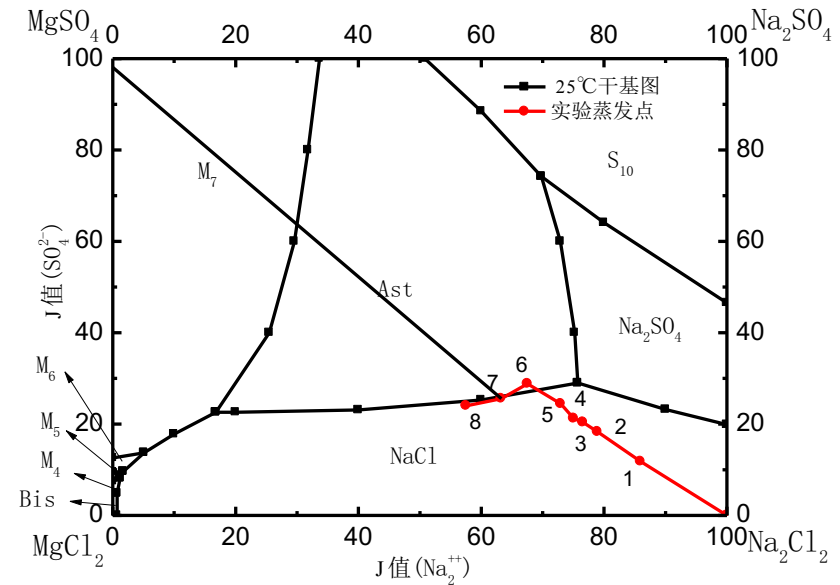
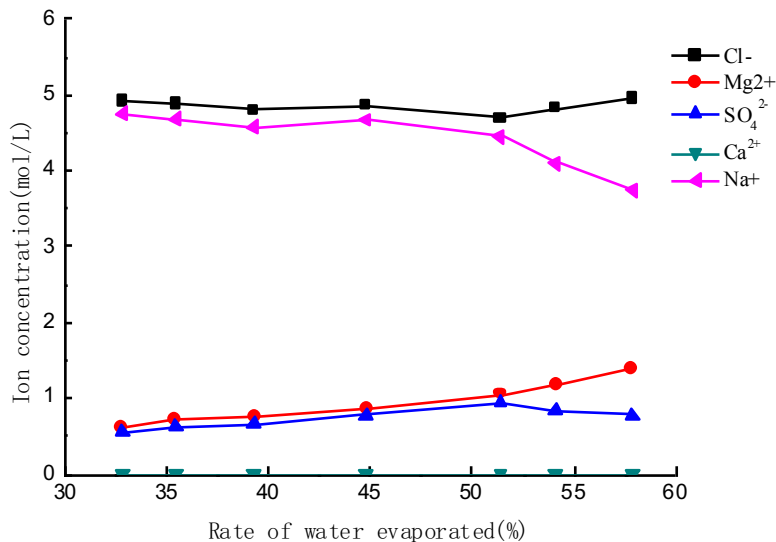
crystallization of Yabulai salt-lake brine in evaporation process at 20°C



At 20 °C, when the liquid phase moves to point 6, the water evaporated rate is 51.49% and there are two components in the solid phase (NaCl and Na₂SO₄·MgSO₄·4H₂O). From point 1 to point 6, only NaCl precipitates and the yield is 68.53%.

# Recycled Salt Precipitation Rules

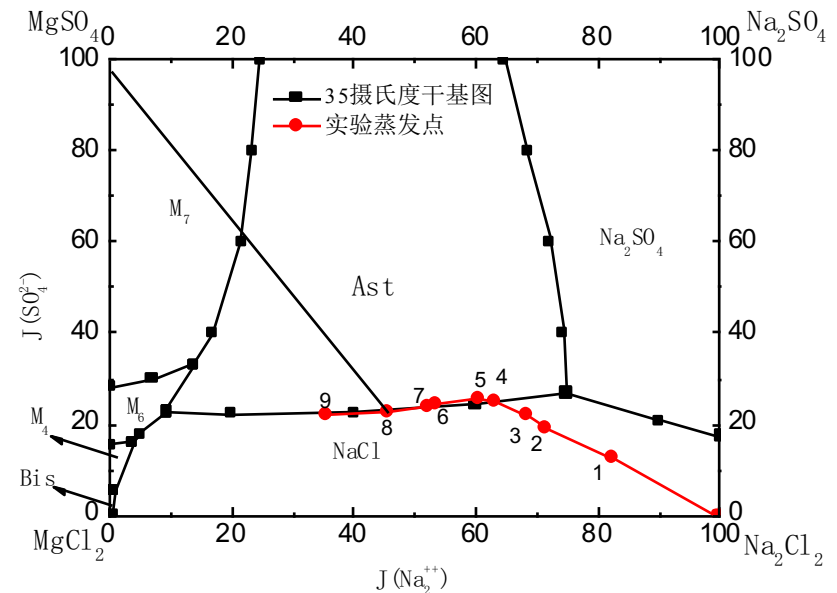
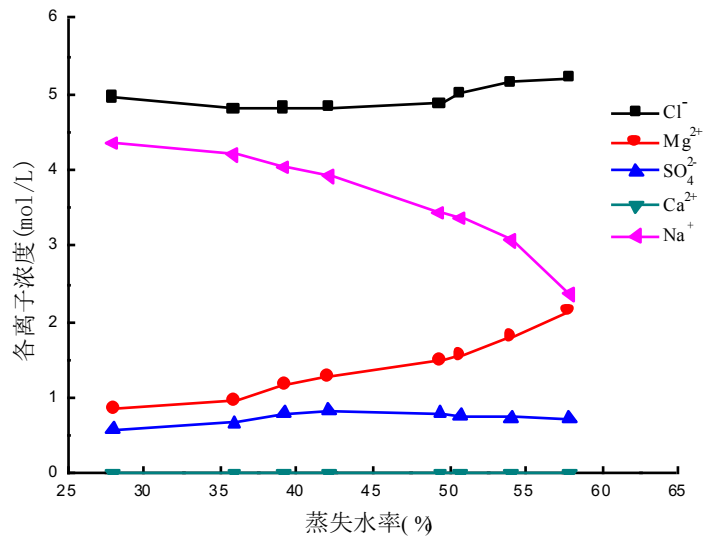
crystallization of Yabulai salt-lake brine in evaporation process at 25°C



At 25 °C, when the liquid phase moves to point 6, the water evaporated rate is 51.38% and there are two components in the solid phase (NaCl and Na<sub>2</sub>SO<sub>4</sub>·MgSO<sub>4</sub>·4H<sub>2</sub>O). From point 1 to point 6, only NaCl precipitates and the yield is 69.54%.

# Recycled Salt Precipitation Rules

crystallization of Yabulai salt-lake brine in evaporation process at 35°C

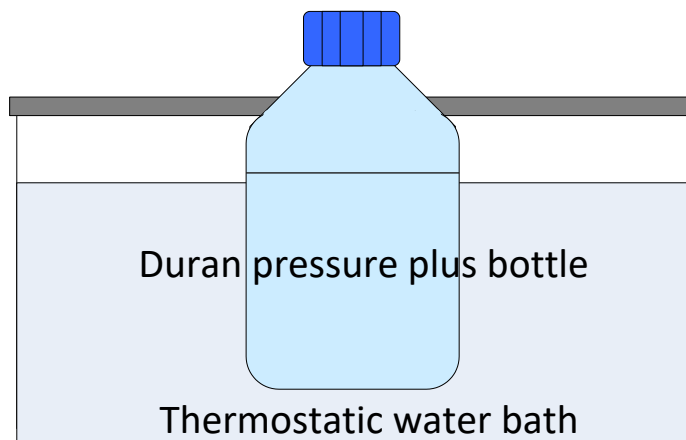


At 35 °C, when the liquid phase moves to point 5, the water evaporated rate is 42.11% and there are two components in the solid phase (NaCl and Na<sub>2</sub>SO<sub>4</sub>·MgSO<sub>4</sub>·4H<sub>2</sub>O). From point 1 to point 4, only NaCl precipitates and the yield is 64.39%.



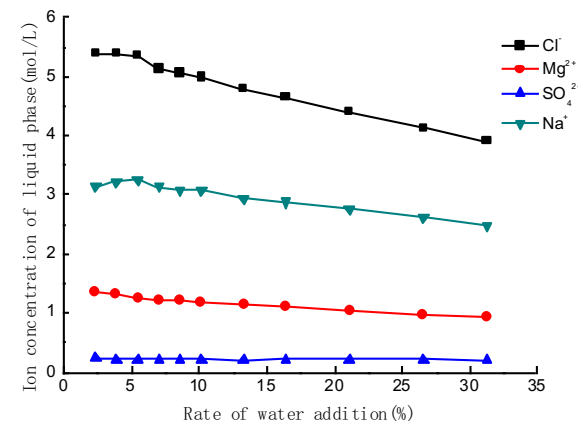
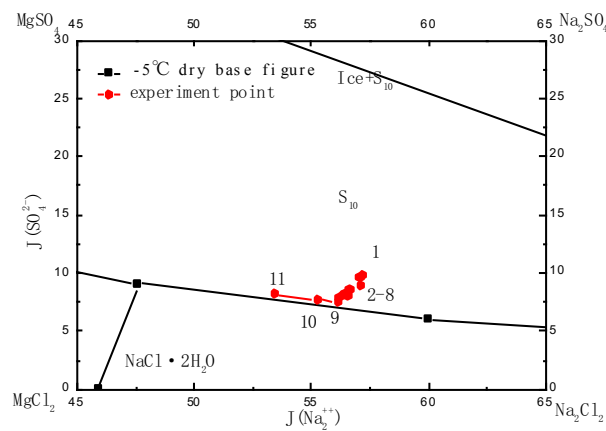
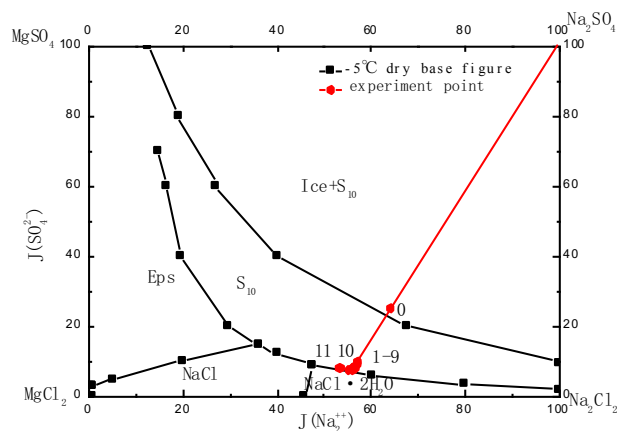
# Glauber' Salt Precipitation Rules

Brine composition after extraction of NaCl (g/L)						Other items	
Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	H <sub>2</sub> O	Brine temp. (°C)	Density (g/cm <sup>3</sup> )
172.11	77.32	0.01	27.82	95.24	883.51	25	1.2560



# Glauber' Salt Precipitation Rules

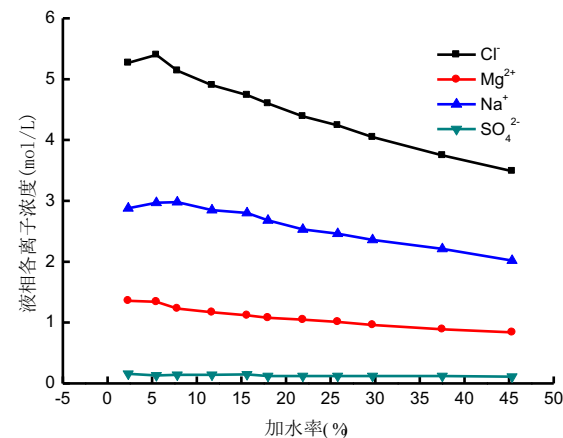
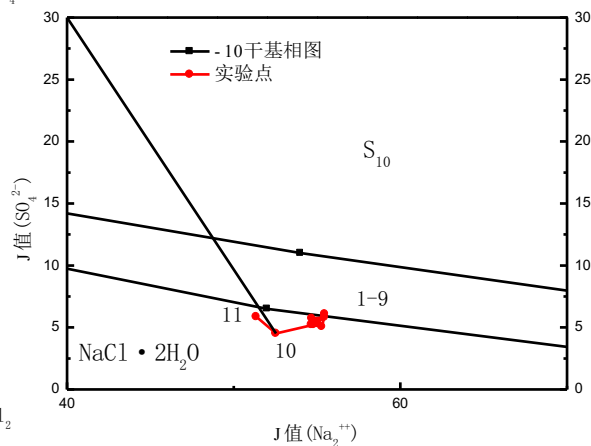
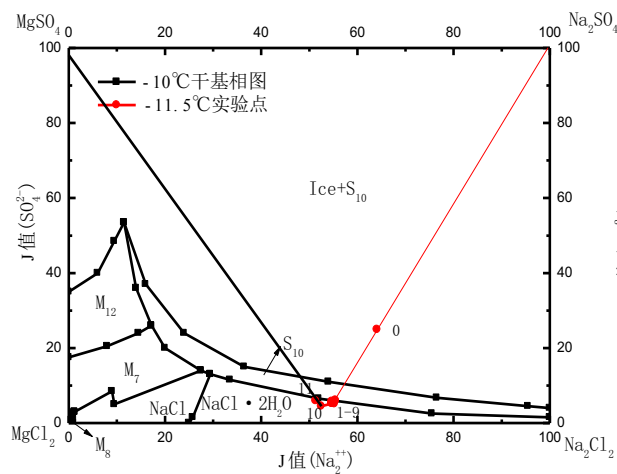
crystallization of Yabulai salt-lake brine in low freezing process at  $-5^{\circ}\text{C}$



At  $-5^{\circ}\text{C}$ , when the water content is higher than that of the ice and  $\text{S}_{10}$  ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ) boundary and when the water addition rate is higher than 5.47% (point 1-9), ice and glauber would co-crystallization. When the water addition rate is lower than 5.47% (point 10-11),  $\text{NaCl} \cdot 2\text{H}_2\text{O}$  would also crystallize, which leads to the waste of NaCl and impurity of glauber.

# Glauber' Salt Precipitation Rules

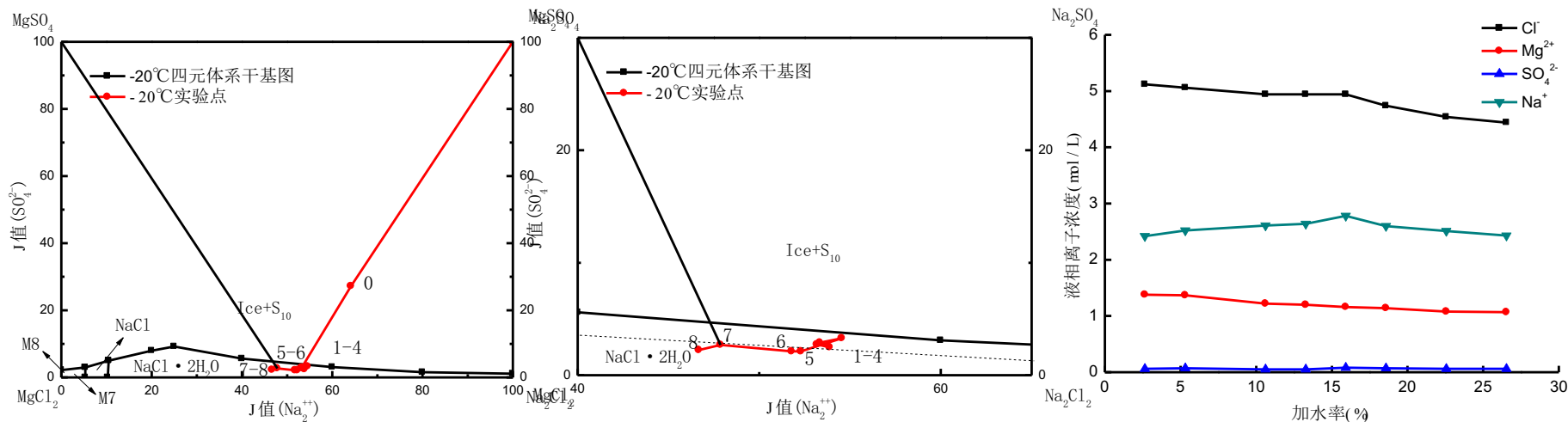
crystallization of Yabulai salt-lake brine in low freezing process at  $-11.5^{\circ}\text{C}$



At  $-11.5^{\circ}\text{C}$ , when the water content is higher than that of the ice and  $\text{S}_{10}$  ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ) boundary and when the water addition rate is higher than 7.82% (point 1-9), ice and glauber would co-crystallization. When the water addition rate is lower than 7.82% (point 10-11),  $\text{NaCl} \cdot 2\text{H}_2\text{O}$  would also crystallize, which leads to the waste of  $\text{NaCl}$  and impurity of glauber.

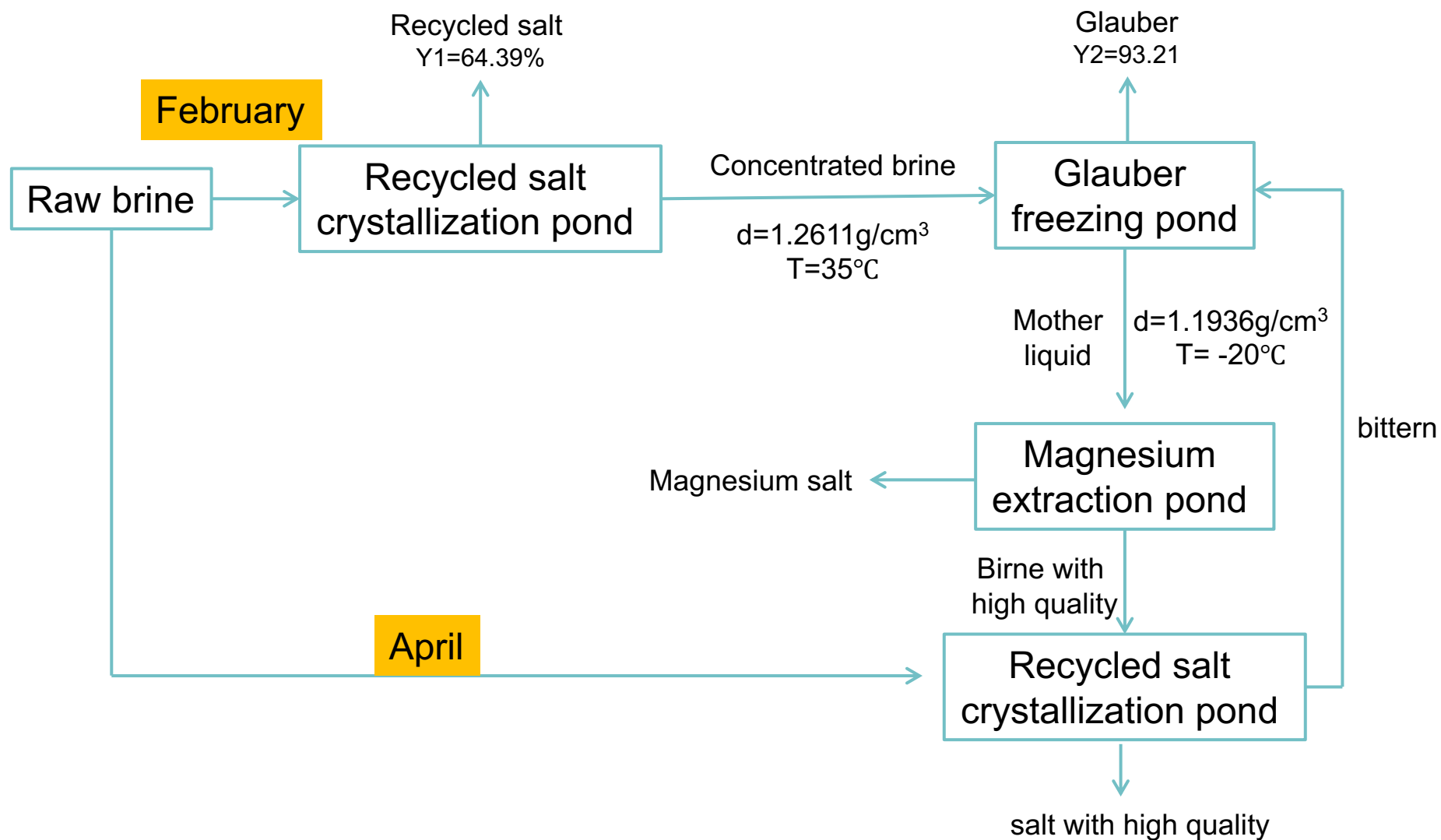
# Glauber' Salt Precipitation Rules

crystallization of Yabulai salt-lake brine in low freezing process at  $-20^{\circ}\text{C}$



At  $-20^{\circ}\text{C}$ , when the water content is higher than that of the ice and  $\text{S}_{10}$  ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ) boundary and when the water addition rate is higher than 15.92% (point 1-4), ice and glauber would co-crystallization. When the water addition rate is lower than 15.92% (point 5-8),  $\text{NaCl} \cdot 2\text{H}_2\text{O}$  would also crystallize, which leads to the waste of  $\text{NaCl}$  and impurity of glauber.

# Process optimization





# Thanks for you attention!

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