

## SELECTIVE RECOVERY OF BISCHOFITE FROM SEBKHA EL MELAH NATURAL BRINE

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**Abstract**--Brines are high concentrated aqueous solutions frequently used as raw materials for the recovery of several salts, which are industrially useful and necessary in some agricultural applications. This paper deals with a six-stage process for the recovery of magnesium chloride hexahydrate (bischofite) from Sebkha El Melah natural brine (South of Tunisia). It is based on successive evaporation sequences to precipitate firstly sodium chloride and then potassium-magnesium double salts. After that, the mother liquor is cooled to remove magnesium sulphate heptahydrate (epsomite). This step is essential before precipitating the potassium-magnesium double salt  $\text{KCl.MgCl}_2.6\text{H}_2\text{O}$  (carnallite). At the end of this step the recovered solution still contains sulphate ions which may disturb magnesium chloride extraction. In order to overcome this difficulty, a sulphate removal step has been advocated using calcium chloride solution. The treated solution becomes sulphate ion free and thus suitable to be used for bischofite preparation. The investigated procedure makes available the production of a magnesium chloride salt (purity upper than 90%) and various by-products, such as: halite ( $\text{NaCl}$ ), gypsum ( $\text{CaSO}_4.2\text{H}_2\text{O}$ ) and epsomite ( $\text{MgSO}_4.7\text{H}_2\text{O}$ ).

**Keywords**--brine, isotherm evaporation, bischofite recovery, process.

### I. INTRODUCTION

In southern Tunisia there are many salt lakes which are considered as important material resources useful for industry and agriculture. They are called *sebkha* or *chott*, and they cover a large part of Tunisian land. The liquid raw material enclosed in these deposits is named brine and always assimilated to the quinary system:  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+} / \text{Cl}^-$ ,  $\text{SO}_4^{2-} // \text{H}_2\text{O}$ . These solutions are valuable and expected to play an important role in the economic sector.

To take advantage of this raw material, several works were developed. Besides the study of geological aspects and phase diagrams of the system representing the brines (Hajeri, 1979; Chaabouni, 1980; Guerfal, 1981; M'nif, 1984; Kalai, 1986; M'nif and Rokbani, 1998), investigations were extended to the modelling of phase diagrams (Chehimi 1997; Zayani, 1999; Zayani *et al.*, 1999; Hammi *et al.*, 2001; Hammi *et al.*, 2003a; Hammi *et al.*, 2003b; Hammi *et al.*, 2004a; Hammi *et*

*al.*, 2004b) and extraction of interesting salts (Djebali *et al.*, 1998; M'nif *et al.*, 1998; Zayani and Rokbani, 2000; M'nif and Rokbani, 2000).

The present investigation pertains to the recovery of salts from aqueous salt solutions containing a plurality of water-soluble salts, such as the chlorides and/or sulphates of sodium, potassium, magnesium, etc. It is more particularly concerned with the recovery of magnesium chloride hexahydrate (bischofite) from the naturally occurring brine of Sebkha El Melah of Zarzis. The expected salt is used for fireproof materials, pharmaceutical products and for the preparation of specific cement pastes.

### II. PROCESS DESCRIPTION

As shown in Fig. 1 the investigated process is mainly composed of six stages. The adopted flow sheet is principally supported by the previous works on natural brines (Janecké, 1907; Berthon, 1962; Cohen-Adad *et al.*, 2002; M'nif and Rokbani, 2004; Hammi, 2004) usually described using the oceanic quinary diagram  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}/\text{Cl}^-$ ,  $\text{SO}_4^{2-} // \text{H}_2\text{O}$ . This useful graphic-tool is helpful in natural brines exploitation or valorization. In fact, it defines, during the system's evolution, the number, the nature, the composition and the relative quantity of different condensed phases that crystallize or disappear.

The first treatment step consists in evaporating at 35°C the raw brine (after being filtered). Simultaneously, a large part of sodium chloride (halite) is precipitated and removed.

In the second step of the process, the obtained mother liquor is further concentrated until a saturated magnesium salts solution. The precipitated salts may be said to consist essentially of sodium chloride and small amounts of magnesium-potassium double salt.

The third stage consists in maintaining the obtained saturated solution under magnetic stirring during four hours at 5°C and then removing the precipitated salt. This stage is devoted to partially desulphate the treated brine and slightly decrease its magnesium ions content which increases the evaporation rate in the following stage.

The fourth step consists in precipitating the potassium-magnesium double salt, carnallite ( $\text{KCl.MgCl}_2$ ).