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Influence of Painting and Dyeing on Temperature Fluctuation of Northern Tibetan Salt Brines

WU Zhiming[1], ZHENG Mianping[1*], CUI Xiangmei[2] and NIE Zhen[1]

1 MLR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, CAGS, Beijing 100037, China
2 School of Chemical Engineering, Qinghai University, Xining 810016, China

Introduction

The amount of the total dissolved salts (TDS) in most of the salt brines on northern Tibet is relatively lower. So the effective brine concentration technique is needed for lithium, boron and potassium extraction from these brine resources. Since the day time in a year of this area is totally about 3000 hours, the solar energy can be used as the main method to concentrate brine. Also because the below zero time of the area takes more than half of a year, the freezing technique may introduce as an auxiliary way to separate out ice, $Na_2SO_4 \cdot 10H_2O$ and $Na_2CO_3 \cdot 10H_2O$. Joint utilization of solar energy and cold energy was carried out both on the brine concentration of Zabuye and Dogai Coring salt lakes (Zheng Mianping, et al., 2007; Nie Zhen, et al., 2011; Wu Zhiming, et al., 2012a).

Dying the walls and bottoms of the evaporation pond with deep colors is not only beneficial to the solar energy adsorbent, but also to the acceleration of evaporation. On the contrary, dying with reflecting colors is favorable for freezing method. The research on salt production from sea water indicated that the salt yield increased by 15%-20% with dying technique. Thus, the adoption of dying technique is expected to shorten the concentration cycle of the low TDS brines on northern Tibet.

Experimental and Results

The painting and dying experiment was done on northern Tibet and the temperature changes of the salt brine were investigated. The 5Kg of salt brine was poured into five plastic tanks, with the same size, painted the inner walls and bottoms with yellow, green, blue, white and black respectively. A horizontal line over the evaporating tanks was pulled and a thermometer was hanged over each, keeping all of them 5centimetres above the brine surface (Fig. 1). Take notes of the temperatures every thirty minutes. Then the temperature changes of the brine with different color painting were investigated (Fig. 2).

According to the experimental results, the temperature of coloring black was 3-4℃ higher than that of coloring white. The temperatures of brine that colored black and green rose quickly and much higher, which is beneficial to the absorption of solar energy. While, the temperature of brine colored white rose slowly and relatively lower, which is indicating the poor absorption ability of solar energy. That is to say, the solar evaporation efficiency could be improved by coloring the inner walls and bottom of the evaporating pond with black and green. On the contrary, coloring with reflective colors have advantages

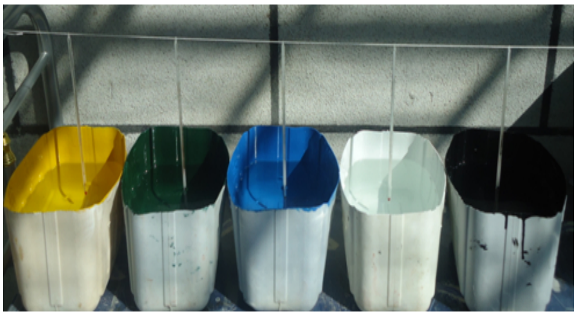

Fig. 1. Influence of inner wall painting on temperature changes of salt brine.

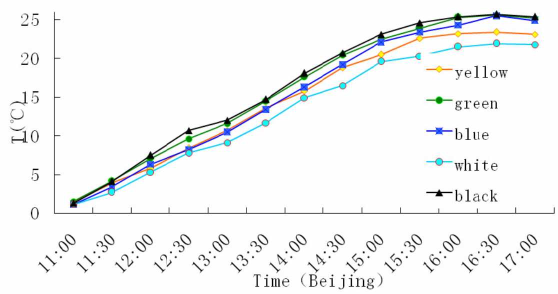

Fig. 2. Temperature changing trends of salt brines in tanks painted with different colors.

* Corresponding author. E-mail: zhengmp2010@126.com

Fig. 3. Influence of brine dying on solar energy absorption and temperature rising (Real reflection of brine dying effect by pouring them into 1.8L bottles).

on improving the efficiency and shortening the time limit of freezing process.

The brine dying experiment was carried out as shown in Figure 3. Six evaporation tanks with the same size were made by the steel bar frame. Each was filled with 10Kg of target salt brine and red, yellow, blue, green and purple dye was added respectively into the brine. Then temperature changes of the dyed brine were compared with that of the brine without dye. The experiment related to different mass ratio of brine to dye was carried out and the brine temperature changes corresponding to the ratio of 50000:1 were shown in Figure 4.

The results indicate that the transmittance effect of sunlight in brine is not good when the mass ratio of brine to dye is lower than 1000:1 which lead to the surface temperature rise rapidly while the temperature below brine

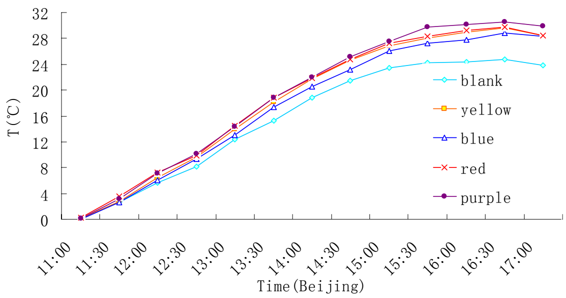

Fig. 4. Temperature change curves for salt brines dyed with different colors.

is oppositely lower. But at an appropriate ratio, the temperature rising speed and the highest day temperature of the brine dyed with colors is obviously better than that of the blank brine. Figure 4 shows that the temperature rising effect of brine dyed with purple and red is much better than that of yellow and blue in the same conditions. Also, the highest temperature of brine dyed with purple and red can be 5-6℃ higher than that of the blank brine.

The key point in brine dying is that the acidity/alkalinity properties of brine and dye should make a perfect match with each other. The acidity/alkalinity of dye can be chosen according to the pH changes of salt brine during evaporation (Wu Zhiming, et al., 2012b). Some researchers tried to add Naphthol Green B, which was used in the Dead Sea exploitation, to Zabuye salt pan. The experiment failed and caused losses because Naphthol Green B, also named Acid Green 1, is an acidic dye and neutralization reaction might happen when it is interacted with the strong alkaline Zabuye salt brine.

Keywords: salt brine; paint coating; dye; solar energy; pH value

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