STUDY ON IMPROVING THE QUALITY OF SATURATED BRINE AND REDUCED COST OF REFINED SALT PRODUCTION

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Abstract: The effects of the quality of the saturated brine which was produced from solar salt field brine on the production costs in the refined salt production system were discussed. It was found that the reason for low quality of saturated brine is that the brine was mixed with the mother liquor of the NaCl salt out. The method for improving the quality of the saturated brine was proposed.

Keywords: saturated brine; the quality of brine; the cost of refined salt

1.THE TECHNOLOGIES OF MAKING SALT FROM SATURATED BRINE OF SOLAR SALT FIELD

Comparing the technology of making salt from saturated brine of solar salt field (Brine Solar Field, BSF) with the traditional one which the brine was made by dissolving the salt solid with fresh water (later after called as Brine Solid Dissolved BSD), the process has three advantages: Firstly, the solid salt was not needed and the consumption of fresh water is very low. It means that the process is not only saving raw salt but also saving the fresh water. Second, less loss of evaporated mother liquor, the more brine can be produced for the resources of the other product. Third, a large amount of crystalline pond area was reduced, the costs of production and management of solar salt crystalline pond was reduced.

However, the concentration of NaCl is low in BSF that in the BSD. The concentration of NaCl of BSD generally is 250～300g/l , while the concentration of NaCl in BSF is about 210～240 g/l . It means that the water evaporated for producing unit product is higher. The consumptions of the energy and electricity are also higher. Therefore, the method of improving the quality of BSF, that is concentration of NaCl in BSF is needed to be found.

1.1 Composition and analysis of salt field saturated brine

The most representative composition of BSF used in the production of refined salt is given in table 1:

Table 1 composition of BSF

Order number	name	Unit	Concentration	remark
1	NaCl	g/l	236.23	
2	$MgCl_2$	g/l	48.73	
3	$CaSO_4$	g/l	0.81	
4	$MgSO_4$	g/l	33.12	
5	KCl	g/l	13.31	

From table 1, It can be seen that concentration of NaCl in BSF is about 10% which is lower than that in BSD, while concentration of $MgCl_2$ and $MgSO_4$ is several times higher, even more than ten times.

1.2 Potential in improving the quality of BSF

The composition of BSF changes a lot depending on the management of salt field producing process and the technology used in producing brine process. The saturated point of brine increase with increasing the concentration of $MgCl_2$ and $MgSO_4$, which results in the concentration of NaCl decreased. The concentration of NaCl was increased with reduce of the concentration of $MgCl_2$ and $MgSO_4$.

In producing brine process if there is no mixing of the mother liquor after salting-out with the new brine which was concentrated from seawater, there will be no any salt to be crystallized out before NaCl is saturated . Therefore the ratio of Na/Mg in the brine will have the same value as that in seawater. It was called as general saturated brine.

Based on the experimental results concentration of Mg^{2+} in general saturated brine should be less than 13g/l, SO^{2-} less than 18g/l and NaCl about 260g/l. Considering the data presented in table 1 and the data from experiment, the general composition of BSF is given in table 2:

Table 2 composition of BSF and general saturated brine

Brine name	Na/Mg ratio	Chemical composition					
		SO^{2-}	Mg^{2+}	NaCl	$MgSO_4$	$MgCl_2$	KCl
BSF	4.87	29.44	19.14	236.23	33.31	48.73	13.31
general saturated brine	About 8	<8	<13	About 260			

From table 1, we can see that the ratio of Na/Mg of BSF is much lower than the one in general saturated brine. The concentration of SO^{2-} in the former is 1.469 times higher than that in the latter. The concentration of Mg^{2+} in the former is 1.472 times higher than that in the latter. NaCl in the former is about 90 percent of that in the latter. This phenomenon shows that mixing of the mother liquor of salting-out brine with the one in producing line result the concentration of SO^{2-} and Mg^{2+} increased and NaCl decreased.

The value of the concentration of NaCl in BSF is inversely proportional to the amount of mixed mother liquor. The more the mixed mother liquor is, the lower the concentration of NaCl in BSF, the higher the concentration of SO^{2-} and Mg^{2+} are.

From the above analysis, it can be seen that the concentration of SO^{2-} and Mg^{2+} has to be reduced in order to increase the concentration of NaCl in the BSF. The key of reducing the concentration of SO^{2-} and Mg^{2+} is to eliminate amount in mixing the mother liquor in brine producing process.

2.The effect of the quality of BSF on the production costs in refined salt production

Refined salt production line in which salt of 150,000t a year is now produced. The requirements of BSF are: The ratio of Na/Mg is not less than 5 and concentration of NaCl is 236.23g/l. If the necessary control method was used in brine producing process, the ratio of Na/Mg in BSF can be near the one in seawater. It can be sure that concentration of NaCl could be increased about 20g/l, and reached to 256.23g/l. Therefore, the cost of the refined salt production will be decreased.

2.1 The effect of the quality of BSF on production capacity

After improving the concentration of NaCl in the brine, the brine consumption of 1000 kg product will be decreased from $6.27m^3$ to $5.78m^3$. It means that the production capacity can be increased by 7.8 percent. Based on the design capacity of 15,000t per year the actual production capacity can reach to 161,700t per year.

Meanwhile, the costs of unit product will be declined with the increase of production capacity.

2.2 The effect of the quality of BSF on steam consumption

Based on process design the capacity of the production line is about 15,000t per year of refined salt. The steam consumption of

1000 kg product is about 1480 kg. The ratio of the consumed steam with the evaporated water is 0.265:1. Due to the concentration of NaCl in BSF is increased, brine consumption was decreased from 1480 t0 1350, reduced by 8.8 percent. If the calculation is based on 150,000t product, the steam consumption can be reduced by 19,500t, the save is 1,057,900 RMB.

3 THE METHOD TO IMPROVE THE QUALITY OF BSF

3.1 Establishment an independent production system of BSF

BSF, as the raw material of refined salt, can be produced separately with the one for solar salt production. In this way, the mother liquor mixing can be eliminated. The ratio of Na/Mg is the same as in the seawater. The concentration of NaCl should be close to 260g/l.

The attention should be paid that after the brine producing system for BSF is independent the NaCl dose not salt out in every stage of producing brine process. Therefore, intentionally or unintentionally mixing with different concentrations of brine in this system will not lead to the change of the ratio of Na/Mg of saturated brine.

3.2 mother liquor after salt out treatment

When brine producing system of BSF can not be separated with the general solar salt production system, the further evaporation of the mother liquor has to be arranged separately so that the mother liquor mixing with the new brine can be avoided. In this way mixing the mother will be avoid in brine producing process, The ratio of Na/Mg of BSF can be ensured as the same as the seawater.

4 CONCLUSION

The ratio of Na/Mg in the saturated brine made from solar salt field and its effect on the production of refined salt were analyzed. After taking the necessary measures in brine producing process, the quality of BSF can be improved. The ratio of Na/Mg and concentration of NaCl of the brine can be increased. The production capacity can be increased about 7.8 percent, steam consumption can be reduced 8.8 percent with the method proposed.