

APPLICATION OF SOLUBILITY PRODUCT CONSTANT IN THE SALT MAKING PRODUCTION

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Abstract: With solubility product constant, some phenomena of chemical reaction and scaling and antiscaling in salt making production is explained.

Key words: Salt making, Solubility product, Constant, Application

INTRODUCTION

As shown in Fig. 1, the saturated sodium chlorite solution is added into the connected device at room temperature. Smaller amount of sodium sulfate is added and agitated in the Container A. Some crystals will be

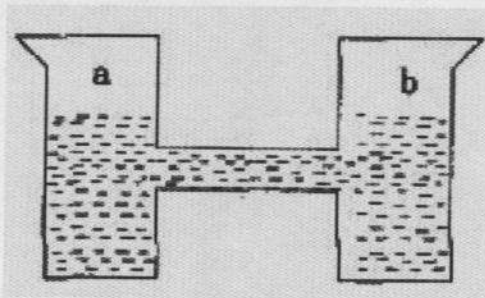


Fig.1 Saturated NaCl solution in the connected device at the room temperature

THEORY

For a variety of soluble or insoluble crystals, ions on the crystal surface gradually leave the crystal surface and enter the water

APPLICATIONS IN THE PRODUCTION

precipitated at the bottom of Container B. The amount of crystals of Container B will be increased with the increasing of the sodium sulfate addition in the Container A. The crystals in the Container B are cleaned with distilled water after filtration, the major component is sodium chlorite.

under the water molecular. These ions are freely moved ions. At the same time, the cations that had already entered solution can come back to the surface of the crystal. They will re-deposit. The dissolved dynamic equilibrium will be established when the speed of the two process. The solution gets the saturation point. Under this dissolved equilibrium, the concentration of cationic times the concentration of anionic ions is a constant under certain of temperature, designated as solubility constant. The solubility is constant if the temperature keeps constantly.

The wastewater pipelines are used to transport wastewater to the mine Haolong CNSIC Co., Ltd.

The waste water poured into the wells again. Since the wastewater contain more impurities, the wastewater pipeline will scale for running some time, thereby block the pipelines and reduce wastewater flows. These influence the normal production of the mines and the waste water supply. The feeding capacity decreased at least 100 m³/h per three months operation because of the scaling in the pipeline.

Analysis

After sample analysis, it was found that the scales were very loose, 95% are calcium carbonate. Calcium carbonate is an insoluble material, a very small solubility in water. At 25 °C, pH of 7, the solubility of calcium carbonate is only 0.00632g/L, solubility constant is 4.7×10^{-9} , solubility decreased with increasing of the temperature and pH. Wastewater is the mixture of 30 °C circulation water and 63 °C III, IV effects condensed water, the ratio is about 3:4. Ca²⁺ in the condensate water is 0.155 g/L in the III, IV effect, 0.483 g/L in the circulation water, 0.342 g/L after these two types of water mixed. Temperature is about 50°C, pH of 8.6. The solubility of calcium carbonate is far less than 0.00632 g/L. Supposing the solubility of calcium carbonate after mixing is 0.00632 g/L, the Ca²⁺ content is 0.342 g/L, the calcium carbonate will be precipitated if CO₃²⁻ content is higher than 0.00033 g/L. The waste water is rich in CO₂ because the circulation water passed the air mixture condenser. The content of CO₂ is higher than tape water. CO₃²⁻ content is usually 0.00042 g/L (0.0000069 mol/L) for CO₂ dissolve in the water. The results of Ca²⁺ concentration times CO₃²⁻ concentration are bigger than the CaCO₃ solubility constant,

calcium carbonate must be precipitated. This indicated that the calcium carbonate scaling in the waste water chest and pipelines was originated from waste water chest and precipitated because of their properties. Calcium carbonate has already formed during waste water movement. It precipitated in the waste water chest and scaled in the feeding process because of unsmooth inner wall pipeline and enrichment on the inner wall pipelines.

Measures

Based on the analysis above, these problems can be solved by controlling the product of cations concentration less than solubility constant and prevent the ions association to form calcium carbonate. It is not easy to reduce the concentration of Ca²⁺. It is feasible to reduce the CO₃²⁻ concentration. pH of the waste water can be decreased by adding acid into the waste water chest. CO₃²⁻ and H⁺ will react to form CO₂ which is freely in the waste water. The CO₃²⁻ form ions should be reduced. It need add hydrochloric acid 16 tons every day, 1700 yuan/ton, the total cost is 11200 yuan. The cost is little higher. It can save cost to use high pressure water gun to clean the pipe, this method need to stop the production. The effect of stop on the production will be serious if the pipe stops too long.

Technical staff decided to use the raw material brine to clean the pipe. The raw brine is acidic properties naturally. The pipes of brine and waste water can interchange for a period of time. These acidic properties of brine can remove the calcium carbonate scaling costly.

The scaling phenomena is serious outside shell side of the heating room of III, IV effect and in the condenser pipes.

These scaling prevents the exit of condensate and jams the uncondensed water. The production cannot carry out.

Analysis

Scale composition, III effect scale, CaCO_3 is 97.5%, 0.38 CaSO_4 . IV effect scale, CaCO_3 is 89%, 7.24 CaSO_4 . The main component of the scales is CaCO_3 . The impurities of the brine are CaSO_4 , CaCl_2 , MgCl_2 , without CaCO_3 , where CaCO_3 come from?

We have two sets of 600,000 tons / year production line, one line has scaling phenomena, and another set is very clean. The

Table 1 Ca^{2+} content in the condensate

water of III, IV effect for two sets

Time	1# line $\text{Ca}^{2+}(\text{g/L})$	2# line $\text{Ca}^{2+}(\text{g/L})$
2007.11.6	0.159	0.148
2007.11.7	0.152	0.153
2007.11.8	0.157	0.150
2007.11.9	0.151	0.147
Average	0.155	0.149

As shown in Table 1, the Ca^{2+} for line 1 was higher than line 2. However, line 1 did not scale. The condensate water of Line 2 had scaling problem, which resulted evaporation strength decreasing. CO_3^{2-} content was higher than Line 1. Higher CO_3^{2-} content was causes

According to the checking uncondensing air and equipment operation record, we found that some staffs had misunderstanding on the ways of exiting uncondensing air. They assumed the steam can be saved through exiting uncondensing air timely. The uncondensing air was discharged every one hour, the discharging time was 5 min. The pump of V effect has been broken for several months. The brine did not preheat mandatorily. The role of removing uncondensing air of V effect was weak. The uncondensing air such as CO_2 content was high when the brine entered into the tank to evaporate. pH adjustment of solution was comparatively high, resulted higher alkaline of the condensate water. It also

process condition of the two is the same. The difference of the two should be the key point of scaling of CaCO_3 .

We analyzed the synthesis parameters, Ca^{2+} content in III, IV effect condensed water of the two sets was analyzed, the results are shown in Table 1

found quickly combining the uncondensed air blocked. The main component of uncondensing air is CO_2 . The uncondensed air is blocked. High concentration CO_2 accumulated under the out shell side of the heating room. pH of condensate water is 8.6, weak alkaline properties. Most of CO_2 is dissolved in the condensate water and dissociate H^+ and CO_3^{2-} . H^+ neutralizes the alkaline of the condensate water. The concentration of CO_3^{2-} is increased. The solubility product of Ca^{2+} and CO_3^{2-} is over solubility constant at that condition. The scaling will be formed defiantly. The origin of the scaling is that the uncondensing air is blocked and excessive CO_2 dissolved into the condensate water.

led to absorb CO_2 easily and increase the concentration of CO_3^{2-} .

Measures

The stopped condense effects were restarted and preheated brine. Most of the uncondensing air in the raw brine should be removed. The brine containing more uncondensing air cannot enter the evaporation system. The ways of discharging uncondensing air should be changed, and continuous discharging is adopted. All the staffs should strengthen responsibility. pH of the solution in the tank should be controlled strictly.

CONCLUSIONS

Solubility product constant of the theory exists in our extensive production and research work. It analyzes the problem from the source and by using the solubility product constant of the theory to solve the problem; we concluded that the use of the laws of nature and science is necessary to treat these problems.

References

- Xue, F.Y. 1991. Physics Chemistry. Central broadcasting and television university publishing house, Beijing.
- Cao, T.L. 1990. Fundamental Chemistry. Central broadcasting and television university publishing house, Beijing.