APPLICATION OF SALT WASHING PROCESS WITH COUNTERCURRENT, BACKWARD WASH, FLOATATION AND SEPARATION IN THE SALT-MAKING PRODUCTION BY SODIUM SULFATE TYPE BRINE

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Abstract: The paper presents that in order to keep stable quality and make orderly production, China national salt industry zao yang salt chemical co. Ltd. applied salt washing process with countercurrent, backward wash, floatation and separation in salt making production and made a transformation for old salt washing system. Since the project went into production in September 2006, it has been shown that the salt quality was easy to control and the application effect was obvious. Hence, I wrote the paper for reference.

Keywords: Salt washing process, Application

1.INTRODUCTION

China national salt industry Zao Yang salt chemical co. Ltd. is a vacuum salt making company, which applies "three effect production, feed from axial direction and multiple-effect salt discharging" technology by the use of sodium sulfate type brine. The content of sodium sulfate in brine is high, of which annual output can reach 52g/L and the content of NaCl is 280g/L. The production has strict demand for salt washing process.

How to make full use of salt washing process and guarantee salt quality is the matters of concern. Our factory made a technical transformation in August 2000. Before technical transformation, all the equipments in the salt washing process cannot work well due to process design, salt washing worker labor intensity was intensive and salt washing was realized by adding salt. Since salt supply shortage, the process was hard to control. Meanwhile, the adding amount of brine was hard to control and salt in the old brine occurred frequently (it can be found from the waste salt in old brine tank). Due to blockage of wastewater pipeline in very serious situation, the production would be forced to stop and it had an influence on effective production and energy comsumption.

In order to improve the production, the production technology department in our factory combined with process equipment and brine quality to adopt the new technology with combination of tanks and drums countercurrent, backward wash, floatation and separation. According to the actual situation of sodium sulfate type brine, the transformation

of salt washing process has been successfully by enlarging the upper diameter of floatation device (Ø2.5m), heightening the height of salt washer and making use of two stirring salt washing tank. Since salt washing system went into operation in September, 2002, it not only has reduced consumption of brine and the labor intensity of salt washing worker, but has controlled salt quality easily, enlarged the cycle of washing tank, reduced the times of shutdown, guaranteed good quality and improved the production.

2. PROCESS FLOW & PRINCIPLE

2.1 The structure of salt washing process

The salt washing process with combination of tanks and drums countercurrent, backward wash, floatation and separation includes salt washing tank, cyclone, floatation device, salt washer and corresponding feed pump and stainless steel pipeline. It is shown in Fig. 1

2.2 Process flow

At first, the brine becomes salt crystals after three effects and the salt crystals are discharged into No. 1 salt washer from salt leg of each effect. In the No. 1 salt washer, salt slurry with high temperature are centrifuged to separate water and are stirred to decrease temperature; after they were transport into No. 1 cyclone separator through No.1 feed pump, the salt slurry are separated into the weight salt slurry and the light mother liquor to increase the concentrate of salt slurry in No. 2 salt washer. After hydrocyclone separation, the mother liquor will carry away some fine suspended salt or nitrate particle (the specific weight of nitrate is lower than that of salt). After preliminary separation between salt and nitrate, the top fluid from No. 1 cyclone separator will flow into No. 2 cyclone separator for second hydrocyclone separation. The top fluid from No. 2 cyclone separator flows into preheater. The working state can be controlled by the bottom valve of No. 2 cyclone separator to keep the normal flow rate and to achieve the purpose of thickening in the end.

The bottom fluid flows into No. 2 salt washing tank through valve. In the No. 2 salt washing tank, the bottom fluid is diluted by cyclone separator and is mixed with raw brine. In the last, some nitrate particles will be washed away form slat slurry. After twice mix and wash, NaCl liquid –solid mixture is added into floatation device through No. 2 feed pump. The feed position is 2m higher than the top of floatation device and feed mode adapts tangential feeding, whose purposes are to make NaCl liquid –solid mixture rotational settled and to make salt and nitrate separated. The top fluid flows into old brine tank and the thick salt slurry is transported into salt washer by No.3 feed pump. The feed position is 2m higher than the top of floatation device and feed mode adapts tangential feeding, whose purposes are to make NaCl liquid –solid mixture rotational settled and to form the state with dense in the surrounding and dilution in the middle. Top fluid of salt washer is added into floatation device from the position which is 1.5m higher than the bottom of floatation device. After the second floatation separation, the liquid in the floatation device can be fully washed to improve the floatation effect.

Adding brine and backward wash in salt washer is that, raw brine flows into salt washer from the bottom (see Fig.1) and the flow mode is upward scattering mode, which can mix, wash and settle nitrate particles in the salt slurry fully. After washed repeatedly and settled down, NaCl liquid –solid mixture enters into centrifuge depending on the height difference between salt washer and centrifuge. The thicker (cyclone) on the centrifuge has a liquid-solid separation effect.

The salt washer process has tow key control points. One is pressure control for adding brine and backward wash in the salt washer; in generally, the pressure should be controlled in the range of 0.5-0.7MPa (Adding amount of brine is large when low pressure and adding amount is small when high pressure). The other is the opening of bottom

valve of No. 1 cyclone; it needs to keep the consistency of salt slurry.

In summary, the brine is discharged into No. 1 salt washing tank respectively through three effect legs and salt slurry is centrifuged to separate water and mixed with some raw brine to wash salt and decrease temperature. Then, the salt slurry is transported into No. 1 cyclone on the No. 2 salt washing tank through No. 1 feed pump to separate from old brine. Salt slurry enters into No. 2 salt washing tank and mixes with some raw brine for dilution and salt washing and then is transported into floatation device for floatation separation through No. 2 feed pump. The top fluid of No. 1 cyclone goes back to No. 2 cyclone on the No. 1 salt washing tank and salt slurry and old brine are separated again. Salt slurry is collected in the No. 1 salt washing tank and is involved in salt washing. In the end, the top fluid goes back to preheater to heat brine. Through feeding by feed pump, increasing feeding brine temperature, making full use of heat energy and increasing salt growth rate in the evaporator, the purpose of improving production and reducing energy consumption can be achieved (the heat source of preheater comes from condensed water in one effect heating chamber and in dry radiator). After salt slurry entered into floatation device through No. 2 feed pump, salt particles and little nitrate particles settle down and the brine is transported into salt washer through No. 3 feed pump. Salt washing process in salt washer is that some brine is added into the bottom of salt washer to backward wash from bottom to top and the floatation sequence of top fluid in salt washer is from bottom to top. Old brine is discharged into old brine tank through floatation device and then goes back to wastewater tank. In the end, the brine is transported into mining area through wastewater pump to mining brine. After salt washing in salt washer, salt slurry enters into centrifuge for desalination through salt slurry pipeline depending on the height/ pressure difference between salt washer and centrifuge (16m) and is transported into boiling bed to dry through wet salt belt. Meanwhile, the top fluid of centrifuge goes back to No. 2 salt washing tank and is involved in salt washing. The liquid from centrifuge goes back to No.1 salt washing tank to wash salt. Till then, the whole salt washing process is finished.

2.3 Principle

The principle of the salt washing process is mainly to make use of the solubility change with temperature when NaCl and Na_2SO_4 dissolved simultaneously and to change the temperature of mixture of NaCl and Na_2SO_4 to make system temperature varied. Hence, Na_2SO_4 unsaturated solution can be used to wash salt containing Na_2SO_4 crystal in the mixture of NaCl and Na_2SO_4 for Na_2SO_4 solid re-dissolving. In the end, according to the difference of particle size, viscosity and activation grade between them, NaCl and Na_2SO_4 can be separated. During salt washing process, the dissolution rate of NaCl is low and that of Na_2SO_4 is fast, since the concentration of NaCl in raw brine is close to saturation corresponding to small concentration difference between the concentration of NaCl in raw brine and saturated brine concentration and Na_2SO_4 is not, corresponding to larger concentration difference of Na_2SO_4. In other words, the crystallization rate of NaCl is fast due to high concentration; the crystallization rate of NaCl is low. When dissolution and crystallization reach equilibrium, Na_2SO_4 crystal with size less than 0.01mm would be formed and suspended in the saturated brine to change the brine to turbid emulsion. Due to the increase of particle size and buoyancy of emulsion brine and the difference of particle size, crystal surface area and crystal shape between salt and nitrate when they are crystallized in the evaporator, the hydraulic rising force carries away fine irregular Na_2SO_4 crystal with emulsion brine and salt and nitrate can be separated in the end when emulsion brine containing many Na_2SO_4 is mixed in countercurrent by salt slurry through emulsion floatation device.

3. IMPLEMENTATION PROCESS

Since 1997, our company has introduced three effect production, feed from axial direction and multiple-effect salt discharging process, which made use of salt washer and floatation device to backward wash and worked out very well. However, with enterprise development, brine consumption varied continuously. Until 1999, the content of sodium sulfate has reached 45g/L, which had serious influence on normal production and had induced factory shutdown and the decrease in efficiency due brine consumption and salt carryover were large. In view of the case, the plant administration built a special group and the production department also built a technical group. According to the experiment of brother plant, we combined with the actual situation to design a feasible salt washing process, which made use of three salt washing tanks and salt washer to build the salt washing process with countercurrent backward wash. On August 2000, we made a transformation for production equipment. After new salt washing process has gone into use, it reduced the problems at that time such as brine supply storage and difficult control of process indexes etc and the effect was very good. However, at early 2002, the brine situation got worse and the content of sodium sulfate reached 48g/L, which had serious influence on production and product quality. Plant administration organized production technology meeting in time and made a decision with adding a new floatation device and removing a salt washing tank through repeated discussion and careful study. After practical operation, the new salt washing process including two salt washing tanks, one salt washer and one floatation device has achieved the design requirement. Moreover, the process indexes were easy to control comparing to any previous transformation. The technical transformation for floatation device can solve the problem of previous floatation device in the production such as (when the diameter of tank is 1.4m) high flow rate and big salt particle. According to the existing floatation device design, the old tank was changed to the tank including stainless steel lining tank body with 3m in diameter on the upper and stainless steel lining tank body with 1.8m in diameter on the lower, which improved the settlement effect and solved the problem effectively of salt carryover in old brine when salt-nitrate separation. Moreover, the usage of two cyclones can separate salt slurry from mother liquor effectively and keep mother liquor with high nitrate content from salt washing system, which ensured product quality.

4. APPLICATION EFFECT

Since the successful use of salt washing process with "combination of tanks and drums countercurrent, backward wash, floatation and separation", it has solved the problems caused by salt carryover in old brine, stabilized salt quality, reduced the times of shutdown and wash, greatly reduced coal and electric power consumption and improved working efficiency, which has increased output value by more than 5 million RMB.

The production situations in recent years are shown in the comparison in following table.

	1999	2000	2001	2002	2003	2006
Coal consumption per every salt	366.20 Kg/T	358.91 Kg/T	350.21 Kg/T	347.70 Kg/T	292.76 Kg/T	273.06 Kg/T
electric power consumption per every salt	93.13 KWH/T	90.18 KWH/T	85.42 KWH/T	83.23 KWH/T	73.91 KWH/T	70.23 KWH/T
Salt production per work hour	12.5 T/H	14.5 T/H	15.00 T/H	15.3 T/H	17.65 T/H	19.95 T/H

5. CONCLUSIONS

Through process design transformation for salt washing system, it greatly improved the production environment of our country, lengthened the washing cycle, ensured product quality, improved working efficiency and reduced labor intensity, which has achieved the purpose of high quality, high production and energy saving and further improved economic efficiency of the enterprise