

# AN INNOVATIVE SALT WASHING EQUIPMENT AND METHOD

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**Abstract:** This paper introduces an innovative raw salt washing process and washing facilities, which had been proved to be stable in the running of the actual production line. The method not only assure the sea salt quality, and also has the merits of slighter extent in the secondary broken process with larger size and less grinding product as well as low power consumption, which can effectively reduce the cost of washing salt production.

**Key words:** raw salt; salt washing process; washing equipment

## 1 OVERVIEW

As early as the beginning of the 1980s, Tianjin Hangu Changlu Saltern has taken the lead in the mode of sea salt production during the implementation of "three mechanization and four focuses", which was realized as the mechanization in the process of transportation, washing and stacking of raw salt. The whole procedure included such process as utilizing special collection equipment to collect raw salt land, sending the salt to a pumping station, washing the salt within the pipeline, separating the salt and brine in a washing tank, dehydrating by vibrating and last stacking it. However, as time goes by, drawbacks of this method of salt collecting technique gradual was revealed. That is, in the process of using pipelines to transport the raw salt, the salt size was severely damaged and created more salt fines, and also caused high energy consumption.

According to statistics, the first and second crystallization pond in the third production line which has an annual output of 500,000 tons of salt had lost about 35,000 tons of salt fines, accounting for about 7 percent of the raw salt production, which cause big loss to the production of raw salt. Despite relative research had been carried out in the Hangu Saltern Company and better recovery of salt was achieved, instable quality of the salt was still existed due to the tiny size. It cannot be treated as salt product to sale. Those problems have never been soundly resolved.

According to the actual production problems, the company set up a special project team to conduct relative scientific and technological research on the transportation and washing equipment of the salt, which was included in the technological innovation projects approved by the Tianjin municipal economic commission. After unremitting

efforts, we eventually developed an innovative technology in salt transportation and washing as well as relative equipment, which has successfully solved the high energy consumption and huge salt loss in the transportation and washing of the raw salt in the crystallization area of the Hangu saltern company.

## 2. PRINCIPLES OF SALT WASHING TECHNOLOGY

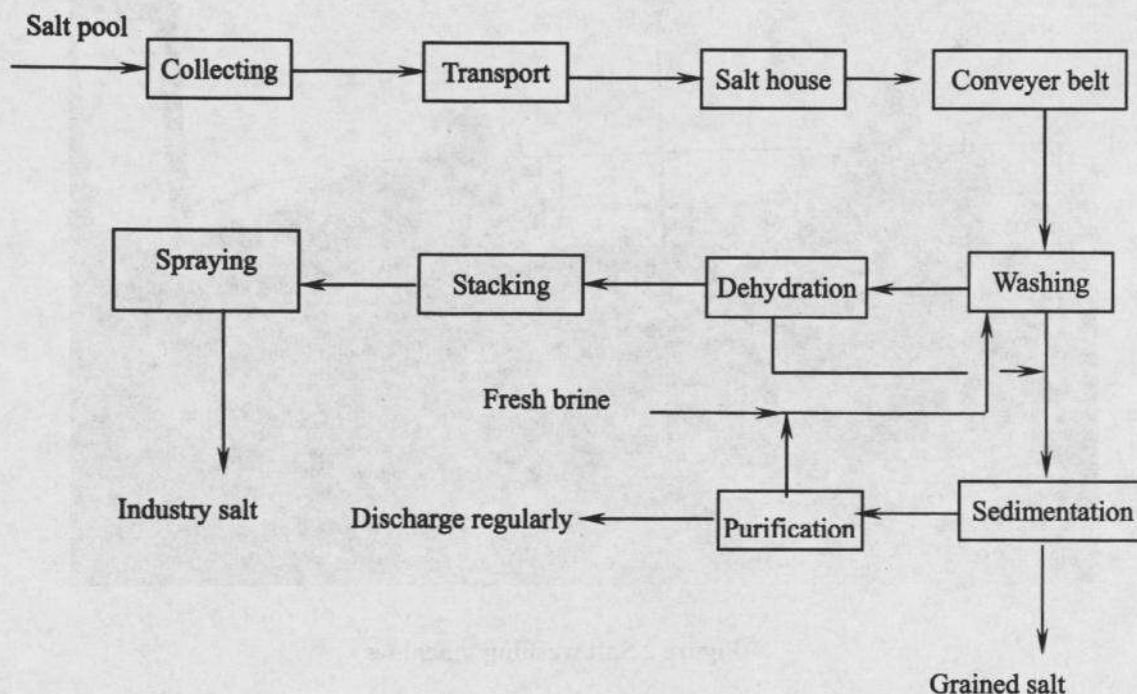
### 2.1 Principles of salt washing

The product of NaCl has some impurities such as  $MgCl_2$ ,  $MgSO_4$ ,  $CaSO_4$ , sediments and other impurities. According to the evaporation rule of brine under common temperature,  $MgCl_2$  and  $MgSO_4$  just attached to the surface of NaCl crystal (which caused by the entrainment of mother liquor), the process of washing salt is a mother liquor replacement process, which can be washed away easily, yet the insoluble compounds such as  $CaSO_4$  are often wrapped in NaCl crystal. In order to separate the tiny pieces of  $CaSO_4$  the product crystals have to be broken by the process of agitating and turbulent flow of the liquid in the washing procedure, which caused the washing process a more difficult

task in the real production. At the same time the washing process of  $CaSO_4$  can cause a large amount of salt fines.

### 2.2 An innovative salt washing process

Salt collecting machine and salt transportation vehicles used in the original collection technique was still utilized in the innovative technology but not include the pumping station. Instead of the raw salt was delivered directly into the underground salt storehouse, the salt was transported by conveyer belt to mandatory washing machine. After washed by the machine the salt was then dehydrated by vibration sieve and finally was stacked by conveyer belt. The brine used for washing the raw salt was consisted of brine with density of  $20^\circ \text{Be}$ , saturated brine of grained salt and the other brine from saltern. Brine overflow from the washing machine firstly flowed into the sedimentation tank and then into the purification pool for recycling. In order to enhance the quality of brine purification, there is an overflow weir in the middle of the purification pools ( $200 \text{ m} \times 30 \text{ m}$ ), which discharge on a regular basis to meet the needs of the quality of washing salt. The process schematic diagram is shown in Figure 1



**Figure1 Schematic diagram of the innovative method**

### 3. Working principle and performance of Salt washing equipment.

The special salt washing machine co-designed by our company and a mining design institute of research was shown in Figure 2. The salt washing machines has the structure of screw band with the shell was docked by a 1/4 rectangular and a circular. The salt washing machine was placed to certain angle, which was in a favor of the separation of raw salt and the impurities. The head of salt washing machine (feeding box) was surrounded by three weir plate, while a salt separation machine (washing liquid inlet)

with an overflow weir in the upper part was installed at the bottom of the machine. The head and body part of the screwed washing machine was immersed in the salt solution in order to achieve mandatory washing for raw salt. At the same time the tail part was set above the surface of the solution with the aim of better separation of the solid-liquid phase. While working, the electric reducer droved the screwed washing machine to rotating, the raw salt in the washing machine and the washing solution overflowed from the salt separation machine forming countercurrent in the head of the salt washing machine, which completed the four process of strong washing, grading, transportation and dehydration.





**Figure 2 Salt washing machines**

While washing, brine entered the salt separation machine located at the bottom of the washing machine. Such method not only causes the washing solution and the raw salt can form countercurrent which enhanced the

washing performance, but also solved the impact of rapid deposition which influence the washing performance.

Main performance specifications of salt washing machine are as follows:

Screw diameter:  $\phi 1200$  mm

Power: 18.5 kW

Salt washing production capacity: 150 ~ 190 t / h

Brine consumption volume: 300 ~ 400 m<sup>3</sup> / h

Dimensions (length  $\times$  width  $\times$  high): 14170  $\times$  3080  $\times$  4560 (mm)

1) Mandatory washing: the raw salt entered the feeding box, under the mandatory enforcement of the spiral equipment and countercurrent of the washing solution, the impurities on the surface of the raw salt was removed by the friction and rolling of each other. With the help of the spiral current, the washed raw salt was delivered to the dehydration process. The small grained salt and sand overflowed from the overflow weir, thus complete the washing process. Such mandatory washing mode avoided the defects of secondary crushing of the salt pump and pipeline transportation to salt.

2) Classification: Classification of production

was realized by the overflow weir, which can separate particle that does not comply with the requirements of the fine particle. The controlling performance is to adjust the height of the overflow weir and the speed of spiral equipment.

3) Dehydration: the small particle was settled down to the bottom of the salt washing machine and was washed away by the overflow of the countercurrent solution into the sedimentation tanks. After mandatory washing the raw salt was separated by the solid-liquid separator and spray device and finally was sent to the dehydration process

Salt washing machine main performance

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#### 4. APPLICATION PERFORMANCE

The innovative method was applied at the second crystallization pond of the Hangu slattern company and then was promoted to the first crystallization pond. The production performance in such area proved that the

equipment functioned smoothly; the product was up to the standard and achieved satisfying economic and social effects. The comparison of the quality of product was shown in Table 1, and the particle size distribution in Table 2 and consumption in Table 3

**Table 1 Comparison of the quality of salt from traditional and innovative technologies**

Item	Salt in pool	Salt from pipeline	Salt from machine
Insoluble(%)	0.06	0.02	0.02
CaSO <sub>4</sub> (%)	0.49	0.14	0.31
MgCl <sub>4</sub> (%)	1.15	0.89	0.75
MgSO <sub>4</sub> (%)	0.77	0.52	0.48
NaCl(%)	87.44	87.71	87.49

**Table 2 Comparison of the particle size distribution from traditional and innovative technologies**

Item	Salt in pool	Salt from pipeline	Salt from machine
>10mm (%)	7.7	0	4.7
10-5 mm (%)	51.9	23	39.2
5-2 mm (%)	30.5	45.5	34.9
<2 mm (%)	9.9	31.5	21.2
Grained salt (%)		1.42	0.24

**Table 3 Comparison of energy consumption from traditional and innovative technologies**

Item	Salt from pipeline	Salt from machine
Power (kW·h/t)	1.84	0.89
Brine (m <sup>3</sup> /t)	1.33	0.57
Water(t/t)	0.01	0.01
Fuel (l/t)	0.2	0.25

With the results obtained by a year trial run, the advantage of the innovative method using special designed salt washing machine has

shown the following aspects:

- 1) The innovative washing technology cause less secondary damage to raw salt. The

particles whose size is smaller than 2 mm is about 31.5% of the total amount of particle with the traditional method, but it is only 21.2% with the innovative method,

- 2) The innovative method maintains the ration of raw salt, and kept its quality no less than that of the pipeline method. Because of less grained salt and larger particle size, the spraying effect become obvious.
- 3) Less grained salt: The traditional method lost about 80 kilograms of grained salt per ton of raw salt with an annual loss of 36,000 tons. The innovative method lost about 40 kilograms of grained salt per ton of raw salt with an annual loss of 18,000 tons, which benefits the company of 3,6 million yuan per year.
- 4) Low energy consumption: The original method need a total installed capacity of 550.5kW, but the innovative one just need 266.8KW. Subtracting the factor of longer distance of raw salt transportation, it saved about 100 thousand Yuan per year on energy consumption.

## 5. CONCLUSION

The innovative washing machine has integrated the four main functions of mandatory washing, grading, dehydration and delivery. It not only assured the sea salt product quality and also has the merits of less broken salt crystals. Larger particle size distribution with less salt fines and low energy consumption are expected. The successful application of such innovative technology has played a very good role model in the sea salt collecting method within the sea salt production enterprise nationally.

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