

# ON THE APPLICATION OF SIPHON SCRAPER CENTRIFUGE IN PROCESSING OF SALT GYPSUM

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**Abstract:** The application of the siphonic scraper centrifuge in the processing of salt plaster was discussed. This technology could effectively remove the plaster from the mother liquor of salt production. Excellent separation performance could be obtained. The water content and salt content could be reduced effectively and the product could be sold directly. Consequently, the waste plaster could be utilized.

**Key words:** Siphonic scraper centrifuge; deal with plaster; solid-liquid separation

## 1. PREFACE

In the salt production, gypsum is produced as by-product from the gypsum-based brine. Gypsum has small particle size and high viscosity. Hence, how to remove the by-product gypsum effectively from the production system has been a difficult problem for the gypsum-based brine enterprises for long. Some enterprises can not remove the gypsum from the production system, causing low heat transfer coefficient, high liquid viscosity and low product quality. Some enterprises are able to separate gypsum, but the by-product has high water content or salt content and the product is polluting. How to separate the gypsum from the system, meet the requirement for sale, cooperate with the with the main industry, and form a stable process has become a major subject of our company in science and technology development.

About ten years ago, our company firstly used the horizontal spiral centrifuge to separate gypsum effectively. However, the gypsum water content is as high as 39%. And large drying site and long drying time are required. Moreover, in the rainy days, this process will pollute the surrounding environment seriously. After the acquisition of three foot-type centrifuge separation of gypsum, is able to

meet customer requirements, but the disadvantages of low separation efficiency, high maintenance costs, many employers and other disadvantage make we give up. In recent years, we have researched the frame filter, vacuum filter and so on, and all are unable to meet production needs. The processes always have problems of high water content, the need for large drying site, and long drying time, serious environmental pollution and other issues. Through investigation of a large number of scientific and technological literatures, we recognize that by choosing more suitable gypsum treatment solid-liquid separation equipment, the target of treating the gypsum simply and effectively can be achieved, the gypsum solid-liquid separation performance increases, and the operation costs and the environmental pollution decrease.

## 2. TECHNICAL PREPARATIONS

### 2.1 Analysis of gypsum

In nature, there is three types gypsum, including gypsum plaster, half-water gypsum, anhydrite three patterns. From the standpoint of the solid-liquid separation, the gypsum plaster can be separated relatively easily, because of its large particle size and softness. The anhydrite gypsum is difficult to separate

because of the small particle size and hardness. In the salt evaporation process using gypsum-based brine, gypsum plaster is obtained at the liquid temperature below 57 °C. At the liquid temperature of 57~110 °C, half-water gypsum is precipitated; at the liquid temperature above 110 °C, anhydrite gypsum is obtained. Under normal production conditions, the salt evaporation liquid temperature of our company is in the range of 60 to 130 °C. Therefore, most of the precipitation is the mixture of anhydrite gypsum half-water gypsum.

Currently, most enterprises adopt a simple process of precipitation and washing. After that, separate the gypsum mother liquor plaster mother liquor by using the frame filter, settlement, after washing, use of solid-liquid separation equipment, separation of mother

liquor of gypsum, gypsum extracted, the selected solid-liquid separation equipment for plate and frame filter press, belt press machine, belt type vacuum filter, horizontal spiral centrifuge discharge and etc.. This process has the disadvantages of long lines, a lot of equipment, high water content, high operation cost, and heavy environmental pollution. Therefore, the above processing equipment has not been accepted by the salt enterprises.

We analyzed the original brine and the gypsum mother liquor to determine their properties and characteristics. The analysis results can be seen in table 1-3.

Then, we carried out a sample analysis of the gypsum product to determine their characteristics. Analysis results are shown in Table 4 and 5:

Table 1

Composition	NaCl	CaSO <sub>4</sub>	CaCl <sub>2</sub>	MgCl <sub>2</sub>	NH <sub>4</sub> <sup>+</sup>	B <sub>2</sub> O <sub>3</sub>
Original brine(g/l)	309.4	4.68	1.01	0.17	0.54	0.02

Table 2

Composition	NaCl	CaSO <sub>4</sub>	CaCl <sub>2</sub>	MgCl <sub>2</sub>
Gypsum mother liquor (g/l)	310.2	43.0	16.7	6.8

Table 3

	Density kg/m <sup>3</sup>	viscosity pa · s	heat J / g · °C
Gypsum mother liquor	1.21×10 <sup>3</sup>	0.0017	3.49

Table 4

Product	Anhydrite gypsum	Semi-aquatic gypsum	Gypsum plaster
Content	70%	25%	5%

Table 5

Items	Particle size μm	density kg/m <sup>3</sup>
Product gypsum	5~18	2.32×10 <sup>3</sup>

From the above analysis we can see that 70% of the gypsum product of our company does not contain crystal water, and is anhydrous gypsum, which belongs to hard gypsum. The product gypsum has small particle size, high viscosity, so it can not be easily separated and the subsequent treatment is difficult.

## 2.2 comparative analysis of the existing equipment

Our company investigated and analyzed the existing domestic gypsum processing

equipment. At present, the equipment used by most enterprises mainly includes plate and frame filter, belt press machine, drum vacuum filter, vacuum filter belt, horizontal spiral centrifuge. These equipment has problems of varying degrees, which include:

### (1) Frame filter

Frame filter is a non-continuous operation of the filtration equipment, the main problems are:

- ①The clean-up job after discharge is very cumbersome and labor intensive.
- ②The sealing surface of the frame material is



prone to leak and the leakage is difficult to handle.

③ Since the capacity of a single set equipment is small, and it could not run continuously, the labor productivity is low.

#### (2) belt-type press machine

Belt press machine is used by our company for Tianyuan 1st stage project. the main issues are:

① Gypsum production rate is low, can not meet the gypsum output.

② Need to add flocculants to maintain production, production costs are high.

③ Filter easily damaged, under normal operation conditions the replace run-time is two months, and the maintenance costs increase.

④ After treatment, the water content of the gypsum is up to 40%. Hence the large drying site is required, and the environment is polluted heavily..

#### (3) Belt type vacuum filter

Belt type vacuum filter has the disadvantages of:

① Large footprint, and high investment costs.

② After treatment the water content of gypsum is as high as 40%.

③ Drying needs a large site. Causing serious environmental pollution.

#### (4), Horizontal spiral centrifuge sedimentation

Horizontal spiral centrifuge settlement is used by our company for the 300,000 tons production line. The main problems are:

① After treatment the water content of gypsum is as high as 40%.

② Drying needs a large site. Causing serious environmental pollution.

③ Spiral drum every year needs repair, replacement of bearings and so on, and needs maintenance costs of 10 ~ 15 million, high maintenance costs.

### 3. Separation equipment selection and use

Through analysis and comparison of the existing equipment, we end the conventional method of only investigating in the salt enterprises study, and seek suitable solid-liquid separation equipment in other chemical and food manufacturers. After many rounds of site visits and consulting the professional manufacturer, a kind of solid-liquid separation equipment used in the starch and amino acids industries attracted our interest. That is the siphonic scraper centrifuge.

This centrifuge is currently widely used in the food, pharmaceutical and other industries.

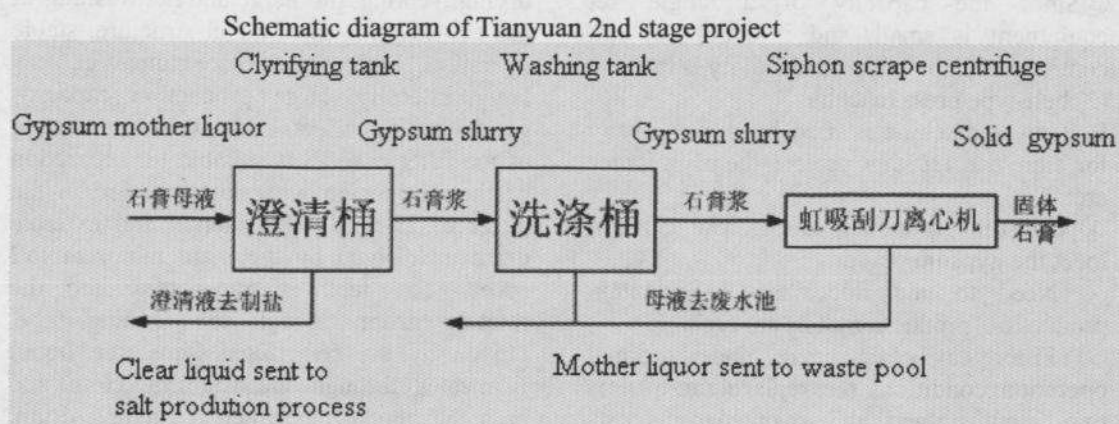
Operating at full speed, it can automatically complete the feeding, separation, washing, drying, venting, discharge and net washing. It has the advantages of novel structure, stable operation, high degree of automation, low labor intensity, large production capacity, good washing effect, and low water content of the filter cake. It is suitable for separation of the suspension with concentration in the range of 25-60%. The internal and external drum are driven by the main motor at full speed. The feed is transported into the rotating drum through the feeding tube. Driven by the centrifugal force, the liquid permeates through the filtrating cloth and pass the pore of the internal rotating drum. The liquid is gathered in the gap between drums. The liquid flows through the siphon chamber pore into the siphon chamber. Finally, the liquid is vented. The solid residue forms annular filtrate cake. After the feed reaches the target capacity, the feed stops. At this time, washing can be carried out. After the washing and separation, the scrape rotates automatically and vent the solid residue. Then, the net washing is carried out automatically and the next circle begins. In the starch industry, the separated starch has a water content less than 12%. The product is in the form of powder and the separation performance is excellent.

Through the relevant investigation and research, our company sent the gypsum product to the professional equipment manufacturer to be tested. After thousands of times of test, the production parameters were simulated, and the equipment operating status was adjusted. Finally, the gypsum product with water content of less than 12% was obtained. The gypsum product is in the form of power and the test results were excellent.

At the basis of the successful pilot project, combined with our company's actual production demand, we used the siphon scrape centrifuge in the gypsum treatment system of the subordinate units of our company-Tianyuan 2nd Stage Project. The process can be briefly described as: the gypsum mother liquor vented by the salt preparation factory is sent to the gypsum treatment tank. After clarification, the clear liquid is sent back to be used by the slat production process. The sedimentary gypsum plaster is sent into the washing barrel to be washed. Then, the washed clear liquid overflows to the waste water pool for

circulating water and is sent back to the mine mountain. Finally, the washed gypsum slurry

is pumped to the siphon scrape centrifuge and the whole process is finished.



In the September of 2006, the Tianyuan 2nd stage project was completed and the siphon scrape centrifuge was fixed. After commission and through a series of repeated adjustments, and after nearly six months of continuous operation, the product powder after the treatment were in the form of gypsum powder which has low water content (at 12% or less). The salt content is less than 1%. The single treatment capacity is 300kg / hour. The pilot was completely successful. Its operation labor intensity was significantly reduced, and the gypsum quality was remarkably improved. The gypsum products after the deal did not require drying treatment and could be sold directly. Because of the high quality of gypsum, the product sells well, and the gypsum products are in short supply, reflecting that this process is obviously beneficial. Due to less inventory, covering less, and does need a drying site of about 3000 square meters, 300,000 yuan is reduced in the investment cost.

### 3. EXISTING PROBLEM

Although the quality of products is good, but it was the first time for this kind of machine to be used in the gypsum separation. Because the manufacturer was not familiar in this field, many problems happened in the beginning. Some problems made the process stop. The problems in the commission process mainly include:

#### 3.1 Weak discharge scraper intensity

Because in the test in the centrifuge factory, the scrape was only used to treat several tons of gypsum slurry, the problems in long-term

use was not found. In practical use, because of the small gypsum particle size, the filtrate cake in the drum filter is hard. The scraper discharges from the rotating drum at a rotating speed of 20r/s and a diameter of 1.25 meters, hence friction of the scrape and the filtrate cake with speed of 78.5 m/s is serious. Because of the wear abrasion of the scrape, the contacting surface between the scrape and the filtrate cake increases and the resistance increases. Consequently, the electrical currency goes superscalar, the scrape fractures, and the fixed discharge scraper bolts fractures.

After repeatedly research and analysis, the main reason for the problems mentioned above was the incorrect material and fix angle of the discharge scraper. Improvement of was needed for the design and material selection of the discharge scrape. After 4 trial tests, in April of 2007, the problem was solved by adopting the laser processing in the design of the scrape and the scrape bolts. The equipment runs smoothly.

#### 3.2 Difficult to clean-up the residue

Solid-phase gypsum is filtered on the filtration net and forms the filtrate residue cake. The discharge scrape shaves it off. Because the relative speed of the scrape to the residue cake is as high as 78.5 m/s, the scrape can not completely remove the residue cake, or the net will be broken. Hence, the gypsum cake that is close to the filtration net becomes intensive under the centrifuge force and this will influence the water passing through the filtrate cake. Consequently, the separation performance becomes worse. As time goes on, the separation efficiency decreases, so the



hard residue cake must be cleaned regularly. At the beginning, we used the steel drill to knock the filtrate net. If we knocked it softly, the residue cake would not leave the filtrate net. If we knocked it hard, the filtrate net would be damaged. If the net is damaged, the local flow rate of the filtrate net increases, the rotating drum lose balance, and the machine vibrates seriously. Thereafter, we improved the method of cleaning the residue cake. We used a hollow pipe with a length of 60 cm. The one end of the pipe was processed into the shape of duckbill while the other end was connected to the tap water through the rubber pipe. Keep the tap water valve open. In this way, the impact was depressed and the cleaning could be carried out fast. Additionally, the cloth breakage was avoided and the problem was solved. A novel effective method was provided for the treatment of the gypsum mother liquor in the gypsum-based salt production process. This method has great potential in the future.

About the author: Hongbin Lou (1969-), male, bachelor, chief engineer of the China National Salt Industry Company, Senior Engineer, is mainly engaged in salt production technology research and technology management.