

AN APPLIED RESEARCH ON THE PLASTIC FILM COVERING TECHNIQUE OF FLOATING TYPE*

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Abstract: The plastic film covering technique of the floating type has been extensively applied to sea salt making. As a result of basic research of the technique, this thesis analyses the problems in production and put forward different methods or directions as well as practical technique to resolve the above problems. Finally, this thesis demonstrates that the plastic film covering technique is an advanced manufacturing technique created according to nature condition of sea salt making in our country and it is necessary to make this technique standardized and serialized .

Key words: floating type; plastic film; covering technique; collecting and spreading machine assembly

INTRODUCTION

The sea salt in our country originally created the plastic film covering technique of crystal pond, which is an advanced production technology combination with the natural conditions of China's sea salt production. Before raining spreading the plastic film covering on the brine surface of crystal pool, in order to protect salt and brine, segregate the rain from the film, then outside the pool at any time; after the rain away collecting films, drying salt with sunshine solar, resulting in increased production and quality of crude sea salt, and significantly in stabling and increasing production. The key of the plastic film covering technique is collecting films, there are two methods: pultrusion method and floating type. Pultrusion method structure, including: thin film, floating panels, sliding cable, pulleys, traction rope and drive equipment, are usually a number of co-crystallization using one

driver pool equipment. Its simple structure, low investment; but more than employment, a shorter film life (3-4 years) are used for the crystallization of the smaller pool. Floating type is the using of buoyancy of brine to float floating scroll on the surface of brine to reduce the rotational resistance, the use of power to spread or collect film from the floating scroll , including: thin film, floating bar, floating plate, orbit, and slide , pulleys, traction rope and collecting and spreading machine assembly and so on; there is a machine with two pools and a pool with two machines, compared to the pultrusion method it has complex structure, high investment but a high degree of mechanization, film life long (5-7 years), applicable to the crystallization of larger pools (from 10000m² to 16000m²), a wide range of applications [1].

The plastic film covering technique has been applied in sea salt production in China for more than 40 years, from the initial pultrusion method to

the later floating type, the technique has made great progress, compared to the rapid development of industrial technology and computer technology, it has slow development and there are still many problems need to be solved. Due to the specificity of the environment of sea salt production, as well as traditional low-precision equipment, restricted the

CONDITION OF TECHNICAL EQUIPMENT OF THE PLASTIC FILM COVERING TECHNIQUE OF THE FLOATING TYPE

Components: collecting and spreading machine

plastic film covering technique to further enhance, after testing and researching the technique, the author thinks that the basis of technology and equipment are the key of the problem, should improve its reliability, to meet the requirements of modern control technology.

assembly, floating scroll, orbit, and slide (track), roller traction, traction system, sub-rope, and plastic film, floating plate, drop, driven wheel, showed in the Figure 1 [1].

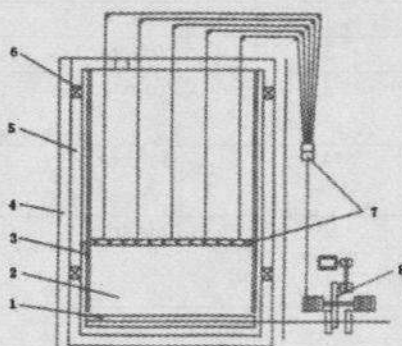


Fig. 1 The Equipment diagram of the plastic film covering technique of the floating type in crystal pool

1. Floating Scroll 2. Plastic Film 3. Slideway
4. Discharging fresh water row 5. Crystal pool
6. Outfall 7. Traction System (floating plate and traction rope) 8. Collecting and Spreading Machine Assembly

Process

When covering with plastic film, start floating scroll, make the film into the orbit with the traction system, covering the surface of the brine regularly; when collecting the film, collecting and spreading machine assembly driving reversing floating scroll, film neatly back to the floating scroll.

There are two main forms:

Driven respectively

There are two sets of motor and reducer components, respectively leading floating scroll and traction roller.

(1) Spread Film

Ikegami: Motor (Forward) - Coupling - roller reducer - roller axle - Traction roller - tight rope
Pool under: Motor (reverse) - Coupling - floating scroll reducer - floating scroll

(2) Recover film

Ikegami: Motor (reverse) - Coupling - roller reducer - Traction roller
Pool under: Motor (Forward) - Coupling - floating scroll reducer - floating scroll

Focus-driven

Mainly driving by a suit of motor and reducer, using the clutch on or off to drive floating traction bar or traction roller axis.

(1) Spread film

Motor (Forward) - reducer - double the output shaft (each at about or perpendicular)

The right output shaft - cardan shaft - coupling - Floating Scroll Left output shaft - traction roller clutch - Chain Drive (need to install) - traction roller

- traction rope - floating plate

(2)Collect film

Motor (reverse) - reducer - cardan shaft -
coupling - Floating Scroll

The traction roller friction clutch making it
disconnect, traction free rotating roller, collecting

film only rely on floating scroll rotation.

Technical parameters and applications

Table 1 Performance Parameters of Parts of Plastic Film Covering Equipment

Serial number	approach of collecting and spreading	Single-pool area (m ²)	The number of drive pool	Power of collecting and spreading machine assembly (kW)	Speed of collecting and spreading (m / min)	Applications
1	Floating type	176×88=15488	2	7.5(electricity)	7.5~9	Tianjin Hangu
2	Floating type	142×64=9088	1	3(electricity)	13.17	Tianjin Tanggu
3	Floating type	178×50=8900	2	5.5(electricity)		Liaoning Yingkou
4	Floating type	155×53=8200	2	2.2(electricity)	10.8	Guangdong Xuwen
5	Floating type	154×71.4=10995	4	55(petrol)	10	Shandong Chengkou
6	Floating type	131×40=5240	2	3(electricity)	12.1	Zhejiang Salt Company

The SJ plastic film covering technique of the floating type equipment researched and developed by Salt Research Institute, using Ikegami, under the sub-pool structure, that is, two machines form a pool. This structure is easy to operate, reliable, suitable for a wide range of application, can be used

in the crystal pool, the brine reservoir tanks and liquid chemical storage tank and so on. To meet the power outage was still being used in the equipment; it has a clutch connected to other power operations to complete operation.

Table 2 Performance Parameters of SJ Plastic Film Covering Technique of the Floating Type Equipment

Model	SJ—350	SJ—450
Covering Capacity (m ²)	<9000	<11000
Covering Speed (m/min)	9~12	9~12
Motor Power (kw/each machine)	3	4
The number of motor(each machine)	2	2
Floating scroll diameter(mm)	350	450
Roller diameter (mm)	340	440
Voltage of control system (V)	36	36

The SB plastic film covering technique of the floating type equipment developed by Tianjin

Changlu Haijing Group, composed of traction covering and floating recovery, has two sets of

power and transmission, operation can be completed respectively, can better resolve the problem of the asynchronous speed between spread and traction.

MAIN FEATURES OF PLASTIC FILM COVERING TECHNIQUE OF THE FLOATING TYPE EQUIPMENT

Reducer and Clutch

Type of reducer are: common cylindrical gear reducer, bevel gear reducer, worm reducer, as well as combination form with them, compatible with reducer are the embedded teeth clutch, friction clutch, overrunning clutch and the electromagnetic clutch, the latter two can automatically adjust the speed synchronization between traction rollers and retracting film of floating scroll within a certain range. In order to better meet the floating scroll up and down with fluctuations with brine level changes, some reducer directly installed in the end of floating scroll, part of the shell of reducer is also

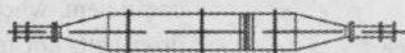


Fig. 2 Structural Diagram of Floating Scroll

Technological requires when plastic film over floating scroll, floating about $1/2D$; when spread the plastic film, floating more than $2/3D$ (D is floating scroll diameter). In the same collecting and spreading length, floating shaft scroll smaller with more film layers, speaker more likely appears in shaft end, the reason is there are pressurized multi-layer film and nylon rope at the edge, in addition, plastic drop make the plastic film on both sides thicker than single-layer of the middle, caused as rolling film, loose in the middle and tighten in the both ends, make the floating plate into a curved plate, as a result of shaft end flared has large diameter, spread the same round, its length longer than intermediate, make the entire film loose in the middle and tighten in the both ends, drop difficultly enter the orbit. So make the structure of floating scroll at both ends have to be made of the structure of taper.

floating on the pond, floating synchronized with the floating scroll up and down.

Floating Scroll

It is used for collecting plastic film. In order to make floating scroll float on the water surface, basically use the thickness of about 3mm steel plate into a roller, for the conical surface at both ends, intermediate for the cylindrical (See Figure 2), roller diameter is 350-450mm. Taper at both ends of approximately 1:2-1:3, in order to facilitate the assembly and transport, each scroll is divided into several sections, each is 7000-8000mm long, connect each section with the flange connecting bolts. Due to high differences in the width of the crystal pool, using one section of floating scroll to be the adjusted section, to adjust the length of floating scroll. It can make itself adapt to the width of the crystal pool. In order to enhance the life of floating scroll, covered the roller surface with plastic foam and plastic film, and take anti-corrosion measures.

Floating Plate

The floating plate using traction rope, can driving plastic film in parallel, when floating scroll collecting the plastic film can make traction rope back to original location. The larger crystal pool, the longer the length of collecting, the greater the traction rope tension, the floating plate is required higher strength, current material of floating plate are timber, bamboo, plastic. The plastic commonly is used into hollow floating plate.

Traction rope

Traction rope material include plastic rope, hemp rope, wire rope, etc, as a result of the hemp rope after the water gets heavy, resistance increased, the wire rope easily corroded by brine, the traction rope connections with floating plate, due to soaking in brine, it is necessary to using the plastic rope, by the composition of 5-7 ropes, the total traction rope use of wire rope (or hemp

rope). The total traction rope spreading or collecting directly around or into the traction roller, roller diameter, length, location of ranked rope directly impact on the smooth of speed and synchronized of the work, such as the diameter difference between the outermost layer and innermost layer make difference in the speed, caused the speed is uneven; if single-row open ,need large length of scroll, using row rope on the rope reduces the length of scroll, rope difficultly arranged neatly, both two forms are applied at present. Salting on the rope increase resistance ,as measured, when there is no salt on the rope, traction is 8000-10000N、 changed to 10000-12000N with salt,16-20% increase in resistance, attention should be paid to the timely fighting rope to clear the salt.

To make the rope have uniform force, and achieve shift, devices have sub-rope device, each rope through sub-rope devices, connected with the total traction rope, variations bodies of each rope and rotating bodies of sub-rope device, all adopt a fixed pulley, change sliding friction of the rope to the body into rolling friction.

Slide (track) and the Insertion device

Collecting the plastic film, films were volume on the floating scroll, the drop on both sides of film

leave the chute beside the pool; spreading the plastic film, expanding film by the floating plate, floating scroll, slideway, drop, then drop into the slideway through the insertion orbit device, slideway and insertion orbit device is the key components to whether the equipment is reliable. Require straight smooth slideway, corrosion-resistant, small joint gap.

The insertion orbit device using at present include structural steel welding, plastic structure (see Figure 3) and the mixed structure of steel. The material of slideway and insertion orbit device include ordinary carbon steel, PVC and glass fiber reinforced plastic, Ordinary carbon steel is stiff, and thermal expansion coefficient is small, is not easy to deform, single-length is long, but has poor corrosion resistance bitter; PVC has strong corrosion resistance, easy processing, easy to install, but less stiffness, the easy deformation suffering the lateral force[2]. The glass slideway overall use of glass fiber materials, connect cards and tube by the sticky and riveting technology, rugged, long life, the small deformation coefficient and friction coefficient, when running do not stuck the ball, not drop ball, not tear cloth, has a good performance, easy to install and operate.

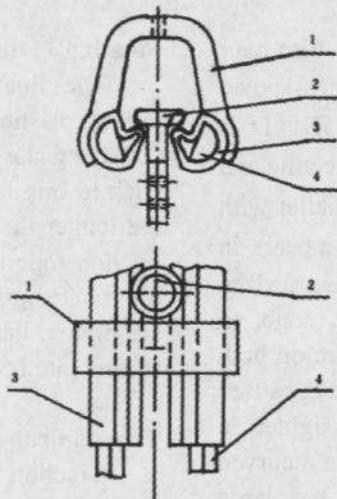


Fig.3 PVC Slideway Structure

1. Fixed Card 2.Drop 3. Slideway 4. Connecting Pin

Plastic Film and Plastic Drop

There are two types of the plastic film used in plastic film covering technique are: white and black.

The material is often using PVC. Black films are usually added to the high carbon black pigment, and carbon black is the most effective light

shielding stuff to prevent film from aging caused by light, it filter the UV having greatest impact on the PVC film, thus greatly improving the performance of tolerance light aging of film. Now widely used is the black film. Thickening and enhancing on both sides of the plastic film, that is flanging and added many strings in it, strong bonding, forming a thickening layer bearing longitudinal and transverse tension, fixing drop on it at a certain distance and play the role of tightening film. Drop is the largest amount of components used in the equipment, materials are nylon, polypropylene, polystyrene, etc., and its performance should be hard, smooth, small friction coefficient, high strength, ease of orbit and glide.

Wrap

It is used to press the film on the floating scroll, also has the leading role, can increase the stiffness of floating scroll, and increase system reliability. It has a good protective effect on plastic film. Stent of wrap is casted by cast iron, rigid, and resistant to corrosion of brine. For gray cast iron main, the outer surface of rubber of the die-casting, the overall is high strength, strong resistant, long life, easy to install.

MAIN PROBLEM AND TECHNICAL MEASURES

Asynchronous spread film

As a result of plastic film on the floating scroll spreading, its outer diameter change from large to small, resulting in the linear velocity of spreading film gets small; at the same time because traction roller continuous winded by traction rope, its outer diameter gradually increasing. A difference occurs between spreading film line speed and line speed of traction rope, the difference will be gradually increased with the continuous plastic film spreading, if not timely adjusting them to synchronous, will have an impact on the effect of plastic film covering, can not completed the work, even damage plastic film covering equipment. The traditional method is manual adjustment, however, do not adjust in time and the effects is poor. The operators operating in a corner of the room can't observe that

the functioning of the whole system, so more people need to surveillance the operation of systems in key locations, due to noise of transmission, the impact of external factors such as wind, signals sometimes can not be accurate transmitted from monitor staff to the operator, which may result in the expansion of the incident.

One of the measures to solve is the remote control, the advantage is reducing monitoring staffs, achieving the remote control, when there is no synchronization, deviation, the stuck, film winding inequality, control the motor to stop and start-up in the edge of the pond can be long-range (200-300m)[3], to some extent, protect the film and transmission equipment.

Using computer-controlled experiment, install a pulse generator (photoelectric) in the reducer output shaft to records the number of reducer rotating ring, converted into the straight-line distance each film turned out, and to establish its running mode, recorded in the single board computer memory, control by changing the output speed, to ensure the uniformity of film line speed. The main problem is the elongation of the plastic film is continuously changing with the temperature and tensile changing, in addition, more plastic film joints, computer difficultly collect data, to achieve automatic control for further research.

One salt field used a friction wheel contact with the plastic film to obtain film of the length and speed of collecting, the principle is that through the changes of speed signal of the friction wheel, to adjust inverter to control the speed of motor output, however, due to the phenomenon of friction slip, the data is not accurate, affect the control accuracy. Thus detection of the photoelectric sensor speed and magnetic induction sensors can accurately detect the speed reducer output shaft, however, through the servo device and automatic adjustment device feedback the actual speed of film rapid to the control device, make compensation, in order to accurately adjust.

Plastic Film Mechanical Damage

Mechanical damage or break of the plastic film is a common form of film failure, the film often having mechanical damage will not be able to use not yet reached the degree of aging of failure.

The form of mechanical damage includes tear, pull off, cut, crease, wear and tear, plastic deformation.

(1) When spreading film, the line speed of weaving out film on the floating scroll and the line speed of rope of traction roller is not synchronized

Due to the non-synchronous, made the film under a certain tension originally be further stretched, when the film beyond the scope of elastic deformation will result in plastic deformation, even tear, pull off, severely damaged. Due to at the beginning of spreading film, the floating scroll are winded by multi-layer films, diameter is large, line speed of film output is greater, excessive stretching is less than the mid and late.

(2) Brine depth is not enough

Film density is greater than the density of brine, film has sinking trend in the middle part, if the brine deep is not enough, when collecting or spreading film, the plastic film layer contacts easily with the salt, salt will scratch film, resulting in mechanical damaging.

(3) Drop can not orbit or out of slide

Drop can not orbit or out of slide, significantly increase the tolerance of the adjacent one, when the film beyond the scope of permitted strength, it will tear the film or pull off the film of the junction of drop.

(4) Low Precision of Slideway Joint

The slideway using plastics and the production of thin steel, often have a deformed used for a period of time, made drop not run smoothly in the slideway, and slideway are sub-production, field installation, bad or uneven joints or too large cracks may cause the drop stuck, resulting in mechanical damage. Crystal pool area is large now, such as a crystal pool of Hangu salt field, its length is 176m, width is 88m, this brought difficulty to layout the slideway, its straightness, joint roughness, and the number of joints has a direct impact on the control of speed and reliability.

(5) Brine leakage to the film, salting on the surface, collecting film caused mechanical damage.

(6) Pulley and wrap Inflexible operating

Pulley and wrap Inflexible operating or break down, increased resistance when collecting films, the wrap directly tear the film, these cause film mechanical damage.

(7) Film mechanical damage in the processing

and installation

Film at the factory is not the size of the structure of the standard crystal pool, its width to heat and to be widening, the edge of film to be thickened, reinforced and perforated, front-end of film stapling with floating plate, a part of improper processing directly injury the film; the second is in the using reducing film strength, stay hidden, the result is the plastic film will be premature damage, failure.

In addition, in the process of plastic film covering, the plastic films are often too tight, too loose, blocked. Too loose make plastic film rewind in the wrap, caused tearing cloth; too tight make the plastic cloth deform, reduces the service life of plastic film, if the tension is too large, it can happen to tear cloth, rope stretched great traction off, seriously, will make floating scroll out from the wrap, resulting in damaging or deforming floating scroll.

In view of the above issues, it is necessary to carefully processing and installation of equipment, attention should be paid to use a variety of protective measures, carefully check the drop-orbit, do not install film in wind weather. When collecting film, in time to cover to prevent a long time exposure to sunlight and to remove salt accumulation on the film.

In the collecting and spreading process, in the preparation stage to check all the equipments are indeed intact, the depth of brine requires more than 6cm in salt field. Timely clean-up the salt on the plastic rope, to reduce the collecting resistance, clean the deposit salt in the ditch under the floating scroll, to prevent drawing film blocked.

Anti-corrosion Machine for Collecting and Spreading

As other equipments in salt field, anti-corrosion is very important for the machine for collecting and spreading. Choosing of bittern corrosion-resistant material as the basis for machinery and equipment, regular cleaning, painting with corrosion-resistant coating, positive selection of a variety of plastics to replace metal materials, Such as plastic pipe, plastic pumps, plastic rope, plastic bearings and other mechanical equipment in the salt industry has been widely

used.

The Resistance of Traction rope and Sub-rope Device

Traction rope rope-oriented devices and sub-rope device use fixed pulley body, making sliding friction into rolling friction to be effective in reducing resistance. However, the pile fixed pulley (shaft) still insufficient stiffness and strength (wood piles more), there is excessive deformation or fracture, resulted in increased resistance. At the same time after traction rope leaving the crystal pool, both easy to crystallized on the rope and produce deposited silt due to a long time contacting with the ground, have generated resistance to itself and the sub-rope devices. So as far as possible using steel wire rope to be the total traction rope, when arranging rope, as possible as to reduce the bend number of rope, and to reduce directly contacting with the bare ground.

The Coordination of Transformation of Salt Field and Plastic Film Covering Technique

As the salt is a low value-added products, the technological transformation of the salt by the financial and technical constraints, both require plastic film covering technique matching salting technology, and in the transformation of salt field to take fully attention to the working conditions of equipment and technical specifications, such as the direction of collecting and spreading film should be oriented towards the main wind direction for the benefit of the wind to cover the film, to reduce the effects of side wind, as well as the severe weather damage to the film. Strengthen the research of plastic film covering technique and the management of the crystal pool, make the equipment reliable and efficient; strictly implement management practices in the rainy season, such as: when starting machine for collecting and spreading, spreading the plastic film, timely adjust the speed of traction roller and floating plate, in order to maintain plastic film in the state of tension, drop automatically into orbit and wrap have not bitten cloth. After spreading plastic film, must tighten the plastic rope, bolting the drawing rope of floating plate, were covered the place easy to inlet the wind with bags to prevent inlet the wind. Connecting to

fresh water emission, movements of brake to be flexible, finding have brick or blockage phenomenon to timely clean up, do more checking in the raining, prevent leakage of fresh water emission and brake. Ensure plastic film covering technique meeting to standards, enhancing the rate of freshwater discharging.

CONCLUSION

Sea salt production is a full use of solar energy, non-polluting industries, will exist in a long time. As a result of the rapid development of coastal areas, the land resources for sea salt production has been continuously occupied, further enhancing the single sea salt production is a new topic, this provides an opportunity for in-depth studying of plastic film covering technique, taking full account of the specificity of sea salt production processing, such as open-air operation, humidity, brine corrosion of metals, and strong seasonal, strengthening the basic research on the floating type, designing orbit and slideway in accordance with its kinematics and dynamics characteristics and pull in the monitoring devices.

The plastic film covering technique need making application-specific standard as soon as possible, to be standardized, universalized, and serialization of development, thereby reducing production costs, easy maintenance, application of automatic control methods to improve the technical level of the salt industry machinery and equipment.

References

- Liu, W.L., Zhang, X.K.,2005.The Application of Remote Sensing Technology using in Salt Industry. First Asian Salt Forum.
- WANG Zi wen, DUAN Run bao, HAO Li wen, LI Jian gong. Automatic Control of Plastic Film Cover System of Saltpan[J].Sea-lake Salt and Chemical Industry, 2003, 32(4): 25-29.