THE DESIGN STUDY AND ECONOMIC ANALYSIS OF THE SALT-MAKING ENTERPRISE'S PRODUCTS WAREHOUSING AND STACKING

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Abstract: This paper introduced the key points of the products warehousing and stacking design of those well rock salt making enterprise's, and analyzed the three types of stacking equipment's advantages and disadvantages. According to the actual use, illustrated through analysis that the stacking way should act as circumstances permit.

Key words: storage products, stacking; package type; bridge-type stacking machine, high stacking machine, manipulator stacking machine, economic analysis

1. PREFACE

Major well rock salt making enterprise's products warehousing and stacking is an important step in its production. Due to the large production scale, the products' stacking, warehousing, transportation and delivery are very important. Especially at the enterprise's technological innovation period, it plays a very important role to carry out the product's warehousing and stacking design well and reduce the production cost. I obtained some experience from our factory's distribution technological transformations project, and in this paper I share the experience with everybody.

When designing the product storehouse, factories should fully consider the product's quantity and kinds; then select the corresponding packing equipment and stack the products in different districts. At the same time, the present situation and future development of the warehouse, the mechanized degree, the warehouses' internal management method and the pass in and out requirements of the warehouse should also be considered. Each work's security must be obtained so as to form the sole distribute direction. The unloading and arrangement of storage place of the products that come from the packing line must be adapted to the warehouse's production process. The best way is to flow at a fixed direction. We should try our best to short the stored product's stacking transportation distance; and reasonably arrange the storehouse's stacking area according to the operating method and the variety of the warehousing product. The product's stacking should be completed just in one time, and maximally use the warehouse space. Gain the biggest profit by the smallest warehouse cost.

2. SALTY PRODUCT'S CATEGORY

According to the well rock salt product's packing type, at present, most big package salt products in the market is basically 25 kg/per bag, 50 kg/per bag, 1000 kg/ per bag. The products of 50 kg/per bag are quite many, but 1000 kg/per bag salts directly supply those chemical companies. Their stacking methods

are quite fixed, no matter use the forklift or the cargo transportation. But the stacking method of 50 kg/per bag is different and its cost is different due to the different stacking method.

3. DESIGN RESEARCH OF THE SALTY PRODUCT'S STACKING WAY

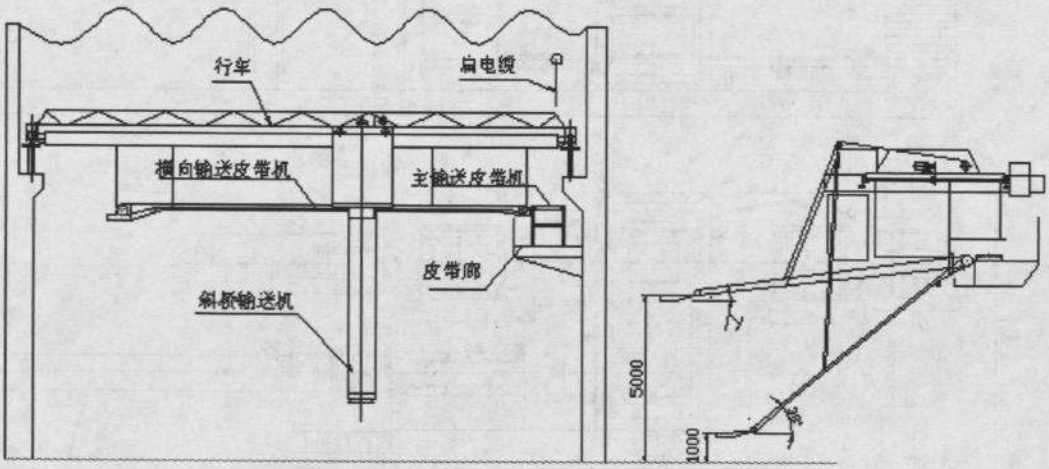
3.1 stacking ways

At present, most big enterprises generally use the bridge-type bag loader, the high key charter flight stacking machine and the manipulator stacking machine for the 50 kg /per bag product, because of the big output. This three stacking machines all have their advantages and disadvantages. The author believe the stacking way should be selected according to enterprise's actual situation.

3.2 Application of the bridge-type stacking machine

3.2.1 bridge-type bag loader's structure features

The bridge-type bag loader is generally composed by the main transportation belt fastener, the runway girder, crosswise transports the leather belt, the pitch transportation leather belt and the electric control system. The structure is quite simple, the technology is mature. The service life is long if the related high quality spare parts are selected. Equipment's installment is not complex, but equipment's install height has certain space requirement, the arrangement of the packaging machine and the bunker position is rather high, it is convenient for those enterprises that its product dry bed and the packing house has the arranged height. The bridge-type bag loader's stack is rather high, generally can pile up 24 packages (approximately 3.6 meters). The operation is simple, the equipment maintenance is simple, does not take the storehouse area. But the bridge-type bag loader's guide rail and the main transportation belt and the corridor must be considered when designing. The bridge-type bag loader's guide rail and the main transportation leather belt's position, theoretically speaking, can be up set or down set. But considering the salty dust's strong corrosiveness and looking from the operation reality, the bridge-type bag loader's guide rail should put in the main transportation belt's upside, establish a cab on the bag loader and its all around movement operates by the worker in the cab. After localized the pitch transportation belt, the transport salty package should be piled by man-power. The operation is simple. The bridge-type bag loader only occupies the space, does not occupy land area, and its structure like the following chart.



桥式码包机示意图

The disadvantage of using this method is that the piles must be dismantled by hands when loading. The labor intensity loading operation is slightly high.

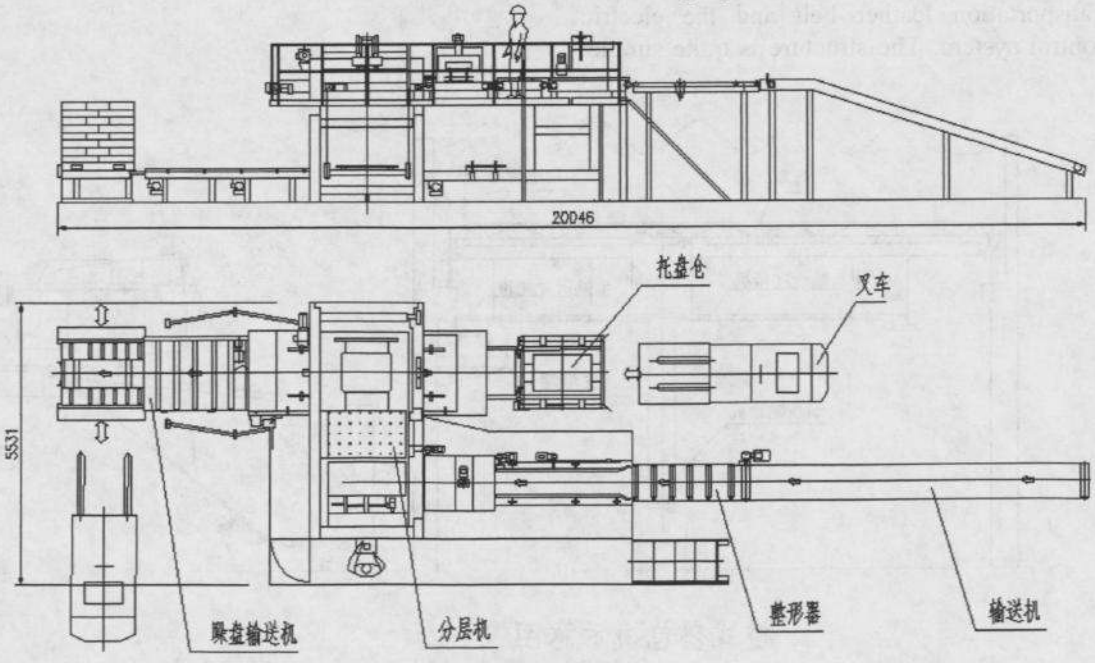
3.2.2 bridge-type bag loader's speed design

Bridge-type bag loader's operations include: one is running along the guide rail; the other is bag loader car's running (pitch transportation belt machine). Theoretically speaking, it can be bigger or smaller. When designing, you must consider matching the main transportation leather belt's running speed. But main belt's speed is decided by the packing line's speed. If two packing lines are used for a bag loader, its main belt's transportation capacity may generally be in the range of 1600~2000 packages /per hour. Considering that the salt packages running on the main belt will get to the crosswise transport belt through the curve machine, the salt package's spacing should be designed to be 1.5~3 meters. Therefore, the speed is 0.8~1.6 m/per second. Through the observation of the practical application, the main transportation belt's best speed should be about 1.0 m/per second. If the main belt's speed is too high, it's easy to blow off the package or rotten the package. If the speed is too slow, the salt package's density increases, which will impact the curve machine's running.

3.3 High charter flights' application

3.3.1 Structure features of high charter flights

High charter flight is generally composed by the pitch transportation belt, the reshaping conveyer, the slow even pressure even conveyer, the indexing conveyer, the grouping machine, the push and press bag machine, the lamination machine, the elevator, the tray warehouse, the tray conveyer, and the pile plate conveyer. The equipments are arranged on the ground. Compared with the bridge-type bag loader, this kind of installment is more convenient. The stacker and the packaging machine located at the identical plane, so its operation is quite intuitive and easy to be automated. Using the tray to pile the package, the forklift to stack, pile can be stacked to be three layers (24 packages of salts, top height is about 4.05 meters), load by the forklift. The entire work is easy to be mechanized. But the high charter flight need much area and affects the reserves. Using the high charter flight; the salty package that comes from the packing line can be transported to the stacker after reshaping. Charter flights is approximately 21 meters long and approximately 6 meters wide, occupying a footprint of $21\times6=126$ m^2 which needs much land area, as shown by the following figure:



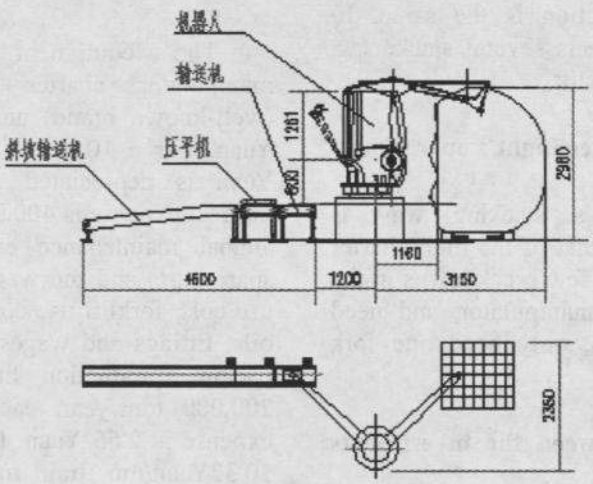
高位码垛机结构示意图

3.3.2 High charter flight's speed design

The high charter flight's running speed is mainly determined by its packing line's speed. Because the salty package has short transportation distance and needn't to make a turn, the salty package's blow scratching is rather few. The bag loader's pile ability is possible to reach 1400~1600 packages /per hour without accident. But the piling plate's transport in fork garage is closely related to the piling position. If one forklift is used for a stacker, the line of the packing piles to the warehouse's far-end can't surpass 200 meters or a forklift would be insufficient.

3.4.1 Manipulator charter flight's application

The manipulator charter flight conveyer is mainly composed of the reshaping machine and piling robot. Its running speed is related to the manipulator's programming. Its key point is the manipulator's swinging scope and amplitude vibration. Robot's gripping performance is the very essential part, involves the shapes of the piles and plates' neat and artistic. Due to the low installment area of the manipulator, the storehouse can have a high using rate. Using the manipulator to pile the salty package that comes from the packing line would be transported to the mechanical gripping device's scope after reshaping. the transportation and reshaping line has a length of nearly 6 meters, its width is approximately 3.2 meters, the scope of the mechanical gripping device is 3.2×3.2 ㎡. Therefore, the occupying land area is $6\times3.2+3.2\times3.2=30$ m^2, the area is not big, like the following graphical.



机械手码垛结构示意图

3.4.2 Manipulator's running speed design

Manipulator's running speed is mainly determined by the operating frequency and its packing line's speed, the manipulator can grip a package or two packages in one time, and its operating frequency is about 800 times/hour with high quality. The machine has been used by Shuncheng Salt-making Company of Sichuan Hebang Group and the Shandong Taiyue salt-making Ltd.. All run well. The salty package pile's shapes on the tray are similar to that by high charter flight.

4. Economic analysis

4.1 Bridge-type bag loader's operation

A salt-making enterprise has purchased 3 bridge-type bag loaders when constructed the railroad trestle warehouse in 2005 and has started production in the second half of the

year. The phenomenon of rotten, falling and scratch is serious, because of the long transportation belt of the salty package. Moreover, due to the over high speed of bridge-type bag loader's main transportation belt which is 2 m/second, the operation was always unstable. In 2008, after transformation, the transportation belt machine was changed to under the bag loader guide rail, establishing concretes corridor for the main belt machine. The main belt's inspects was convenient and safe. At present, the 3 bridge-type bag loaders run stably. Each bag loader supplies a packaging machine automatically with an output of 860~1000 packages per hour. 3 operators were required for each bridge-type bag loader: one for operating, one for piling, and one on rest.

4.2 High charter flights ' operation

A company purchased four top digit stackers in 2007. The difference with the bridge-type bag loader, mainly is the stacking way. The packing section is the same. In operation, a man inspects several stackers, a man for piling with forklift.

4.3 Manipulator charter flight's operation

The manipulator's stacking way is basically similar with that of the high charter flights. There are quite few breakdowns in the earlier period of the manipulator, and need less operate personnel, only need one fork worker to pile.

4.4 Comparisons between the investments and the operation cost

For a convenient cost comparison, we answer the questions through analysis of an enterprise's production process data.

4.4.1 Cost expenses of the bridge-type bag loader

Bridge-type bag loader and its main transportation belt's direct expenses are 1,650,000 Yuan. For 10 years depreciation, 165,000 Yuan is depreciated every year, and the indirect expense is 125,000 Yuan (equipment's annual maintenance expense, including spare parts cost and the wages of the operators). For a packing production line with capacity of 200,000 tons/year, each ton salt's stacking expense is 1.45 Yuan, and the loading expense is 8.90 Yuan/ton (train transportation). The total expenses of stacking and loading is 10.35 Yuan/ton.

4.4.2 High charter flights' cost expense

The equipment cost of the top digit stacker (entirely stainless steel), forklift (well-known brand) and so on is 1,390,000 Yuan. For a 10 years depreciation, 139,000 Yuan is depreciated every year, and the indirect expense is 400,000 Yuan (equipment's annual maintenance expense including the spare parts and wages for the operators, tray cost, forklift cost which includes fuel oil, fittings and wages for operators). For a packing production line with capacity of 200,000 tons/year, each ton salt's stacking expense is 2.70 Yuan, the loading expense is 10.32 Yuan/ton (train transportation), and the total expenses of stacking and loading is 13.02 Yuan/ton.

4.4.3 Manipulator charter flight's expense

The equipment expense of the manipulator charter flight and forklift (well-known brand) and so on is 1,090,000 Yuan. For a 10 years depreciation, 109,000 Yuan is depreciated every year, and the indirect expense is 400,000 Yuan (equipment's annual maintenance expense including the spare parts and the wages for operators, tray use cost, forklift use cost which includes fuel oils, fittings and wages for operators). For a packing production line with capacity of 200,000 tons/year, each ton salt's stacking expense is 2.55 Yuan, the loading expense is 10.32Yuan/ton (train transportation), and the total expenses of stacking and loading is 12.87 Yuan/ton.

5. CONCLUSION

Through the above analysis, ignoring the variation of the storehouse's building cost, if the working condition premised, selecting the bridge-type bag loader needs the least packing expense, the manipulator charter flight's cost expense is higher, and the high key charter flights 's cost expense is the highest. But from the standpoint of the work environment and method, the high charter flight and the manipulator charter flight are more mechanized, and are more suitable for the big enterprises. From the standpoint of the

equipment's technical aspects, the bridge-type bag loader uses the general technology and requests less skill of the operators, the high key charter flights and the manipulator charter flight are high technological equipments and request high skills of the maintenance personnel. The maintenance intensity of these three kinds of equipment's is not too high according to the situation of the companies using these equipment. Therefore, the enterprises with different loading ways can choose the suitable equipment according to their characteristic.

About the author:
Qiushi Xie (1962-): male; born in Shaoyang, Hunan province; senior engineer. At present works in the science and technology department of Xiangheng salt mine; has engaged in the works of salt's production, process, equipment, technological innovation and management for a longtime.