The development of grain storage silo in Tianjin, China

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Abstract

Silo is a kind of modern grain storehouse, which covers a small area and has a larger storage capacity per unit area. It is easy for the realization of mechanized and automated operations as well as scientific management. The silo can meet the requirement of high working efficiency, large storage capacity and fast grain circulation. The storage capacity in silos has increased quickly in China. The state grain warehouse in Tianjin urban possesses more than 50% of the total national silo capacity.

The Types of Grain Storage Silo

The height and the diameter of silos in Tianjin are usually 15 – 35m and 6 – 8m, respectively. The diameter of some steel plate silo is over 8m. A group or several groups of silos and working towers are together formed a whole structure. Single-row or multi-rows arrangement makes the shape of silo group a square or a rectangle, which is to be specified according to the topography, technology, engineering geology and construction conditions.

(1) According to their working functions, the silos are divided into four kinds as follows: the receiving silo, the storage silo, the transfer silo, and the raw material process silo.

- The receiving silo: It is responsible for receiving the grains from peasants and farms and not used for long term storage. There is only some small scale or movable machinery in it.
- The storage silo: The silo is used for long-term grain storage. Its storage capacity is larger. It is provided with fixed equipment for grain entering and out-going, cleaning up, weighing, ventilation, etc. The prevention and cure functions are perfected.
- The transfer silo: The more advanced mechanized and automatic large-scale silo is set up in the grain warehouse along the railroad line and port. The steel plate silo located in XinGang of Tianjin is an example, which capacity of a single silo reached 4500t, the total is 14 silos and the total capacity is more than 60,000 tons.
- The raw material process silo: It is used for storing the grain and oil process raw materials for the different types of grain process factories. In the past, the brick silos were set up, and currently most of the silos were made of steel plate.

(2) According to the construction materials, the silos can be divided into reinforced concrete, brick and steel plate silos.

- The reinforced concrete silo: The top and body of the silo are both made of reinforced concrete. The sliding form construction technique was used.
- Brick silo: The body of the silo is made of bricks. Its top was made of pre-fabricated plate. Because of the low cost, easy construction level, in the initial stage, it was the most popular silo type. Now the production of the clay solid brick had been limited. The development of this type of silo will be influenced to a certain degree in the future.
- The steel plate silo: The development of this type is fast, because the dead weight is light, the requirement for the base brick is not very strict, the standardization degree is higher, the construction period is shorter, and the cost is lower.

(3) According to the shape of the silo bottom, the silos are divided into cone bottom and flat bottom types.

(4) According to the section of the silo, the shape can be divided into three kinds: round, square, rectangle, and the round is more popular.

(5) According to the capacity and height of the silo, the medium and small-scale deep silos are more popular.

The Accessory Equipment with Various Functions

The silos are usually set up more advanced accessory equipment for loading and unloading, conveying, weighing, cleaning, prevention and cure. It brings the characteristics of large quantity grain storage and quick circulation into full play.

(1) Entering grain into silo: For the unloading of the ship at the port, the pneumatic unloader is often used to convey the grain into the transfer silo or load the grain directly onto the truck. For the grain unloading from the train and truck, the dump pit should be set up beside the silo and along the special railroad section for unloading grain. The level of underground water in Tianjin is higher, for the grain unloading from the train, the
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Silo Grain Storage
Safety and Preservation

In accordance with the change of ‘three temperatures’ in the silo and peculiar law of insect and mould activity, the corresponding scientific methods are used to ensure the safety of the stored grain.

1. Strictly control the quality of the grain entered in silo:
   The entered grain should be clean, saturated, and non-insect. The grain, which is different in variety and moisture content, should be stored in the different silos. The polluted, deteriorated and heat-generating grain is prohibited from entering the silo.

2. Grasp the suitable opportunity for entering the silo: For the grain to stored over a long period, the suitable time is from the end of autumn to the low temperature season at the beginning of spring. After being filled with grain, the silo should be properly sealed. Thus the grain stored in silo can be retained a lower temperature over a long period. If the stored grain entered in a silo is not same batch or origin, the difference in grain quality should be paid attention.

3. The silo transfer or ventilation, temperature dropping:
   When grain has been stored in a silo for more than half a year, transferring or ventilation should be carried out. With the lower temperature of grain, the storage time may be properly extended to avoid the transferring or ventilation in summer. When the grain was entered the silo in summer, then the ventilation and temperature dropping should be done at the end of autumn. The ventilation pipe system had been installed in Tianjin grain storage silo for mechanical ventilation. The arrangement of pipe is like the shape of the Chinese character ‘I’ and ‘|’. Now the multi-purpose piping system is being used in the whole nation. The benefit of this design is not only in good ventilation effect, but also in many other prevention and cure functions.

4. CO₂ atmosphere controlled grain storage: Fill CO₂ into the silo, which is sealed properly. Regulate the atmosphere composition in the silo to control the activities of insects and mould, and to delay aging of the grain and deterioration in quality. The ratio of CO₂ in atmosphere in silo should be above 70% and should not be reduced lower than 35% within 14 days. When filling CO₂, the multi purpose piping system is used to promote the circular ventilation in the silo.

5. Because of the big capacity of the silo, the material that after a silo was emptied out, it should be cleaned up thoroughly, then the new grain can be loaded in.

The Comprehensive Management
for Grain Storage Insects

There is a lot of stored grain in silos. It is quite easy that the stored grain get damp and heat because of the respiration of grain, insects and mould, especially in the high-temperature season. After the grain was entered the silo, its temperature will drop very slowly and is suitable for the insects activity over a long period so that the grain will heat. Many safe, economic and effective methods are used to prevent and cure the insect.

1. The clean up and sanitation to silo: There should be no residue grain, no dust and no insects in the emptied silo. The windows, walls, and floor as well as machinery equipment in the silo should be clean up or sterilized periodically.

2. Grain protectants: The protectant should be mixed in spring with the grain to spend in summer. If the whole grain in silo was mixed with protectant or it is done alternately in different layers of grain, the prevenion effect will be the best. If it is done only on the surface of grain pile, the multi-purpose pipe system should be used to carry out the circular ventilation to make the agent spread evenly. Once the protectant was applied, the grain pile or the silo should be properly sealed.
(3) The storage under low dosage of application: The storage under low dosage of application is often carried out when the temperature is lower such as in the spring. After applying low dosage of insecticide, the silo should be properly sealed, and the circular ventilation should be done in a shorter time.

(4) Fumigation: In order to make fumigant gas even distribution inner the silo, the multi-purpose piping system can be used for the mechanical ventilation. The circular fumigation with methyl bromide or phosphine can be done by means the pipe system mentioned above, and the lethal effect may reach up to 100%. During circular fumigation, due to the danger of inflammation and explosion resulted from the mixture of phosphine and air, it should be taken to monitor the concentration of phosphine in atmosphere for ensuring the safe fumigation.

Modern silo is provided with the advanced mechanical and electrical equipment, and its economic benefit is better. It is expected that the modern silo will be developed in the future in China.

References

David, S., 'Silo warehouse' in 'Overseas stell-plate silo technology material' published in USA, 79p.