SILOS CORDOBA

Soybeans and soybean meal storage

Recommendations for the storage of soybeans and soybean meal in a metal silo.

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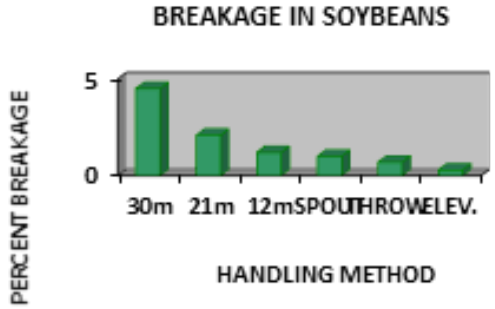
RECOMMENDATIONS FOR THE STORAGE OF SOYBEANS AND SOYBEAN MEAL IN A METAL SILO.

The spoilage is a process irreversible and inevitable, but it can be delayed.

The handling of soybeans involves conveying and transporting from the farm to end-user. It is possible for soybeans to be handled as many as fifteen times from the time they leave the farm until processing into oil and meal. This number may increase to as high as twenty for exported material.

The structure of a soybean seed makes it susceptible to splitting and breakage during mechanical handling. The extent of breakage in soybeans during conveying varies with the impact force imposed on each individual seed. The least breakage occurs when soybeans are conveyed in a bucket elevator as compared to other conveying methods.



This image shows the extent of soybean breakage with four methods of conveying: the first one represents the percentage of breakage of the grain in a free fall of 30, 21 and 12 meters.

The soybeans storage is affected by the degree of damage to the seed coat and by other factors such as mold or insect attack. It is therefore important to inspect soybeans for mechanical and other forms of damage prior to storage. If the amount of broken or split soybeans is very high, it may be prudent to separate the broken or split grains by sieving. This material can then be used first as opposed to long-term storage with the original stock.

Soybean meal is difficult to handle because of poor flow ability and bridging characteristics. Soybean meal tends to settle or consolidate over time. This phenomenon occurs in most granular materials and becomes more severe with increased moisture, time and small particle size.

The flow characteristics of bulk materials are dependent on individual particle shape, density, frictional property, and moisture content. For granular materials like grains, they have three typical flow patterns during discharge from hopper bottom bins: normal discharge pattern (there is no problem here), bridging and funneling. These two problems occur in grains containing high content of foreign material or moisture.

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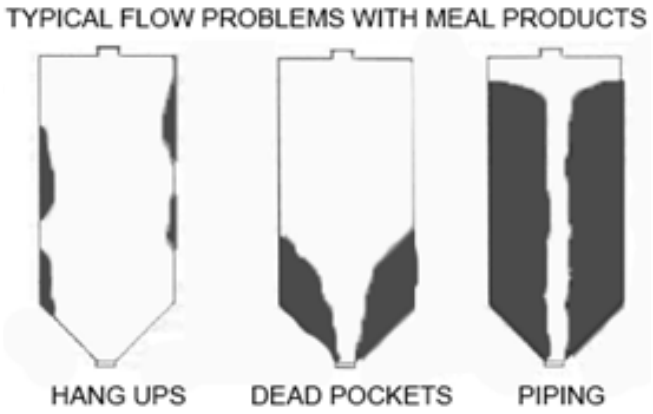

Typical flow problems of meal products discharged from storage silos are hang-ups, dead pocket and piping. These are usually due to a combination of factors such poor hopper design, high moisture content and storage time.

FACTORS AFFECTING THE SOYBEAN STORAGE

The three major factors affecting the storage of soybean and soybean meal are moisture content, temperature, and storage duration. The general condition of the product and amount of foreign materials also affect their storage. By focusing on these three elements we can insure the perfect storage of soya meal:

Moisture content. Depending on the moisture percentage, the storage period may change. At harvest time, soybeans moisture content ranges from 12% to 15%. Above 13%, grains should be dried to reduce the risk of deterioration due to seed respiration, mold attack, spontaneous heating and reduced germination.

The following table shows the recommended storage period for soybeans depending on the moisture content levels:

Moisture content, % wet basis	Safe storage period	
	Market stock	Seed stock
10-11	4 years	1 year
10-12,5	1-3 years	6 months
13-14	6-9 months	Poor germination
14-15	6 months	Poor germination

Temperature. Temperature is very important factor influencing in soybean storage. Growth of fungi and chemical changes such as oxidation are increased with temperature. Moreover, it is really important to consider the climate in the different regions of the world. Experience indicates that under hot and humid tropical conditions, grains stored in metal bins exhibit sweating. This problem arises with extreme high temperatures reached on the inner surface of the metal silo on a hot day, then, at night, the rapid cooling of the metal results in moisture condensation as the dew point is reached.

Caking and charring in metal silos can be attributed to this phenomenon. Installing suitable ventilation, cooling and insulation systems help maintain the required temperature, thus avoiding these problems.

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Storage time. The shorter the better. Fine foreign materials tend to segregate during bin loading and occupy void spaces in the central region of the grain mass. Meanwhile, the large and lighter materials will accumulate close to the walls of the silo. Then, during aeration, the air will flow around spots with higher concentration of fine foreign materials and through pockets of high concentration fo large foreign materials. This condition creates a nonuniform flow of air during aeration, thus, making it an ineffective operation. Hence, cleaning soybeans prior to storage will minimize the risk of spoilage and economic loss.

INDICATORS TO DETECT PROBLEMS WITH THE PRODUCTS STORED IN A SILO

Heating. Heating is the most common indicator of a problem in stored grains and oilseeds. High grain temperatures normally indicate either microbial or insect activity. If left unchecked, this may lead to heat-damaged or charred grains due to the phenomenon of stack burning.
Because of this danger, hot spots in stored soybeans must be cooled or dissipated before they reach the critical level. If no action is taken when heating in soybeans occurs, either the product will be lost by stack burning (charring) or at worst, the entire facility will be lost through fire.
Warning! Aerating soybeans when fire has already started makes the situation worse.
A temperature monitoring system in soybean storage silos is essential. Immediate corrective measures for heating cannot be over-emphasized.

Change in color and general appearance. In general, sound soybeans are plump with bright uniform tan and not green color and free from unusual spots and shrivelled appearance. Discolored soybeans usually indicate inferior quality and lower market value. The change in color is usually associated with mold invasion accompanied by microbial respiration and subsequent heating. This deterioration process can be detected by periodic drawing of samples from the stored soybeans as part of an integrated approach to quality maintenance.
Once detected, appropriate measures can then be taken such as cooling the grain either by aeration or use of a portable cooling unit. Another corrective measure is to transfer the grain to another silo thus breaking any hot spots present and cooling the soybeans during the conveying process. However, this should be done only as a last resort since it is costly and will increase the amount of broken or split soybeans.

Mustiness and off-odor condition. Musty odor usually indicates an advanced stage of insect or mold infestation and should be dealt with immediately. If this is detected, the soybeans should be aerated to remove the bad odor and cool the material. Beans should then be used at the earliest opportunity.
The grain should be fumigated immediately if insects are present. A sharp odor may indicate rancidity due to chemical changes in the oil component.

Lumping and caking. Lumping and caking indicate a very advanced stage of fungi invasion in soybeans and soybean meal.
In metal bins, caking usually occurs on the bin walls as a result of sweating or moisture condensing on the inner surface of the cold bin wall. The condensing moisture is absorbed by the adjacent grains resulting in either sprouting or mold growth.
For all these reasons, it is advisable to reduce the humidity and temperature of the product and shorten its storage period, even more so in the case of tropical climates with high temperatures and humidity.

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MACHINERY AND EQUIPMENT RECOMMENDED FOR THE STORAGE OF SOYBEANS

1. **Hydraulic sweep auger** with hydraulic central (for soybean meal). This sweep auger effectively reclaim meal products from silos because is able to work with full silos.

2. **Smooth wall silos for soybean meal.** Washer outside the silos and head-round bolts inside the silos.

3. **Precleaner.** Fine foreign materials tend to segregate during bin loading and occupy void spaces in the central region of the grain mass meanwhile the large and lighter materials will accumulate close to the walls silos. That fact affect to the ventilation, the air will flow around spots with higher concentration of fine foreign materials and through pockets of high concentration of large foreign materials. This condition will create a non-uniform flow of air during aireation, thus, making it an ineffective operation. Cleaning the product prior the storage will minimize the risk of spoilage and economic loss. Moreover, if the product has to be dried it is totally necessary to avoid the burn of the waste (fine foreign materials like straw, dust, etc) inside the dryer.

4. **Dryer.** Soybeans and soya meal with moisture above 13% should be dried to reduce the risk of deterioration due to seed respiration, mold attack, spontaneous heating and reduced germination.

5. **Ventilation.** Centrifugal fans. The primary purpose of aeration is to make the temperature of the grain bulk uniform. This prevents moisture migration in the grain mass due to natural convection. Aeration may also be used to hold partially dried soybeans for a few days to prevent spoilage before proper drying. It should be noted that aeration is not intended to dry grains.

6. **Cooling machines** are strongly recommended in tropical climates with high heat and high humidity. Soya beans, even after harvested, still keep on breathing. Bur once chilled, the grain keeps its low temperature for a long time, without the need for a continuous cooling. Direct consequences of non-controlled storing of wet grain are the appearing of fungi and toxins, which are a very dangerous for the health of humans and animals. The proper storing of grain by means of chilled and dry air fix completely or widely minimize the problem.

7. **Temperature monitoring system.** This device is essential to control and correct any deviation from the optimum temperature.

8. **Belt conveyors** to prevent the breakage of the soybeans. This kind of conveyors can move grains for great distances without damage.

9. **Periodic drawing of product samples** and accurately testing them.

By following all this steps we can avoid the risk of deterioration due to seed respiration, change in color, mold attack, spontaneous heating, mustiness and off-odor conditions, the presence of insects, lumping and caking and finally the economic loss.

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Soybeans storage plants by Silos Córdoba worldwide:

2002 | Bell Hassan Group Morocco

Plant conceived for the storage of soy and sunflowers seeds for the subsequent oils extraction. The total capacity of the plant is 20.000 m³ for the storage of 15.000 T of cereal. The project includes:

- √ 3 silos model 22.92/12 of 6.550 m³ capacity each.
- √ Loading and unloading is done at 100 T/h.
- √ The facility is connected to an oil extraction plant.

Under construction | NKF Iran

Plant conceived for the storage of soya bean, corn and wheat.
The total capacity of the plant is 489.792 m³ for the storage of 367.000 T of cereal. The project includes:

- √ 48 silos model 24.45/17 of 10.204 m³ capacity each.
- √ Intake conveying capacity: 1.200 T/h (600 T/h double).
- √ Discharge capacity: 800 T/h (400 T/h double).

2016 | Omega Bolivia

Plant conceived for the storage of soya and maize.
The total capacity of the plant is 47.793 m³ for the storage of 35.850 T of cereals. The project includes:

- √ 4 silos model 27.50/20 of 11.086 m³ capacity each.
- √ 4 buffer silos model 7.64/13 of 771 m³ capacity each.
- √ 1 bulk silo model 4.65/5 of 123 m³ capacity.
- √ 3 train load silos model 4.65/3 of 80,83 m³ capacity each.
- √ Two separates drying lines: The first line with one dryer of 75 T/h.
- √ The second line with two dryers of 75 T/h.
- √ Load is done at 150 T/h. and unload is done at 100 T/h.
- √ Cleaning systems.

Soybeans and soybean meal storage

2016 | SNA Tunisia

Plant conceived for the storage of maize and soy beans.
The total capacity of the plant is 75.180 m³ for the storage of 56.400 T of cereals. The project includes:

- √ 10 silos model 22.92/14 of 7.518 m³ capacity each.
- √ Complex metal structures, catwalks of more than 3 meters wide that support doubly the loading of 200 T/h and specials towers.
- √ Turn-key project entirely made by Silos Cordoba.

2017 | Niger04 Nigeria

Turn key project conceived for the storage of maize and soy beans located at Kaduna State. The total capacity of the plant is 54.585 m³ for the storage of 50.000 T of sorghum. The project includes:

- √ 5 flat bottom silos model 24.45/22, capacity of 12.917 m³ each.
- √ Ventilation system
- √ Chain conveyors and bucket elevators.
- √ Loading and unloading is done at 250 T/h and 75 T/h.
- √ Towers, catwalks, support structure for elevators and pre-cleaners.
- √ Intake pit warehouse and flow scale.
- √ Complete cleaning system, including De-awner, stone separator and magnetic separator.
- √ Electrical panel and control system.
- √ Complete assembly.

2017 | Ngeria 05 Nigeria

Turn-key project conceived for the storage of maize and soy beans located at Ilorin. The total capacity of the plant is 51.668 m³ for the storage of 40.000 T of cereals. The project includes:

- √ 10 silos model 24.45/22 of 12.917 m³ capacity each.
- √ Ventilation system.
- √ Bucket elevators and chain conveyors.
- √ Load is done at 250 T/h.
- √ Unload is done at 75 T/h.
- √ Towers, catwalks, support structure for elevators and pre-cleaners.
- √ Intake pit warehouse.
- √ Flow scale.

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Under construction | Bosand Bolivia

This plant is conceived for the reception, storage and expedition of soya bean and rice. The total capacity of the plant is 69.958 m³ for the storage of 52.500 T of cereals. The project includes:

- √ 8 silos model 22.92/15 of 7.990 m³ capacity each.
- √ 2 hopper silo model 7.64/11 45° of 667 m³ capacity each.
- √ 4 hopper silo model 6.88/6 45° of 322 m³ capacity each.
- √ 4 hopper silo model 9.17/6 45° of 762 m³ capacity each.
- √ 4 hopper silo model 5.58/2 60° of 66 m³ capacity each.
- √ 2 hopper silo model 3.50/4 60° of 52 m³ capacity each.
- √ Handling equipment capacity at 120 TPH using enclosed belt conveyors and standard belt conveyors.
- √ Catwalk with tunnel for belt conveyor with tripper for intermediate discharges.
- √ Cleaning, drying and continuous weighing system.
- √ Hopper Silo.
- √ Aspiration system.
- √ Electrical panel with SCADA and PLC.

Under construction | Bosivir Bolivia

This plant is conceived for the reception, storage and expedition of soya bean. The total capacity of the plant is 68.690 m³ for the storage of 51.500 T of cereals. The project includes:

- √ 8 silos model 22.92/16 of 8.462 m³ capacity each.
- √ 2 silos model 7.64/5 45° of 353 m³ capacity each.
- √ 1 silo model 5.35/5 45° of 160 m³ capacity each.
- √ 2 silo model 4.58/5 60° of 66 m³ capacity each.
- √ Handling equipment capacity at 120 TPH using enclosed belt conveyors and standard belt conveyors.
- √ Catwalk with tunnel for belt conveyor with tripper for intermediate discharges.
- √ Cleaning, drying and continuous weighing system.
- √ Hopper Silo.
- √ Aspiration system.
- √ Electrical panel with SCADA and PLC.