Raw Materials. Handling and Control[1]

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Abstract

The handling and control of the raw materials for the oil seed industry can be primarily characterized by the short harvest season, by the necessity to move them into protected storage in minimum time, and by the required care before they can be processed. But they can be treated and stored successfully with minimal deterioration long enough to allow the processing industry to operate throughout the year.

Soybeans, cottonseed, flax, safflower, and other oil seeds are subject to damage primarily from biological actions, which are accelerated by high moisture content, foreign material, physical damage, and such adverse climatic conditions as frost or rain before harvest.

The primary object of the storage units, cleaners, and dryers used by oil mill processors is to minimize further damage and to reduce the effects of damage occurring prior to receipt. The various types of machinery, equipment, and storage units to accomplish this objective successfully are discussed.

It is possible to design and build equipment and storage units which will theoretically handle almost any situation, but the capital investment would be so large that carrying charges would prevent a profit in the market place. Accordingly the oil seed processor must combine ingenuity and foresight with hard work to provide a solution to the problems of each season in an industry where no season is entirely like any other.

Introduction

The principal raw materials for the oil seed industry in the United States are soybeans, cottonseed, safflower, corn germ, and flaxseed. One of the most important branches of oil and fat technology deals with equipment to handle and store these oil-containing materials so as to minimize deterioration before they can be processed. This paper will not deal with corn germ since it is an intermediate product of the corn milling industry and is not stored as separated germ. Some deterioration is to be expected in commercial oil seeds and is actually inherent in the processes by which fat is formed. The enzymes, which are organic catalysts, are capable either of assisting fat synthesis during the growth period or of assisting fat degradation after the seeds are harvested.

Handling and control of the oil seeds as raw materials are characterized by a short harvest season, by the necessity to move them into protected storage in the minimum time, and by the required care for the beans or seeds until they can be processed. Unlike other more perishable agricultural products such as fruits and vegetables, the oil seeds can be successfully stored with minimal deterioration for many months if proper storage control is exercised. This fact allows the oil seed-processing industry to operate throughout most of the year.

It is common for soybean and flaxseed plants to run more than 330 days a year while processors of cottonseed and safflower tend to operate for shorter periods since their seed supplies are exhausted early. This condition will be accentuated if the Government cotton-acreage controls continue their present course. Cotton production will decline precipitously this year but, except for some areas, weather probably will not play a major role in the drop. It is one of the few farm products of which the Government still holds a mountainous surplus; the August carryover is estimated to be enough to meet domestic needs for one and a half years. In 1965 Congress passed legislation to pay farmers for cutting back cotton acreage. This year farmers planted about 10,800,000 acres in cotton, off 23% from 1965 and the smallest cotton acreage in 90 years. Consequently, in many areas, the oil mill turns to soybeans to finish out the year. The effect of this is further to increase the economic importance of the soybean, which is reflected in production statistics. In the United States the rate of soybean production had an increase of about 9%, compounded annually during a recent 15-year period, and seems to be trending upward from this rate. This year's crop forecast is nearly 950,000,000 bushels. On the other hand, even before this year's cut in cotton acreage in the United States, the rate of cottonseed production throughout the world had increased by a total of only about 25% during a 10-year period, reflecting the competition of synthetic fibers with cotton. Safflower has shown a large rate of growth during the past few years, probably because of the increased use of safflower oil in certain highly publicized diets which stress the use of polyunsaturated fats. Flaxseed shows relatively little growth, reflecting the development of water-based and synthetic paints.

Crop Movement

Soybeans and flaxseed are characterized by the large amount of storage capacity on farms, in country elevators, and in terminal elevators ahead of the oil processors. Further, soybeans are actively traded on commodity markets, and the crop is bought and sold several times. Both of these factors control the position of beans in storage and affect the rate of receipt at the mills.

An interesting sidelight on trading in commodity futures is the story of June 16, 1966, when the Chicago Board of Trade experienced the biggest single trading day in its 118-year history. Soybean volume exploded from 8,400,000 bushels for the same day in 1965 to 142,800,000 bushels on that day, that is, about one-sixth of the estimated soybean crop was traded in one day in one market. Likewise wheat trading rose by a factor of 9, corn by a factor of 2, rye by a factor of 20, etc. This surge in trading is attributed to population growth, dwindling surpluses, and bad weather. During the harvest season, on the other hand, many farmers who live near the oil mills want to convert their crops into cash as quickly as possible. These factors combine to require that the mills must take receipts at some 10 or 15 times their normal processing rate while the total storage at the mill need only be 25% to 35% of the annual total crush. For example, a modern soybean oil mill processing 12,000,000 bushels a year may have total storage of about 3,000,000 bushels but must receive at a rate of 15,000 bushels per hour. Flaxseed processors operate under similar conditions and normally have three to four months' storage at the mill.

In the case of cottonseed there is almost no farm storage, and storage capacity ahead of the oil mill is limited. It is probable that there is less than two weeks' storage on farms and at gins during the peak harvest season. About 90% of the normal harvest extends over a period of about 120 days. Figure 1 shows this crop movement graphically. The crop moves to oil-mill storage in accordance with the curve showing percentage ginned by periods. It reaches its maximum rate during the second month and diminishes slowly thereafter. Consequently cottonseed mills must be prepared to receive and store seed at a much greater rate than they can process it. Typical cottonseed storage requirements are shown in Table I.

[1] Presented at the AOCS Short Course, East Lansing, Aug. 29–Sept. 1, 1966.

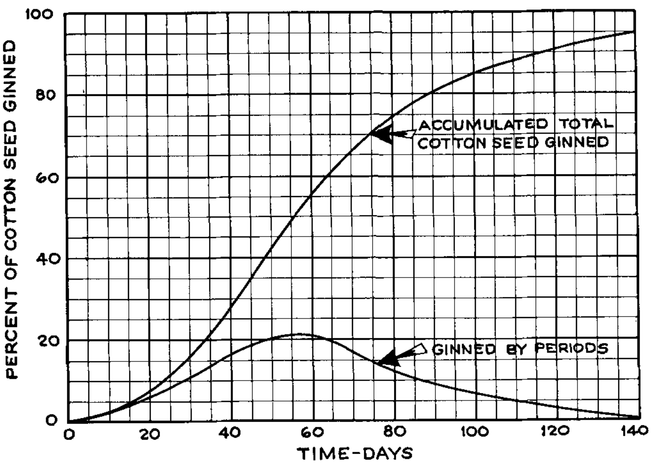

FIG. 1. Typical percentage of cottonseed ginned by ginning periods.

Safflower mills have requirements for storage similar to cottonseed mills since the seed moves to the mill primarily from farmers. However local conditions control to a greater extent since safflower has more recently come into prominence and the crop movement characteristics are not yet fully established.

Deterioration in Storage

The factors which determine the deterioration of soybeans in storage include moisture and control of moisture level in storage; temperature in the storage unit; quantity and type of foreign material; and quantity of frosted, sprouted, immature, heat-damaged, or physically damaged beans.

Moisture is generally believed to be the most important factor in promoting the deterioration of stored grains. Acceptable maximum storage moisture level is about 13% for soybeans. In general, enzymes operate in an aqueous substrate so that dehydration reduces their effectiveness in degrading the fat. Excess moisture assists in the degradation of proteins, carbohydrates, phosphatides, etc., in fatty tissues to produce oil-soluble impurities which are objectionable in color, odor, and flavor. Further the process of deterioration is accompanied by a certain amount of fat splitting to produce free fatty acids in the oil. These reactions are relatively slow in soybeans, particularly those which are dry enough.

For most oil seeds the so-called *critical* moisture-content corresponds closely to that at which the seeds are in equilibrium with air of 75% relative humidity at 75F. It appears that the critical factor is not the actual moisture of the seed but the humidity of the interstitial air around each individual bean or seed in storage.

There is a seasonal movement of moisture within the storage unit even where the average moisture content is low enough for safe storage. During the fall and winter, clean soybeans near the walls and upper surfaces cool more rapidly than those near the center of the bin. Convection currents are created within the storage unit. Cool air moves downward near the outside, becomes warmer, and moves upward near the center. Condensation occurs as the warm moist air reaches the cool upper layers of beans. Tests reveal that beans with a uniform moisture content of 12%, when stored early in the autumn, have reached local moisture contents of 16% to 19% in the upper layers during midwinter. During the spring and summer months the direction of air currents reverses, and the migration of moisture tends to proceed in the opposite direction. However the migration rate is slower during the warm part of the cycle, and the upper central layers of beans tend to be wetter than other portions of the bin contents. This phenomenon partially explains why upper-layer beans may heat in spring and summer after having kept well all winter.

TABLE I

Cottonseed Storage Required at Oil Mills

Operating season months	Storage[a] as % of annual crush
6	35
8	45
10	55
12	60

[a] Assuming operating season begins with first seed receipts.

The remedy for local heating and high moisture lies in the judicious use of cooling fans to remove the moisture during periods when the relative humidity and temperature of outside air are low, *i.e.,* on cool dry nights. If this is not adequate, then the beans must be either "turned over," that is, placed in other storage units with cooling during conveying or they must be promptly processed if damage is to be prevented.

Under certain conditions, foreign material may have substantial effect in determining the condition of beans in storage, particularly since the foreign material has a tendency to concentrate in spots or sections of the unit. Sand, weed seeds, and dirt have different flowing characteristics from those of the rolling beans and tend to hang up in various locations. When this occurs, cooling air cannot move through the tightly packed volume of foreign material to dissipate spontaneous heat. The heat damage spreads to surrounding beans which, in turn, tend to cake, thus accentuating the problem. Likewise physically damaged and/or sprouted beans tend to form cakes, which impede the flow of cooling air and become a center for spreading damage through good beans. The only remedy for this condition is to "turn over" the storage unit or promptly process the beans.

Flaxseed has much the same characteristics as soybeans in storage. The maximum acceptable moisture-level for flaxseed storage is about 10½%.

Cottonseed is much more susceptible to deterioration in storage than soybeans, flax, or safflower. Over-all losses on account of cottonseed deterioration during storage have been estimated at about $1 per ton, a figure which may be considerably higher or lower during any specific season or in a given locality. The factors affecting its deterioration are the same as for soybeans but with the added problems of much more rapid fat-splitting reactions to form free fatty acids and of the liberation of gossypol and other pigments which adversely affect the color of the oil produced. Cottonseed with a moisture content below 11% can normally be depended upon to store well. Above 14% moisture content the seed will generally deteriorate rapidly while, between 11% and 14% moisture, behavior in storage is quite variable.

Temperature of the cottonseed has a marked effect on the rate of deterioration. The insulating effect of linters contributes to the peculiar tendency of cottonseed to heat in storage. Mechanical damage may occur in handling cottonseed or in exposing seed to weather. Immature seed, harvested before enzymes have become dormant, will deteriorate more rapidly than normal seed. Early frosts arrest growth and cause deterioration. Mature seed should not be allowed to stand for long periods in the fields, particularly if there is heavy rain. Regions of relatively heavy rainfall, *e.g.,* Louisiana and southern Mississippi, consistently produce seed of relatively high acidity. On the other hand, seeds matured at low humidity tend to be stable even if later exposed to rain. These effects are attributed to the activity or lack of activity of the enzymes after maturity. Low moisture at maturity tends to make enzymes dormant whereas high moisture at maturity tends to leave enzymes in a condition favorable to resumed activity at a later date.

A rise in free fatty acid is the generally accepted measure of deterioration of cottonseed in storage. This depends largely on moisture content, initial free fatty acid when placed in storage, and seed temperature. Generally seed stored at an acceptable initial moisture and maintained at an acceptable temperature will have a rise in

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free fatty acid during storage which amounts to about 10% per month of the free fatty acid content on entering storage. Since it is easy for losses to amount to considerable money, the following rules should be observed to minimize such losses when it is imperative to store cottonseed initially above 2½% free fatty acid, for example, after extended bad storms over large areas.

a) Store in small units equipped with best air-cooling facilities. Cool to 60F or less as soon as possible. Observe seed temperatures daily.

b) Segregate low-moisture seed. Dry high-moisture seed to 10% if dryer is available. Otherwise mill promptly.

c) Store seed by free fatty acid brackets, that is, 2½% to 5%; 5% to 8%; 8% to 10%; etc.

d) Mill highest-temperature seed first if it contains hot spots or is above 70F. Otherwise mill highest free fatty acid seed first.

Equipment

Economic Considerations. The oilseed processor can study all the problems of fast-moving crops, deterioration in storage, and the nature and location of his sources of oil seeds or beans and correlate them with the desirable equipment and storage facilities so that theoretically he can handle almost any situation which may develop. He must also consider the rate of return on his investment so as to make a profit on his over-all operation. Because of unpredictable fluctuations in crop yields, crop quality, weather, and market conditions, the decisions which the processor must make regarding investment in storage facilities, receiving and unloading facilities, cleaners, dryers, and aeration systems have a substantial amount of uncertainty.

Some of the factors the processor must weigh carefully before purchasing his receiving and storage facilities are: sources of oil seed supply as compared with annual crushing capacity in order to calculate total storage requirements; proportion of his receipts which will arrive by truck, rail, or water transport; probable maximum rate of receipt of beans or seeds, particularly the requirement that farmers' trucks are not unduly delayed in unloading; probable proportion of his oil seed receipts that must be dried prior to storage; possible requirement for short-term storage for tempering incoming seeds or for holding wet oil seeds which arrive too fast for drying on-stream prior to storage; cleaning field debris from soybeans or seeds on-stream prior to storage; classifying soybeans or seeds which may be damaged, have high free fatty acid, or may be otherwise inferior, segregating them into short-term storage for prompt crushing or extraction; and classifying soybeans or seeds according to moisture or other analysis so that final storage units will have uniform contents.

To summarize, the processor could solve almost any problem of raw materials—storage, handling, and control if given sufficient money. But since he must make a profit from his operations, he needs foresight and ingenuity to adapt his equipment and storage facilities to handle the unusual season in the best way.

Farm, Country Elevator, and Terminal Storage. Soybeans and flaxseed are generally stored in farm, country elevator, and terminal storage units with adequate capacity to allow an orderly marketing system to work to the advantage of growers, buyers, and processors. This storage prior to receipt at oil mills accounts for at least two-thirds to three-fourths of the annual production, including requirements for seed and export.

Farm storage units include steel grain bins, overhead bins in combination granaries, Quonset huts, and silos. Portable or permanent mechanical conveyors are used to fill the units and to empty them, usually into trucks.

Commercial storage is loosely divided into country elevators and terminal elevators, primarily depending on size. Typically these units are of the silo type. The smaller country elevators are normally self-contained; with all conveying elements generally built into the main structure, and have a small number of silos. The larger terminal elevators typically have a head house containing the elevating, cleaning, weighing, and dust-collecting machinery. Storage bins are arranged in long rows, which are attached to the head house and connected to it by horizontal conveyors. These silos may be reinforced concrete, brick, tile, or steel with hopper bottoms that have an angle greater than the angle of repose of the grain. Some terminal storage elevators have a capacity of many million bushels of grain.

Soybeans and flaxseed move from farm or country elevators to oil mills primarily by truck with the balance moving by rail. From terminal elevators, soybeans generally move to oil mills by rail or by barge. A few oil mills are equipped to receive soybeans by ship.

Receipt at Oil Mills. Trucks account for the most numerous individual shipments of grains received at the typical oil mill. During the peak of the harvest season the truck-unloading facilities operate at a hectic pace. The receiving operation consists of taking samples of the grain, deciding which individual storage unit shall receive each load, conveying it to that unit, deciding whether the load is to be cleaned on-stream before storage, deciding whether to dry the load of grain on-stream, weighing the truck twice (gross and tare), and unloading the truck rapidly and completely. All this must be done sufficiently fast that the farmer is not delayed so long that he decides to take his next load of grain to a competing oil mill, where he will get faster service.

Truck unloading is done primarily by hydraulic or mechanical lifts which elevate the front end of the truck and allow the beans or seed to flow out of the back gate of the truck into receiving pits. Alternately some mills unload trucks by pneumatic conveyors or by power shovels although these methods are being displaced in newer installations. In every case the grain is conveyed to the appropriate short- or long-term storage unit either *via* cleaning equipment or dryer or both, as required. Spouting from conveyors to bins or to other conveyors may be controlled manually or remotely by automatic turnheads.

Rail shipments of grains are primarily in box cars, but increasingly the new hopper cars are being put in service. These are capable of carrying larger loads of beans or seeds, up to 90 or 100 tons *versus* 40 or 50 tons for the older box cars. The same decisions and operations must be carried out for each rail shipment as for each truck shipment, but the rapidity in handling cars is not normally as fast as for trucks. So the receiving personnel have more time to make the necessary samples, tests, and decisions relative to disposition of the shipment.

Carloads of soybeans or seed on arrival at oil mills are spotted alongside or over receiving pits or hoppers by cable-operated car pullers or small engines. The fastest method of unloading box cars is the automatic car-unloader. Cars, spotted on the unloader, are clamped into place. The car doors are opened, and the car is tilted sideways to an angle up to 30 degrees, emptying about one-third of the grain. Then the side tilt is maintained, and the car is up-ended to about 35 or 40 degrees, emptying another one-third of the grain. Maintaining the side-tilt, the car is up-ended in the other direction while the remaining grain flows out. A final up-ending in the opposite direction may be necessary to complete the emptying. Some of these unloaders can handle up to 10 cars per hour.

Power shovels are used where an automatic car unloader is not available. They may be the double-shovel type, which is actuated by a motor located outside the car and has a system of cables which are mounted on pulleys inside the car. Two scoops are attached to the cables so that, while one scoop is moving toward the open door to push out a load of grain, the other scoop is retreating toward the other end of the car preparatory to picking up another load of grain. Some double-power shovels are arranged for control by a single operator outside the car. The other type of power shovel is an adaptation of the small industrial truck, which may be driven by an explosion-proof electric motor that receives power through a cable suspended from an overhead reel. This relatively new device is small enough to operate inside a box car and is capable of unloading fast enough to be satisfactory. Cars may be unloaded in 20 to 30 minutes with shovels.

As the new large hopper cars become available, it may

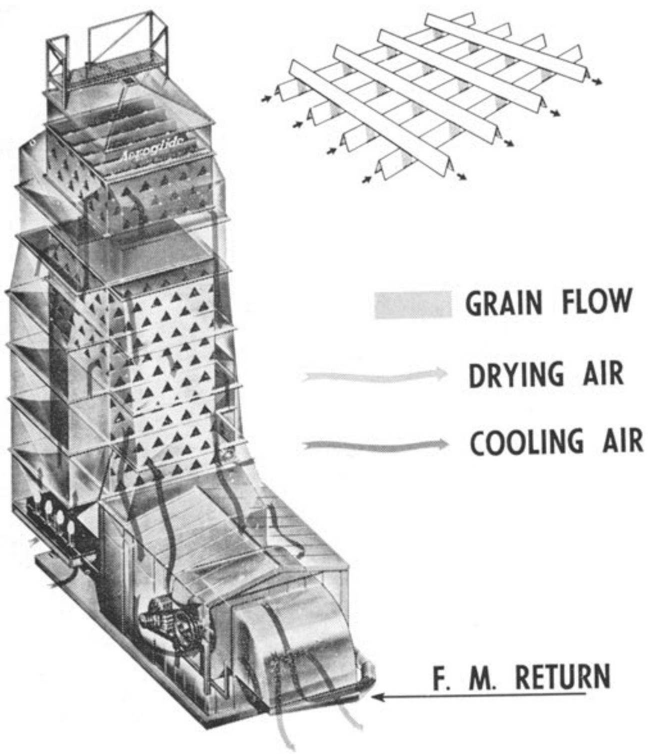

FIG. 2. Aeroglide dryer.

be assumed that they will be almost exclusively used for rail transport, but this conversion probably will take many years to complete. Obviously unloading the hopper cars is fastest and cheapest since only gravity is necessary.

Barge or ship unloading is more specialized since relatively few oil mills are located on navigable waters. Barges have capacities of up to 40,000 bushels. The unloading of barges from rivers presents more problems than from other bodies of water because of the varying water levels at certain seasons. In general, a large crane is mounted on the dock with a boom arranged to move a bucket elevator down into the barge. The buckets scoop up the grain into a system of movable spouts suspended on the crane. These spouts direct the grain onto a belt conveyor, which carries it to the storage area. The bucket elevator is lowered into the grain as it is picked up. It then traverses the bottom of the barge. To clean up the barge bottom, power shovels may be used.

Cleaning. Large-capacity, rough scalping machines are available to clean grains up to 25,000 bushels an hour. It is not necessary to do the best cleaning job on grains before storage but only to remove the worst of the dust, chaff, rocks, scrap iron, wood, etc., before drying and storage. These devices consist primarily of screens, which either rotate or shake. The seeds or beans flow through the screens while the large particles, chaff, etc., are rejected by the screens. Moderate aeration is used to remove the worst of the dust and small light weed seeds, hulls, and similar foreign material. Because of the linters it is much more difficult and troublesome to clean cottonseed so that cleaning equipment is not used nearly so much in cottonseed mills.

Drying. Soybeans, flax, safflower, and similar grains are relatively easy to dry whereas cottonseed drying is most difficult because the linters may catch on fire. For example, the assistant to the chief engineer of one of the largest companies processing cottonseed has stated that his company does not install cottonseed dryers for this very reason.

Grain dryers must be capable of operating over relatively wide ranges of moisture reduction. Well-designed dryers can be operated either with high throughput and small moisture reduction or with low throughput and high moisture reduction.

The principle of most grain dryers is to force a current of heated air through thin vertical columns or horizontal beds of grain. The grain is heated and moisture removed by the air, which is exhausted to atmosphere. Heat may be supplied indirectly by steam coils or radiators or directly by mixing the products of combustion from gas or oil burners with the air flowing to the grain beds.

In the lower section of the dryers, provision is made to cool the dried grain by blowing atmospheric air through the columns or beds. The grain may be cooled to 10F or 15F above ambient while some moisture is removed by evaporative cooling.

The most commonly used dryers for soybeans, flax, safflower, rice, etc., are tall devices where grain enters the top and gravity moves the grain downward. The grain throughput is controlled by the rate at which grain is removed by screws, rotors, or similar devices from the bottom.

An Aeroglide dryer (Figure 2) has open-bottom, horizontal ducts in the drying chamber. Hot air enters one series of ducts from a hot-air plenum, passes through a thin column of grain, and is exhausted through a second series of ducts into the exit-air plenum. A similar air-flow pattern is used to cool the grain in the lower portion of the unit. An induced draft fan sucks both drying and cooling air through the dryer.

The Shanzer dryer (Figure 3) has two thin, parallel, vertical columns of grain supported by vertically arranged, perforated plates through which air is forced horizontally past the grain. Two fans are used, one to force hot air through the upper drying section, the other to force atmospheric air through the lower cooling section. Air flow is from the central plenum between the two columns, outward through the grain, and upward through the two outer plenums to discharge from louvers near the top of the dryer enclosure.

An early type of dryer had thin, vertical columns of grain sustained by a series of shelves, which supported the grain but offered no obstruction to the passage of heated air past the grain. The shelves were mounted at angles to the horizontal and had suitable baffles so that the seeds flowed downward by gravity but did not dump

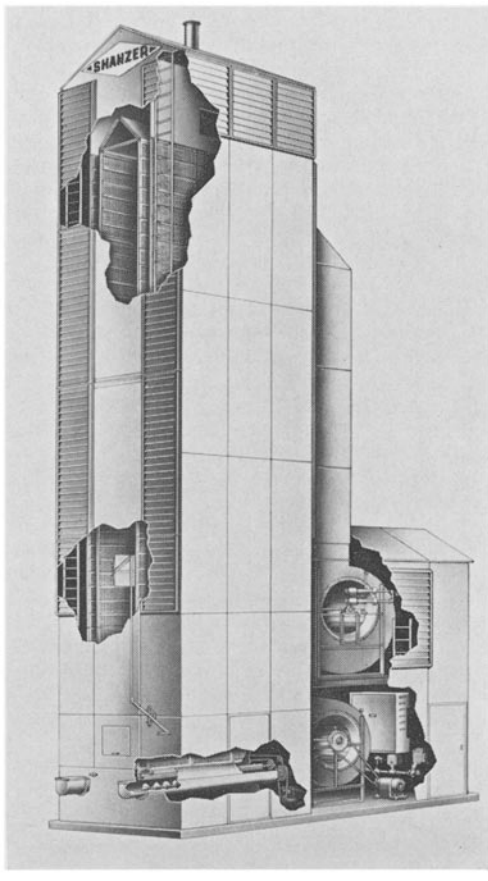

FIG. 3. Shanzer dryer.

completely on account of the angle of repose.

The Arid-Aire dryer employs a horizontal bed of grain, which is supported on a perforated belt, through which heated air moves upward as the grain is conveyed through the drying section. Hot dry grain falls onto a lower perforated belt, which conveys it through a cooling zone, in which atmospheric air is sucked up through the grain beds by blowers. Steam or direct firing is available on this unit. Cottonseed is being dried in some Mexican installations of this unit by using steam as the heat source. Lower temperatures (140F to 200F), with seed retention of 6 to 8 minutes in the heater section and 2 to 4 minutes in the cooler section, and with supplemental cooling by aeration in storage, have been successful in drying cottonseed.

Other cottonseed dryers which have been used include the rotary steam tube dryer and a device developed by the U.S. Cotton Ginning Research Laboratory at Stoneville, Miss. This dryer is comprised of perforated and inclined revolving cleaning drums, which are equipped for hot-air application. It was field-tested successfully, but it is believed that no other installation was made.

Storage. Storage at the oil mill for the beans or seeds which are the raw material is divided into short-term and long-term. If the mill has a multiple-silo type of storage unit, then some of the individual silos or interstices are used for tempering or classifying bins, *i.e.,* short-term storage. Otherwise moderate-size steel tanks are commonly used for this purpose. Grain may be tempered, that is, brought to a common moisture content by mixing wet and dry lots of grain together for a short time and allowing the moisture to migrate and become more uniform. Likewise grain may be classified into good lots and poor lots. The good lots, satisfactory for long-term storage as received, are sent directly to long-term storage units while the poor lots are held in classifying bins until the grain can be cleaned and/or dried before long-term storage.

By far the largest investment in an oil mill is probably its long-term, raw-material storage. Three general types of long-term storage are most used: multiple silos, large steel tanks, and Muskogee-type houses. Some so-called "old-type houses" are still used while, particularly at western mills where rainfall is low during the storage periods, seeds are sometimes stored in piles on the ground and covered with tarpaulins.

While the multiple-silo type of storage, commonly called an elevator, is undoubtedly the most convenient and most satisfactory from the standpoint of ease of operation, since it uses gravity to empty the contents completely, it is also most expensive in terms of initial capital investment. With good soil-bearing conditions, 1966 costs for slip-form silo storage in the range of 500,000 to 1,000,000 bushels should run about 30 to 35¢ per bushel without foundations, piling, conveyors, or other equipment. Planning of these elevators stresses the layout for receiving, conveying, elevating, cleaning, drying, weighing, distributing, and storage to insure the minimum requirements of labor and power for all operations. Their construction and design are sufficiently complex that highly specialized engineer-contractor firms are generally employed for new installations.

Large vertical, cylindrical steel tanks with flat bottoms and conical roofs are used for long-term storage of beans and oil seeds. They may be built in many sizes to suit the individual plant's requirements with a capital investment substantially below the silo or elevator type. A typical large-size storage tank containing 1,000,000 bushels of soybeans has a 170-ft. diameter, 40-ft. straight sidewalls, with a 30-degree conical roof, and extends to an over-all height of 90 ft. The cone angle and over-all height will be greater if cottonseed is to be stored because of its different angle of respose. Steel tanks in the range of 500,000 to 1,000,000 bushels of capacity cost about 12 to 14¢ per bushel in 1966 less foundations, tunnels, etc. Typically a galvanized steel or concrete tunnel extends on the tank diameter, under the tank's flat bottom, large enough for a man to enter, and contains a belt conveyor and the tank's aeration ducts. Individual duct shut-offs are located in the tunnel and provide for the cooling air

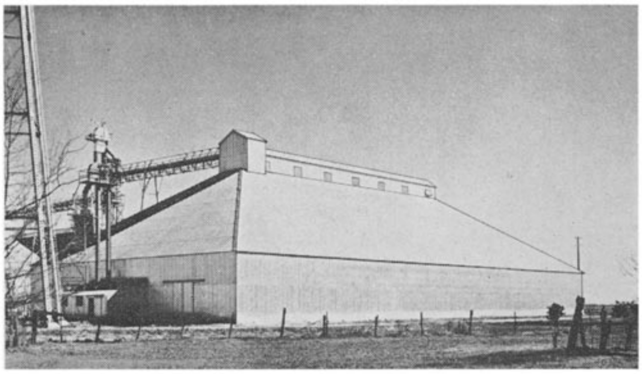

FIG. 4. Muskogee-type seed house.

to be drawn through specific portions of the grain, as required by the temperature profile. Tanks for soybeans only may also have large central vertical air ducts to provide better aeration in the section underneath the high portion of the conical roof. This arrangement has not been satisfactory for the other seeds. By reason of their shape steel tanks have efficient loading characteristics, that is, one-point fill from conveyors dumping through the center of the cone roof. If soybeans, flax, or safflower seed are stored in steel tanks, slide gates are opened in chutes above the belt or other conveyor in the tunnel, and the grain flows onto the moving conveyor until it reaches its angle of repose. The chutes are commonly six to eight feet apart. This arrangement allows about 70% to 75% of free-flowing grain to be removed by gravity. If only one outlet at tank center were provided for the belt conveyor, then only about 55% to 60% of tank contents could be reclaimed by gravity. Industrial-type trucks with shovels or permanently installed, double-power shovels are used to reclaim the remaining grain. Since cottonseed has linters which prevent this method of discharge, cottonseed storage tank tunnels are commonly above the floor and are similar to the Muskogee-house arrangement.

The Muskogee type of seed house (Figure 4) is most commonly used in the cottonseed industry but is now beginning to be used for soybeans, flax, and safflower. It offers low capital investment for large storage requirements, costing about 11 to 13¢ per bushel at 1966 prices in capacities of more than 1,000,000 bushels, without foundations, tunnels, etc. Normally the Muskogee-type buildings are completely open with truss roofs, eliminating the interior supporting columns which were sometimes damaged when seed "caved" in the old style of seed houses. They are available in widths from 60 to 150 feet with lengths to suit storage volumes (up to a few hundred feet). The roof slope is at the natural angle of repose, being 45 degrees for cottonseed or about 30 degrees for soybeans, flax, safflower, and similar materials. The monitor of the building contains the conveyor, which loads and distributes seed or beans into the house. In the center of these buildings, running lengthwise of the house, is a steel tunnel about six feet wide and seven feet high, above the floor for cottonseed, below for free-flowing grain, which covers a reclaim belt. However, even with multiple chutes to an underfloor reclaim belt, only about 50% to 55% of free-flowing grain in a Muskogee house can be reclaimed by gravity, and the balance must be handled by shovels or other devices. In the case of cottonseed, portable screw conveyors are used to feed onto the belt, which carries the seed to the end of the building and discharges into the conveying system. A small house at the end of the building houses the aeration fans, which are connected to an underfloor duct system arranged to draw air down through the seed or beans. The laterals from the central duct leading out toward the walls of the building are spaced at about eight-foot intervals and are provided with shut-offs located in the tunnel so that air may be drawn through those sections of the building contents which need to be cooled.

Storage Temperature Observation. The prime danger to soybeans and oil seeds in storage is heating with a consequent loss in profits because of product degradation and more difficult processing in the mill. The simplest devices for temperature sensing consist of closed-end pipes, which are driven into a mass of seeds or beans from the sides and roof of a storage unit, with a series of thermometers arranged on a stiff cable and inserted into the pipes. These are allowed to come to equilibrium temperature. They are quickly withdrawn and read. Early in the season temperatures are read daily; times are correspondingly longer after the weather cools off, late in the year.

Better, but more costly, temperature observation systems consist of thermocouples placed in pipes or cables and installed in the bin, tank, or house before filling. Wires extend from the thermocouples to multiple switches on an instrument panel located in a house for convenient reading.

Locating the temperature-sensing points is not an exact science, but the following spacings are typical. In Muskogee houses, spacings on 10-ft centers may be used for cottonseed. In a 160-ft diameter steel tank, three circles of suspended thermocouple cables are arranged, spaced about 20 ft apart, both between the concentric circles and around the circumference of each circle. Thermocouples are spaced every five feet in height on the cables, which are suspended from the tank roof and lightly tacked to the floor. An additional cable is suspended in the tank center. While these systems of temperature observation are somewhat expensive, the cost of a good one can generally be recovered in one or two bad seasons.

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8. Private communication, Robert W. Greaser of Anderson, Clayton, and Company, July 11, 1966.
9. Private communication, J. L. McManus of Muskogee Iron Works, June 15, 1966.
10. "Soybeans and Soybean Products," Vol. 1, edited by Klare S. Markley, Interscience Publishers Inc., Division of John Wiley and Sons Inc., New York, 1950, ch. 12 and 13.
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8th International Exhibition and Conference, Paris, 1968

The 8th International Chemistry Exhibition will take place in Paris during the month of May 1968. Also in May, 1968, "The Société de Chimie Industrielle" will celebrate its Fiftieth Anniversary (1918–1968). In honor of this event, it will organize a Congress of scientific and technical meetings, already known throughout the world under the name "Conference Internationale des Arts Chimiques."

Categories of exhibits will include Chemical Industries; Laboratory Methods and Procedures; Engineering Services; Chemical Engineering and Its Equipment; Automation, Process Control, Instrumentation; Corrosion Protection; Nuclear Engineering; Perfumery, Cosmetics, Soaps; Medicinal and Pharmaceutical Chemistry; Pure and Applied Research, Documentation.

Because of the scope of the exhibition and program, the International Chemistry Exhibition will serve as an international meeting-place with a major role to play in the development of international trade, as well as in the exchange of ideas in the world of chemistry.

Saul Gordon Center Established

Saul Gordon Associates announce the establishment of the Center for Professional Advancement, a post-baccalaureate training institution for the continuing technical education of mature scientists, engineers, management personnel and educators.

Located at the Arrowcrest Lodge on the rustic shores of Lake Hopatcong, New Jersey, in the heart of the Metropolitan New York Area, the Center operates on the principles of total immersion in academic subject matter by intensive full-time participation in selected programs of 2 to 5 days' duration. Designed to encourage academic isolation and maximum interaction between all participants, lecturers and demonstration instructors, the compact campus houses dormitories, demonstration classrooms, library, lecture halls and recreational facilities in a comfortable lakefront lodge.

Conferences Scheduled

Workshops covering Introductory Sessions and Recent Advances programs in Thermoanalysis, Fine Particle Measurements, Polymer Characterization and Stabilization of Polymers have been scheduled for June and July.

Thermoanalysis Institute

The Sixth Annual Thermoanalysis Institute will be held in June 1967 at the Arrowcrest Lodge. The first week, June 19–23, covers principles and applications of Thermoanalysis, providing background and laboratory demonstration experiences with such techniques as thermogravimetry, differential thermoanalysis, effluent gas analysis, and differential scanning calorimetry. Lectures will be presented in these fields from industrial, government and university laboratories.

The second part, "Recent Advances Session," will be held June 26–28. This session is designed for people who have some familiarity with the field and who wish to learn about current developments and trends in fundamental principles, methodology and applications.

High Vacuum Techniques

The first High Vacuum Techniques Workshop will be held during the week of July 31–Aug. 4, 1967, and will provide background on various types of mechanical and electronic pumps, gage calibration, materials of construction, leak testing, applications to electronics and thin films, and system trouble-shooting.

Stabilization of Polymers

The first Stabilization of Polymers Workshop will be held during the week of July 20–21, 1967. It will emphasize factors influencing stabilization and methods of achieving stability in olefin polymers and PVC.

Characterization Workshop

The Second Annual Characterization Workshop will be held the week of July 24–28, 1967, and will emphasize both fundamentals and use of instrumentation. Subjects to be covered include the various methods of molecular-weight determination, structural determination, and performance behavior.

Bio-Analytical Techniques Workshop

During the week of Aug. 7–11, 1967, the Associates will hold the first Bio-Analytical Techniques Workshop, a short course in selected physical-chemical techniques and their applications, and providing experience in chromatography, electrophoresis, ultracentrifugation, automated analyses, spectrophotometry, microbiological assay and statistical design and control of analytical procedures.

Further information on all of these programs can be obtained from Saul Gordon Associates, Center for Professional Advancement, P. O. Box 566, Hopatcong, N.J. 07843.