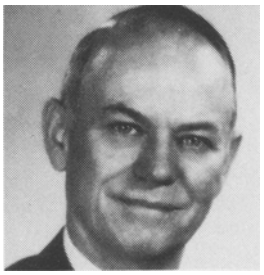
Loading, Unloading, Storage, Drying, and Cleaning of Vegetable Oil-bearing Materials



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ABSTRACT

Handling of various oil-bearing materials and special problems of loading, cleaning, drying, and storage are discussed, along with considerations for preventing quality deterioration during storage.

INTRODUCTION

Everyone involved in processing oils and oilseeds is interested in proper storage and handling of the raw materials. The objective of this presentation is to discuss some commonly used methods for the handling of these raw materials prior to processing, with special emphasis on considerations for limiting deterioration of the materials and their oil content while in storage. Since this is a very broad subject, information presented will be quite general.

RECEIVING AND CONVEYING

In the loading, unloading, and handling of vegetable oil-bearing materials, there is a natural distinction between free-flowing seeds such as soybeans, flax, sunflowers, and rapeseed as opposed to bulkier, less dense materials, such as cottonseed, copra, palmkernels, olives, etc. Table I gives approximate densities and designation of handling characteristics of various oil-bearing materials.

One can generalize and say that the free-flowing group lend themselves to being handled much the same as grains like corn and wheat. They can be handled in conventional grain elevators, and this group also lends itself to long distance transport. The less free-flowing group of oilseed materials tends to be processed closer to the locale in which they are grown and the products—oil and meal—transported to the areas of consumption. The above distinction is only a generalization, and there are many exceptions. For example, copra—a bulky, low-density material— is shipped from the Philippines to Europe for processing; however, processing is predominantly done in the South Pacific countries where copra is grown.

To be technically correct, one would need also to classify some oil-bearing materials as seeds and others as fruits and nuts. For simplicity's sake, I will refer to all vegetable oil sources as being from oilseeds.

Vegetable oil-bearing seeds are normally received from growers in bulk trucks, except in underdeveloped areas where bags may be used. At most receiving stations, bulk trucks are dumped by elevating the front end of the truck on a platform so that all material simply slides out the rear of the truck box.

When railroads are available, it is usually more economical to make longer distance shipments in hoppered rail cars. Still more economical is barge of ship transportation if location source and destination permit.

Oilseed materials can be handled in most conventional materials handling conveyors, such as chain or drag conveyors, screw conveyors, belt conveyors, and bucket elevators. Careful attention must be given in design, especially for handling the bulkier and less free-flowing oilseeds. Many oilseeds are abrasive, and usually special provisions are made to use special abrasion-resistant metal or other materials at points of greatest wear. Oil resistant or oil-proof rubber must be specified for conveyor belts and bucket elevators. Palm "fruit" is very delicate to handle and is processed near the point of origin with no storage. Fortunately, it, like copra, is harvested year around.

LOADING AND UNLOADING OF SHIPS AND BARGES

Since a large percentage of oilseeds is transported by barge or ship, it may be interesting to consider some examples of how this is done. At a modern copra terminal located in the Philippines, for example, copra is received in small vessels from collection stations at various islands and brought to the terminal for storage and rapid load out in large cargo ships mostly destined for Europe. The smaller vessles are unloaded by clamshell-type buckets operated by a swinging boom crane.

Unload rates are 100 tons per hour, and ship loading rates are 400 tons per hour. Large payloaders or rubber-tired tractors with up to three cubic meter buckets on the front of the tractor are used to reclaim copra from the warehouse or bodega to feed a belt conveyor in a tunnel under the floor. Belt conveyors transport copra to the ship loading berth, and a motorized loading boom and telescoping spout with a belt trimmer places the copra in the hold of the ship.

Other methods for unloading barges or ships are (a) pneumatic suckers with up to 200 tons or more per hour capacity per nozzle or (b) marine legs either of the bucket elevator or chain conveyor type. Figure 1 shows a very large and special type marine leg which will unload a 1,500 ton barge of soybeans in New Orleans in less than one hour. The leg is fixed, and the barge, whose hatch covers have been removed, will be moved slowly past the large marine leg. Payloader tractors are used for clean up of the barge.

Figure 2 shows a modern sea coast elevator in the U.S. where soybeans and other grains can be loaded into ships at a 2000 ton per hour rate through each of the loading spouts.

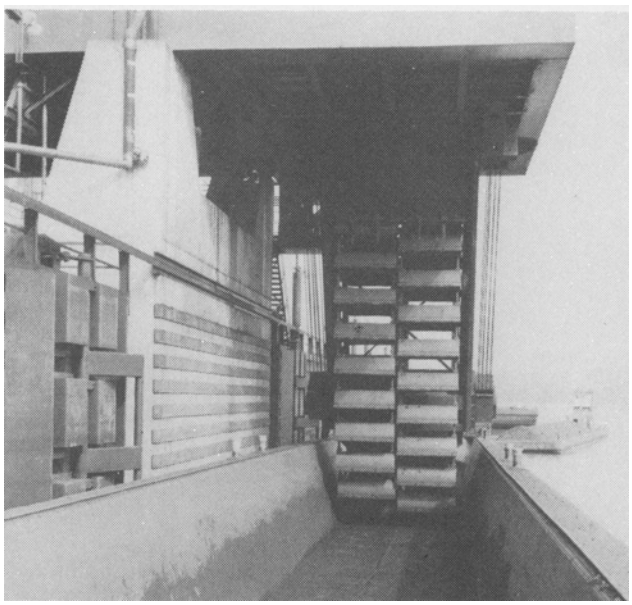

FIG. 1. Marine leg.

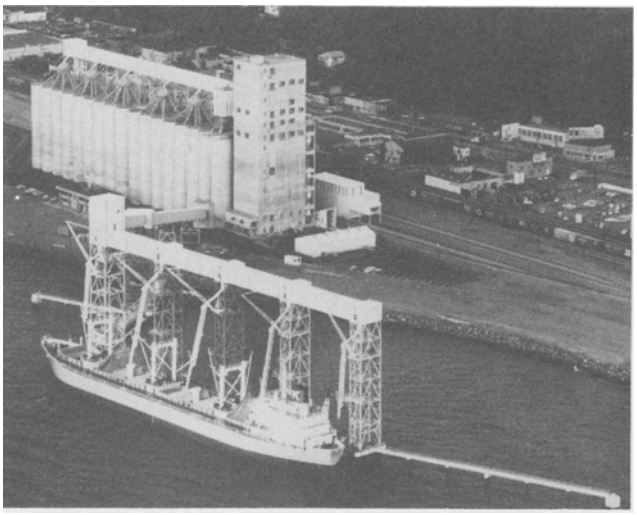

FIG. 2. Large sea coast elevator in the U.S.

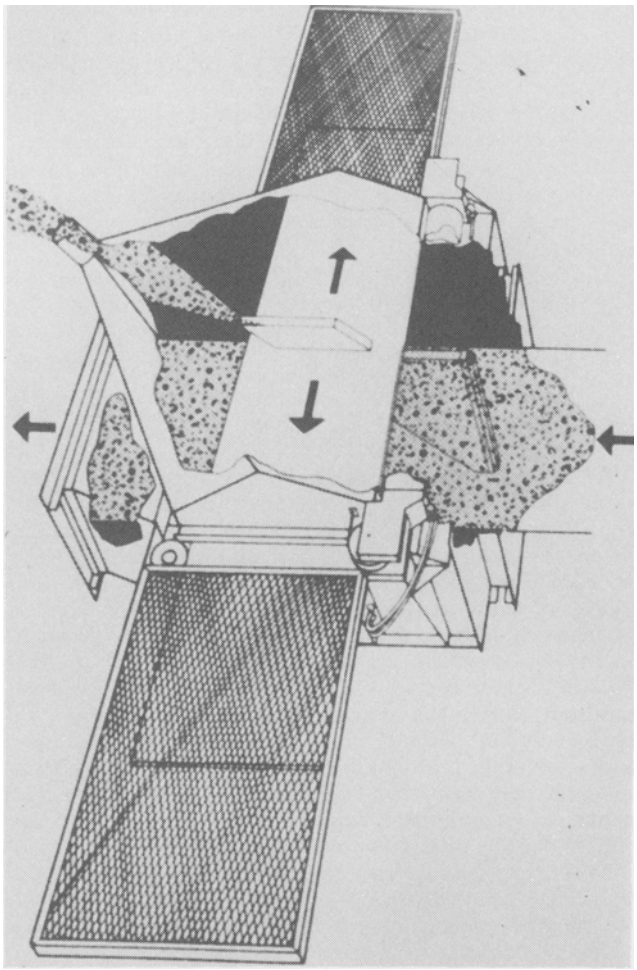

FIG. 3. Diagram of an automatic grain sampler.

For grading purposes, it is very important that a representative sample is obtained during those high speed loading and unloading operations. Figure 3 shows a typical automatic sampler that travels across the stream of grain at some given point to perform this service.

Figure 4 shows a typical ship unloading installation employing several pneumatic suction lines. Pneumatic unloading is the most popular because of ease of operation and flexibility to perform in most any kind of vessel. Port cranes and ships' tackle are also widely used to operate clam-type buckets similar to that used in the copra ship unloading.

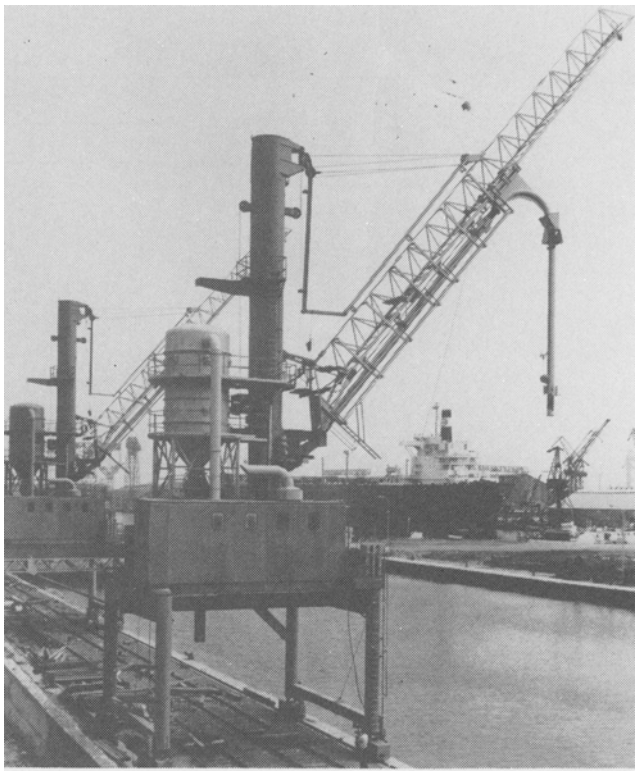

FIG. 4. Typical large ship unloading installation with pneumatic suction line.

STORAGE FACILITIES

The free-flowing-type oilseeds so designated in Table I can be handled in facilities similar to those used for grains. Likewise, they may be handled in the same type warehouses used for copra and cottonseed. Grain-type facilities may be concrete or steel storage tanks. Concrete storage tanks can be built separately or in multiples with common side walls to effect economies of walls and conveyors. Steel tanks can be of any size up to 200 ft in diameter and may contain up to 60,000 tons of soybeans or other oilseeds. Naturally, the risk factor goes up in the large storage tanks because of difficulty to remove oilseeds from any part of the bin where heating may start to occur.

For each oilseed, there is a general set of conditions or guidelines which experience has shown needs to be followed if the seed is to be kept any length of time without deterioration. Most important of these is the moisture content of the seed. Other factors are (a) presence of foreign material such as green leaves, stems, or weed seeds; (b) degree of maturity of the seed; (c) tempering time between harvesting and placing in storage; and (d) ambient temperature of atmosphere at the time of placing in storage. Table II gives moisture levels generally considered safe for storage.

We also need to recognize that one of the factors other than moisture can be the controlling factor. Likewise, under correct conditions, oilseeds above the moisture content listed can be safely stored at least for short periods of time. While in storage, good warehousing practices would include (a) controlled segregation or placement of various moisture level materials, (b) temperature analysis taken at least once a week, (c) aeration of higher moisture seed, and (d) good record keeping of the condition of the material going to storage and of successive temperature checks.

Temperatures can be taken by permanently mounted temperature cables in concrete tanks and in some steel tanks or by installing pipes for temperature thermometers as is done in cottonseed after the seed is in storage. Deterioration can result in increased free fatty acid content or a darkening of color of seed and resultant oil. If permitted to

TABLE I

Oil-bearing Materials

	Density		Can be handled generally like grains	Special handling consideration
	(lb/ft^3)	(Kg/m^3)		
Soybeans	48	769	X	
Flax seed	44	705	X	
Safflower	45	721	X	
Shelled peanuts	40	641	X	
Sunflower	25	401	X	
Castor beans	36	577	X	
Rapeseed	45	721	X	
Sesame seed	37	593	X	
Cotton (delinted)	35	561	X	
Cotton (undelinted)	20	320		X
Copra	25	400		X
Palmkernels	23	368		X

TABLE II

Moisture Levels Considered Safe for Storage

	Maximum moisture (%)
Soybeans	13.0
Flax	10.5
Sunflower	8.5
Copra	7.0
Palm kernel	8.0
Cotton	10.0
Rapeseed	7.0
Safflower	11.0
Peanuts	11.0

continue heating unchecked, almost all seeds will char and then smolder and break into open flames when a hot spot is uncovered and exposed to the air. So, extreme care must be taken in watching temperatures of material in storage and taking the necessary steps to stop any progressive temperature buildup.

DRYING OILSEEDS

Normal moisture at the time of harvest varies from one seed to another. Unfortunately, Mother Nature many times causes rains or early frost at harvest time. Both can cause high moisture in oilseeds. Some of the vegetable oil fruits such as palm and olives will tend to be more influenced by degree of maturity than by effect of rains. In any case, essentially all oil-bearing seeds will require some drying before processing. This drying can be very simple as in the case of copra.

Copra is either dried by simply exposing the white coconut meats to the sun or by placing half coconuts over a smudge-type fire fueled by the husks and shells of coconuts. Free-flowing-type oilseeds are dried in conventional grain dryers. Rates can be up to 100 tons per hour. Aeration, or the practice of simply blowing air through the materials, is also very effective in lowering temperatures as well as moistures.

CLEANING

Ideally, oil-bearing seeds should be cleaned as received and before being put into storage. It is normal that oilseeds coming from the harvest fields will contain some foreign materials. Trading rules specify grades and discounts for various amounts and types of foreign materials received with the oilseeds. In processing, some foreign material may have little effect except to lower protein and to raise the fiber in the meal residue after the oil is removed. On the other hand, some material, such as certain weed seeds, may impart foreign ingredients to the extracted oil.

If rates of receiving and placing in storage will permit, cleaning should be done to remove sand or dirt and material other than the oilseed, such as stems, leaves, weed seeds, stones, strings, or metal. In most cases, receiving rates both at buying stations or grain elevators and at processing plants are too high to economically clean before putting into storage. If oilseeds such as soybeans are dried in modern-type grain dryers before either storage or processing, it is considered good practice to clean before drying.

Cleaners can be of many types and capacities. Good vibrating screens or shaker-type sieves are available in most countries. Some will combine aspiration to remove dust and light materials.

The air from aspiration systems or cleaners and dust collection systems on conveying systems should be discharged into high-efficiency collectors such as cloth bag-type filters to remove the dust from the air stream and prevent air pollution.

SAFETY

No discussion of the handling, storage, drying, and cleaning of oilseeds would be complete without considering the safety hazards involved which affect most importantly personnel and also property. Chief safety concerns are fire and explosion; second is powered machinery; and third is the risk of being smothered by oilseeds in a storage facility. In almost all oil-bearing seeds, dust is associated with handling. Almost any dust in the right mixture with air will explode if there is a source of ignition. To protect against explosion, one must minimize dusty atmospheres and control sources of ignition, such as electric sparks, open flames, welding, and smoking. Grain dryers are also vulnerable and should be protected by alarms and sprinklers. The spontaneous combustion associated with heating seeds can escalate until whole storage areas are involved.

Power machinery always involves risk to personnel. Here one needs to be particularly careful not to get feet or arms into moving conveyors or to make repairs without first locking out control switches. Protective guards covering all moving parts are ideal.

Oilseed storage can be very treacherous for a worker to walk in while material is being drawn out the bottom. The material moves toward the outlet in the form of an inverted cone, and the vortex will suck a man down with its flow. In cases of non-free-flowing materials, danger exists if a person is permitted to work in an area where a high pile or wall may fall and bury him.

Every job should be done safely, with the first concern given to the safety of personnel.