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THE TECHNICAL PRODUCTION PROCESS OF AN OILSEED ✓
PROCESSING PLANT AND QUALITY CONTROL REQUIREMENTS

by

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We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

Technical Aspects of Oilseed Processing

- (a) Production variables and controls
- (b) Product quality control

Method of Approach

- (a) Emphasis on basic principles
- (b) Application of the above by descriptive illustration of unit operations
- (c) Working manual concept rather than textbook

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Introduction

In this paper attention is directed almost solely to the purely technical aspects of vegetable oilseed processing. An attempt is made to consider the more significant production variables and the necessary controls that are available to optimize the efficiency of the various unit operations involved.

A practical rather than a theoretical approach has been adopted. This does not mean that the basic engineering and chemical principles have been neglected. On the contrary we have sought to apply such fundamentals wherever possible. In a word, we adopted the working manual rather than the textbook concept. It is our modest hope that the practical operator will find this sketchy survey helpful in his day to day work as well as reference material.

Acknowledgment is made of the help derived from the various contributors to the 17th annual summer program - Symposium on Processing and Quality Control of Fats and Oils - conducted by The American Oil Chemists' Society, August-September, 1966. Particular thanks is due to Mr. Robert D. Good of Blaw-Knox Company, Pittsburgh, Pennsylvania, and Mr. R.P. Hutchins, The French Oil Mill Machinery Company, Piqua, Ohio.

CHAPTER I

Raw Materials: Handling and Control

The handling and control of the raw materials for the oilseed 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, rapeseed, sunflower and other seeds are subject to damage due to biological actions which are accelerated by high moisture content, foreign material, physical damage and such adverse climatic conditions as frost or rain before or during harvest.

The purpose of the storage units, cleaners and dryers used by oil mill operators 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 and their operation is 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 oilseed processor must combine ingenuity and resourcefulness with hard work to provide a solution to the problems of each season in an industry where no season is the repeat of a previous one.

Receipt at Oil Mills

Trucks account for the most numerous individual shipments of seeds received at the typical oil mill. 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.

Cleaning

All seeds should be cleaned free of trash, hulls, sand, etc., by selection of the type of cleaner and screen size to remove course and fine material. The screens have to be sized to suit the seed being processed. Removal of sand will reduce equipment maintenance and weed seed removal improves oil quality. A marginal improvement achievement will be increased capacity and preparation for the next stage. 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

The drying of seeds for storage prolongs the storage life of the seeds. The "critical" moisture content of seeds is that at which seeds are in equilibrium with air of a 75% Relative Humidity at 75°F. Cottonseed stores well up to 11% H₂O, between 11% and 14% uncertain behaviour, and above 14% seeds will deteriorate.

Drying is usually achieved by the movement of large air volumes of about 100,000 c.f.m. so that seed temperatures do not need to rise too high. A temperature range should be 110°F to 140°F and be cooled before storage +10°F above ambient air. Air temperature up to 190°F through the dryer is required. Damaged seed must always be processed first. It appears that the air surrounding grain has a definite effect on the storage of soybeans as it cools on rising through the beans. Moisture can condense on the bean causing the surface moisture to raise to 19% and thus permit mould growth.

Storage

Raw material storage represents one of the largest capital investments in an oil mill. Storage should be designed to permit segregation of grain by good and poor quality, control of moisture level and control of temperature. Ample use of cooling fans, temperature recorders for seed in bins and conveying facilities for "turning over" the seed should be made to prevent deterioration due to local overheating and high moisture.

Three general types of storage are most used: multiple silos, large steel tanks, and seed houses.

The multiple-silo type 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 capital investment.

Large vertical cylindrical steel tanks with flat bottoms and conical roofs are used for long term storage of oilseeds. They may be built in many sizes to suit the individual plants' requirements with a capital investment substantially below the silo or elevator type.

The seed house is most commonly used in the cottonseed industry but is also used for soybeans, flax, and safflower. It offers low capital investment for large storage requirements.

Comparative Costs of Storage - 1,000,000 bushels
(without foundations, conveyors or other equipment)

Elevator	35c per bushel
Steel tanks	15c per bushel
Seed house	13c per bushel

Storage Temperature Observation

The prime danger to oilseeds 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 with a series of thermometers arranged on a stiff cable and inserted into the pipes. These are allowed to come to equilibrium temperature.

A better, but more costly system, consists of thermo couples placed in pipes or cables and installed in the bin, tank, or house before filling. Sensing points should be located at about 10 foot spacings. Temperatures should be recorded at least at weekly intervals.

CHAPTER II

Processing Control of Crude Oil Production from Oilseeds

The greatest quality advances in milling practice in the last 20 years involve improvements in receiving, drying, storing and cleaning of oilseeds. Probably the greatest change has been in the matter of drying.

In discussing process control, it is necessary to treat the oilseeds separately since specific process requirements to preserve quality for one are sometimes unimportant and even produce the reverse effect on another seed.

It is also necessary to treat the mechanical screw press operation and the solvent extraction operation separately. Although there are many common quality problems, there are many more differences.

Continuous Mechanical Screw Press Process - Cottonseed

After passing over an aspirator type cleaner, the seed then goes through linters. It is then hulled by cutting the seed in bar hullers, and the meats are separated from the hulls in a series of seed separating machines.

The cottonseed meats containing 10% to 15% hulls are then passed through crushing rolls. This is an important process in controlling quality of the oil for most oilseeds. The crushing rolls serve to flatten the meats into flakes and also to rupture a good number of the oil cells. Even more important, they put the meats into a form that permits them to be uniformly treated with heat and the moisture which is so necessary to preserve oil quality. Oil mills using screw presses have made sensational reductions in refining losses by

Improving the rolling of the meats before cooking. It is necessary to maintain crushing rolls in good condition to get good yields of oil. Whole meats or seeds that by-pass the rolls make it impossible to give the seeds the uniform cooking and pressing required for good yields or good quality.

The meats should be passed immediately to a cooker, which is either a vertical stack unit or a horizontal cooker. In the stack cooker the top kettle moisture of 13 - 14% and 190°F for 20 minutes is usually beneficial for a low refining loss and light refined colour, but many mills cannot maintain tonnage or yields if they humidify to that level. The solution for better oil quality is more cooker capacity. Even higher moistures, up to 15 - 16%, will lower refining loss, but there is some evidence that yields of crude oil are reduced by excessively high moisture, above any loss caused by higher discharge moisture. A discharge moisture of about 3% is required for low oil in cake, which may be lower still for some oilseeds, such as sesame seeds or copra.

When seeds are prepressed to produce cake containing 10 - 14% oil, suitable for solvent extraction, the moisture is raised to 7 - 9%. The whole cooking is usually less severe. The presses are speeded up and the cones are opened wide.

Each kettle temperature can be controlled but most operators think that the top kettle temperature and the discharge temperature are most important.

For cottonseed, a top kettle temperature of 190°F is considered best for ensuring a good quality oil. Lower temperatures can be tolerated by good quality seed. Very high acid seed may require a top kettle temperature of 200 - 210°F to obtain the lowest refining loss possible with damaged seed.

A discharge temperature of 240 - 260°F is usual for cottonseed. The best temperature must be found and maintained within plus or minus 5°F. Other oilseeds require a similar discharge temperature.

The cooked meats pass through the screw press which produces extracted cake containing a residual oil content of about 3%. The cake is ground and cooled then stored in bins until a protein analysis can be obtained after which the ground meal is blended with the proper amount of hulls to adjust the protein to 41%.

The crude oil is passed through a settling tank, in which the large meal particles or flocs are allowed to settle and collect by drag conveyors passed over wedge wire. The settled oil is then filtered usually through plate and frame presses, although more sophisticated enclosed leaf filters are becoming more common. The filter press cleanings, together with the flocs from the settling tanks are re-cycled uniformly back into the meats stream to the presses. The finished oil should be cooled immediately because darkening will take place if the oil is allowed to remain hot for any extended period of time, particularly if it is in contact with meats or flocs.

One of the most important considerations from a quality standpoint is to have a continuous and rapid flow of material from one piece of equipment to another. No collection of overflow material can be allowed to accumulate. After the flakers pass through the crushing rolls, deterioration takes place rapidly, particularly if the material is high in moisture or of poor quality. After the meats are rolled, they present a relatively large surface which permits oxidation or hydrolysis or a combination of processes to take place, resulting in darkening of the oil and an increase in free fatty acids which in turn cause high refining loss.

Uniformity is the key to successful operation, particularly a uniform feed or tonnage control.

Solvent Extraction - Soybeans

In discussing the solvent-extraction process for oilseeds, reference will be made chiefly to soybeans as they lend themselves ideally to this method of processing. The other oilseeds high in oil, such as flax, peanuts, sunflowerseed, sesameseed, rapeseed, copra, etc., are all prepressed before extraction. Cottonseed can be direct extracted as are soybeans.

Cracking

The clean beans are cracked by multiple passes through corrugated cutting rolls, which reduce the beans to quarters and eighths with a minimum of fines. Good cracking will produce 6% on 6 mesh, 65 - 70% on 10 mesh, 5 - 12% on 20 mesh and 0 - 3% through 20 mesh.

Hulling

There has been a great demand in recent years for high-protein, low fibre soybean meal, which is particularly valuable in feeds for chickens. Many soybean plants in North America have therefore installed equipment following the cracking rolls, in order to separate the hulls from the bean meats and produce meal of less than 3% crude fibre content. Hull analyze about 33% crude fibre. Since hull-free soybeans themselves will contain nearly 2.5% fibre, few traces of hulls can be tolerated in low-fibre meal. This has been called High Protein and frequently 50% Protein Meal because this was the original way in which it was marketed. Since the protein level depends on the environment during the growing season and since in recent years commercial low-fibre will not reach 50% protein, trading rules now permit the trading of so-called 50% protein meal with payment made on a sliding scale, based on actual protein. The limit for fibre, however, is fixed at 3.0%.

There are a number of systems for removing hulls - therefore, only a general outline will be given.

The cracked beans and hulls are screened and any uncracked beans together with large hulls are re-cycled to the cracking rolls. At the same time, fine meats and hulls are screened out because fine meats and hulls cannot be separated without losing too much oil-containing material. The remainder of the

cracked bean stream is then heavily aerated to take off substantially all the hulls together with a great number of medium-sized meats. This mixture of meats and hulls containing about 50% meats by weight is then passed through a secondary system which will either be a specific gravity table or a reel or hull beater. Then 6 - 7% of the weight of the original beans can be removed as hulls, and the oil content of the hulls can be held between 1 and 2%.

In order to loosen the hulls from the meats, most plants dry the soybeans before they are stored. An attempt is made to temper the beans in storage for at least 5 days before processing. In some plants the cracked beans and hulls are subjected to attrition in order to break loose any hull particles from the cracked beans. The hulls are usually put through vertical-type cookers to toast them and reduce urease activity so that hulls can be used in selected types of mixed feed.

Conditioning

The cracked beans with the hulls, or hull-free if the hulls have been separated, are sent to the conditioner, which is a stack-type cooler with automatic external level control gates, which maintain the cracked bean level in each kettle at all times, to promote uniform conditioning. A bean conditioner for a 300 ton per day soybean capacity will be about 8 ft. in diameter and have 6 vertical kettles with steam jacketed bottoms. In many larger capacity plants a rotary steam-tube dryer is used instead of the vertical stack conditioner. This is a horizontal revolving drum about 8 ft. in diameter and from 30 - 60 ft. long containing bundles of steam tubes which provide a larger heating surface. The cracked beans are picked up with plows and dropped over the tubes as the drum revolves.

For small capacity plants, steam jacketed paddle-type conveyors are sometimes used as a conditioner. All of these types are used to heat the beans in a 15 - 30 minute cycle to about 165°F at a moisture of 10 - 11%. Cottonseed meats are conditioned to about 150°F to preserve oil quality.

Flaking

After conditioning, the cracked beans are flaked. Flaking rolls are rugged machines with a pair of smooth rolls with adjustments to produce flake thickness from about .008 to .012 inches in most operations. The flakes will be introduced into the extractor at a temperature of around 140°F and a moisture of around 10%.

In respect to quality considerations, it is even more important in the solvent-extraction process than for pressing to have no overflow piles of meats or flakes. High moisture flakes will deteriorate rapidly and produce a poor quality oil. Both cottonseed and soybeans are vulnerable to oil damage if flakes are allowed to accumulate in overflow piles. Innumerable cases of "unexplained" production of poor oil is the result of a breakdown somewhere in the plant, during which time hot, moist oilseed flakes were stacked on the floor. After these piles of material are cleaned up, a trouble shooter is hard pressed to find the cause of bad oil in several shipments.

Extraction

The flakes are conveyed in enclosed, mass-flow type conveyors to the extractor and fed through a plug seal conveyor to the percolation-type Basket extractor. This is the most popular type in operation in North America. Few of the immersion type units are being operated but these only in small capacities and in locations remote from the large scale operators.

Solvent extraction in most plants takes place at about 120 - 130°F. Soybeans are usually extracted in 25 - 45 minutes. Cottonseed flakes require 40 - 60 minutes. One important quality consideration for cottonseed involves the deterioration of miscella with time. Cottonseed oil must be reclaimed from miscella quickly by evaporation or refining to prevent serious oil damage. This problem is not found with soybeans or with any other oilseeds.

The flakes are reduced to an oil content of about 1% or less in most commercial operations and the extracted flakes containing around 35% solvent are conveyed through a vapour-tight mass flow conveyor to the flake desolventizing and toasting equipment.

Desolventizer - toaster

The single vertical desolventizer-toaster unit can handle up to 1500 tons per day. The unit is made up of vertical stack kettles of 6 - 8 ft. in diameter and have steam-jacketed trays and sometimes steam-jacketed side walls. For large capacities, the top kettle is expanded into a large dome 8 - 12 ft. in diameter and 6 - 10 ft. high. Great quantities of sparge steam are introduced into this top kettle for soybeans which provides a large cross-sectional area for the hexane vapours to be gathered and led through pipes to the condensing equipment. In the combination desolventizer-toaster urease activity is reduced to a value of under .1 by the standard analytical tests set up by the American Oil Chemists Society.

The vapours from the desolventizer are scrubbed with liquid solvent or hot water in a vapour scrubber. The meal discharged from desolventizers may vary in moisture from 10 - 20% but must be dried and cooled to around 10% if it is to be stored or to 12½% if it is to be sacked or shipped directly in bulk.

An important quality consideration for soybeans only is the high humidification of extracted meal to produce optimum nutrition. High nutrition is obtained for soybean meal at the expense of the liberal use of steam. There are many steam-saving devices in the extraction area but care must be taken or soymeal quality will suffer.

For cottonseed an entirely different treatment is called for to preserve the best meal quality. Almost no sparge steam should be used - only the dry heat from the desolventizer-toaster jackets. Use of sparge steam for cottonseed darkens meal and lowers protein solubility.

After desolventizing, extracted meal must be cooled in order to stop the toasting process. The cooled meal is screened and loaded out in sacks or bulk.

Solvent Recovery

Low temperature miscella evaporation has been a natural result of efforts at steam saving. Dual evaporation does achieve steam economy. Vapours from the desolventizer which contain some steam as well as hexane are fed into the shell of a heat exchanger or first stage evaporator. The full miscella from the extractor containing 20 - 30% oil is pumped through the tubes of this unit and a vacuum is applied to the first-stage condenser.

The hexane vapours from the desolventizer on the outside of the heat exchanger tube condense under atmospheric pressure and yield their heat to evaporate the greater amount of solvent in the full miscella under about a 1/3 atmospheric pressure which is generally designated as about 16 inches of mercury vacuum. The miscella will usually discharge from this first-stage evaporator at about 65% oil, but this can be increased considerably if cold water is available. In most plants, large-capacity cooling towers provide the cooling water which can be supplied only at temperatures of 80 - 85°F during most of the year.

The second-stage evaporator unit is operated either at atmosphere or under vacuum and steam is used in the steam chest outside the tubes. The miscella concentration is increased to about 90% at which stage it is pumped or flashed into the final oil stripper, which is usually operated under about 20 - 22 inches of mercury vacuum. Most of the final oil stripper units are disc and donut type design which have the advantage of being very clean. The disc and donut design has largely replaced the older, packed columns which were almost universally used many years ago.

It is possible to recover oil with such a system without exceeding 200°F. This is a most important consideration for cottonseed oil. In soybean operation it can be beneficial to lecithin colour. The cooling of cottonseed to about 100°F as quickly as possible is essential. It does not appear to be necessary to cool soybean oil at all.

Process Control of Solvent Extraction

The solvent extraction area equipment is usually under the control of one operator. This is true even for tonnages as high as 1500 tons per day. Sometimes he has a helper. The preparation and meal-grinding equipment also has one operator in attendance; a helper is required for the larger plants, particularly if hull removal equipment is being operated to produce high-protein meal.

Instrumentation consists of temperature recorders, a few temperature and level controllers and a great number of temperature, pressure, level and flow indicators. There are some ammeters that show motor loads, and a comprehensive electrical inter-lock system. Yet the plants operate uniformly and economically with almost no operator attention. Careful engineering makes this possible. The secret is to set and maintain a constant flow of material. All equipment and conveyors must be of extra-heavy construction with adequate power and capacity.

True automation would be difficult and expensive (and possibly impossible) to achieve. Even more sophisticated instruments than the simple ones in use are difficult to justify. The one operator is there and has very little to do when the plant is running. His judgment is needed many times, however, to make the proper adjustment.

The great problems for more automatic controls are involved in the long and variable time lags between cause and effect in these plants. An adjustment in solvent rate may take three hours to bring to complete equilibrium in the evaporation system and the effect may be disrupted by a small change in material rate by flake moisture or by some other variable. Yet the plants achieve their own equilibria if an operator does not try to adjust for the small variations. Instruments with the kind of judgment which is needed have not yet been invented.

Yet increased instrumentation is desirable, even automation wherever it can be useful. Progress is gradually made by attacking one small area at a time. It appears, however, that a single operator will be required for the foreseeable future.

CHAPTER III

Refining of Oils

Refining refers in this case specifically to the treatment of the crude oils with alkaline solutions. These are most commonly water solutions of sodium hydroxide and sodium carbonate.

The treatment involves both chemical and physical reactions. The acidity of the oil, expressed as free fatty acids (F.F.A.) is reduced to a low level. Phosphatides and colloidal substances are precipitated. Pigments react with the alkali and are rendered insoluble in the oil. Soap, formed from the F.F.A., is admixed with these other precipitates and varying amounts of neutral oil will be entrained. Together these form the "soap stock" which is removed from the bulk of the neutral oil.

The neutral oil lost in the soap stock will vary in quantity with the type of oil and the method of refining which is employed. A low neutral oil loss is indicative of correct refining procedure.

Two refining systems are in use: batch and continuous - centrifugal.

The greater portion of crude oils are now refined by the continuous - centrifugal system, since for most oils, neutral oil losses are lower than by the batch process.

With oils where neutral oil losses are equivalent with either process, the batch offers advantage in lower mechanical operating costs.

Too, the batch process is more adaptable to processing smaller lots of crude oils, e.g. a single car of special oil. Too much delay would be occasioned in such cases in change over with this continuous system.

Refining by Batch Process

Two general methods are used in the batch process. They are termed "straight refine" and "water refine". The terminology is not too descriptive but is generally so used in the industry.

In the first case a solution of sodium hydroxide, commonly termed "caustic" is used alone in the primary treatment. With the second, water is first dispersed in the oil, followed by caustic. Too, with a water refine a higher temperature is used.

Sodium carbonate "soda ash" is not used in batch refining. The carbon dioxide which would be released with this alkali would float the soap stock in the oil and make separation very difficult. In addition, soda ash has little effect on the pigments in crude oils.

The crude oil, pumped from storage or tank car to the refining kettle, is allowed to stand several hours to permit release of occluded air.

When the oil is to be treated by the straight refine method, bring the oil to a temperature of 70 - 80°F. With the water refine method the temperature may be raised to a higher point, 140 - 150°F. A higher temperature permits a faster release of air.

Whenever heat is applied agitation should be on to prevent localized over-heating but no agitation is used during the air release period.

Straight Refine

After settling agitation is again started and the caustic added to the oil.

The amount and the strength of caustic will vary with the kind and quality of the crude oil. For the majority of crudes 14° Be' caustic is satisfactory. Occasionally 16° Be' will be required as with some grades of cottonseed oil.

Whenever a change is made in crude oil supply, laboratory refines are advisable to indicate a caustic preference.

The F.F.A. is run prior to any treatment and serves as the initial guide for the amount of caustic to be used.

The following table is used to calculate the caustic percentages.

	Caustic Be'		
	<u>14°</u>	<u>16°</u>	<u>20°</u>
Equivalent of 1.0% F.F.A.	1.52%	1.31%	1.00%
Excess of 0.10% actual NaOH	1.07%	0.92%	0.71%

The primary value of the caustic is neutralizing the F.F.A. Accordingly, the first calculation is determined from this. For example: the oil to be refined is a crude cottonseed oil with a F.F.A. of 1.3%. Using 14° Be' caustic the neutralization equivalent is $1.3 \times 1.52 = 1.98\%$. This will reduce the F.F.A. to a theoretical zero. (Actually refined oils always show some F.F.A., usually not lower than 0.03%).

Straight Refine

Practical experience has shown the necessity of using an excess of caustic i.e. above the neutralizing value. The excess is required to reduce the colour of the oil and it also conditions the body of the soap, which is formed from the F.F.A., making it less viscous and therefore more readily removed at the final stage.

The excess caustic to be added is governed by the crude oil quality.

Arbitrary figures, expressed as percentage of actual NaOH are employed. These are then calculated from the caustic solution of different concentrations. (See above table)

As a general rule, 0.2% excess NaOH is suitable.

If, however, with the proposed cottonseed oil the crude is very dark and contains considerable impurities, an excess of 0.3% would be advisable. This then forms a further quantity of caustic - $1.07 \times 3 = 3.21\%$. This latter figure added to the above neutralization equivalent of 1.98% gives a total caustic treatment of 5.19%. With a 60,000 lb. batch the caustic requirement would be 3114 lbs. of 14° Be'.

Usually a very dark oil is associated with a high F.F.A. in the crude state. Caustic employed in such a case may prove of value at higher concentrations, 18° or 20°. Laboratory tests in such cases are required. Attention must be given to the condition of the soap stock in using higher Be' caustics to assure that they melt sufficient for run-off.

Any crude cottonseed oil is very susceptible to colour damage by overheating. An overheated c/s oil will be one set in colour to the point where no amount of caustic or bleaching will produce a light oil. Too much attention cannot be given to car unloading and storage temperatures. Cottonseed oil reacts most readily to heat damage but the same control is required for all crude oils for optimum colour results.

There is no hard and fast rule that may be given for the excess caustic to be employed in straight refining. The condition of the crude, the type of soapstock formed, and colour requirements all influence the treatment. But there is little value in using above 0.3% excess on any oil. Further increases result in excessive losses. If the refined oil colour is too high, a subsequent caustic wash (see below) is more advisable than trying to effect full colour removal at one time.

Agitation is continuous from the start of caustic addition until the oil is fully refined.

With the temperature still at 70 - 80°F draw samples of the mix, in a glass jar, every few minutes and examine its condition.

At first the oil will be murky with the soapstock in a colloidal state. After continued stirring the soapstock will draw together as small flakes suspended in the clearer oil. When these flakes reach the size of a pin head the temperature is raised rapidly by admitting steam to the heating coils.

The stock from some oils is slow in reaching this primary coalescent stage. If, after 15 to 20 minutes stirring, following the caustic addition, no visible "break" develops raise the temperature through 10 to 20 degrees slowly. The higher temperature will usually initiate a break.

Contact of the oil with the stock in a colloidal state does have a beneficial effect on colour but once the stock breaks to a definitely visible size further stirring at the low temperature offers no value.

As the temperature rises the stock particles increase in size and density. Bottle samples, taken at frequent intervals, are checked to note the speed and completeness with which the stock settles from the oil. The particles of stock may be examined on a clean spatula.

With a good refine the stock should settle rapidly and completely. It should be semi-fluid and streak on the spatula blade when touched.

When this stage is reached steam is cut from the heating coils. After several minutes to allow the coil and oil temperatures to equalize, agitation is stopped and the batch allowed to settle.

Experience has shown the final temperature to range from 130 - 150°F.

When the optimum break is developed never continue agitation. Further agitation may result in breaking the stock into smaller size and result in a poor settle.

Too, it is better to err on the high side than the low for cut-off temperature. A soapstock, not sufficiently melted, entrains neutral oil.

After settling one hour, give the batch a "still wash" by spraying hot water through the nozzle above the oil. Use only several hundred lbs. of water. This washes down any floating stock.

Continue the settling for at least two more hours. The longer the settling period, the better the separation but consideration must be given to the danger of the stock cooling and setting in the cone. Without full removal of the soapstock emulsions may be expected in subsequent washings.

If the cones are steam jacketed a touch of heat can "slip" any cooled stock adhering to the side.

The soapstock, after settling time, is removed through the large bottom valve of the kettle with a smaller valve in line to control the flow.

When the soapstock is almost fully removed oil streaks will show. The flow is then throttled down to permit the more viscous soapstock to fully settle out.

It is sometimes advisable with very viscous soapstock to close the valve, give the agitation a part turn on the paddles to dislodge any stock on the side and allow to settle a few minutes before removing the last portion.

With the soapstock all removed and if the oil meets colour requirements three water washes are given the oil in the following manner -

- (1) A "still wash" using hot water through the top sprays, amounting to about 5% of the oil. No agitation is used. After several hours run off the wash water.
- (2) Add ca 10% of hot water, using agitation and raising the temperatures to 165°F. Stir for 10 minutes and then allow to settle two or three hours. Remove wash water.
- (3) Repeat the (2) wash adding 0.01% phosphoric acid. Remove wash water in two to three hours.

When washing is complete "dry" the oil by agitating and raising temperature to about 240°F. This will remove any residual water.

Caustic Wash

Some refined oils may be too dark in colour for specific uses, and will not lighten enough in the bleaching process.

A further treatment, after soapstock removal, with a weak caustic will "soften" an oil permitting improved bleach colours.

Although the greatest effect of the additional "caustic wash" is observed on refined oils, stored over several months, considerable improvement may be noted from a caustic wash directly following the primary refine. The observation, common to the oil industry, that better colours are obtained by storing a dark refined oil and later caustic washing than by caustic washing immediately following the primary refine, would indicate a mild oxidation occurring during storage. Laboratory tests and several plant runs employing hydrogen peroxide would indicate oxidation at least plays a part.

Refined oil, prior to caustic washing, was agitated with 0.05% of 30 vol. peroxide for 30 minutes and a temperature of 140°F. The oil was then caustic washed and compared with another portion so treated but without peroxide. A definite lower colour results down through the bleaching stage with the peroxide oil. This is but a suggestion for trial runs and is not part of the normal refining procedure.

To the refined oil, free of soapstock and after the still wash, is added 10% of hot water, agitation being on, and the temperature raised to 165°F. Caustic equivalent to 0.5% - 2.0% of 20° Be' is added and the whole agitated for 10 minutes and after settling several hours the wash layer is removed and the oil washed as previously outlined in the primary refine.

The amount of caustic required in the caustic wash is dependent on the degree of colour removal required and may be determined by some laboratory runs.

Water Refining

This method is used on crude oils of relatively low F.F.A. and where colour is not a problem. In principle it is similar to the caustic wash except more caustic is required.

The caustic percentage is calculated as outlined in the straight refine; 0.1% to 0.2% excess, with 0.2% being most usually added.

The oil, after settling for deaeration, is brought to 165°F. with agitation and addition of 10% water. The calculated weight of caustic is added. Agitation is continued for five minutes and then stopped.

The soapstock formed in the water refine does not break into large size. It remains as minute droplets, distinctly visible, however, on a spatula blade. Because of the relatively high proportion of water the soapstock is quite fluid.

A sample bottle of the mix is drawn just prior to the stop of agitation and held in a warm place for examination of settling. Separation should be distinct but the oil layer will be cloudy. This is due to traces of soap and moisture.

Some oils, on water refining, will show a thin layer of light colour, between soapstock and oil. This is a water and oil emulsion usually characteristic of crudes with a high lecithin content. An incompletely degummed soyabean oil is particularly troublesome in this manner.

The emulsion layer must be removed with the soapstock and represents an extra oil loss.

Settling time may be judged by the manner in which the sample behaves. It is preferable to allow at least 3 - 4 hours. A longer time is not attended by any danger of the stock setting up as can occur with a straight refine. However, even a liquid stock will gel if allowed to cool to a low temperature. Experience has shown lower losses may be expected by settling coconut and palm kernel oils over night. Liquid stocks of these oils require quite a low temperature to gel.

As with the straight refine a light spray wash is given the refined oil after an hour of settling.

When the soapstock has been removed the refined oil is washed three times, again as described for the straight refine.

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The preferential use of straight or water refining for a particular oil has been based on practical experience. Some oils may be refined either way and satisfactory separations made. Overall oil losses are usually superior with one or the other.

Coconut and palm kernel oils demonstrate this very definitely. These oils, if straight refined, separate a soapstock heavily entrained with neutral oil. Losses are many times the F.F.A. of the crude oil.

Water refines on these same oils give a liquid soapstock, with very little neutral oil entrainment and subsequent losses close to the original F.F.A.

With a good quality crude coconut oil overall losses may show lower than the F.F.A. of the crude. This paradox is explained by the F.F.A. of coconut oil being largely lauric and the F.F.A. being usually expressed as oleic, an acid of higher molecular weight.

Cottonseed oil exhibits opposite conditions to the two above oils. A straight refine will prove superior in the loss figure and particularly in the lighter colour of the refined oil.

In the following listed oils, the first two, coconut and palm kernel, are invariably water refined. It has been customary to water refine the remaining oils if the F.F.A. does not exceed 2.0%. Recent experience has changed procedures on several oils, details of which follow the list.

- Coconut Oil
- Palm kernel Oil
- Sunflower seed Oil
- Rapeseed Oil
- Corn Oil
- Marine Oils
- Lards
- Tallows
- Soyabean Oil

Problems have occurred with rapeseed oil and soyabean oils due to rain damage to the seed and immaturity due to cold seasons. Soyabean oils are usually degummed at the extraction plant with lecithin residues down to 0.1%. Oil extracted from wet or frozen seed has proven difficult to degum with resulting so-called degummed oils showing lecithin contents of 0.3% to 2.5%. In addition some soyabean oils have monoglyceride contents as high as 3%.

Some rapeseed oils are also showing lecithin at 1.5% and mono's above 1%.

These abnormal oils do not refine well with a water refine. Lecithins and mono's are not removed fully by the primary refine and cause emulsions at water washing. Phosphoric acid has been used to advantage for some time on all rapeseed and soyabean oils.

Pre-treatment of these oils by agitating the crudes with 0.1% acid prior to dry refining them has proven satisfactory in removing the mono's and lecithins to low levels with subsequent ready water washing.

A fast test to determine if such crude oils are high in emulsion causing agents may be done by shaking equal quantities of oil and water in a stoppered flask and observing the interface after settling 30 minutes. A little experience with various oils permits a rough estimate to be made.

Occasionally oils of a very high F.F.A. will be encountered. With such oils it is better to double refine, i.e. use sufficient caustic to remove only about one-half the F.F.A., then re-refine with a second charge of caustic.

Laboratory refines are always advisable on high acid crude oils prior to plant processing.

In many cases with F.F.A. higher than 2%, with the other oils listed, a water refine is still preferable. Again, if a high contamination accompanies the high acid a straight refine may be of advantage. Pre-tests in the laboratory are the answer.

Crude Cottonseed oil is always straight refined.

Batch refining of crude palm oil is carried out on the straight refine although it is sometimes of advantage to add a small amount of water when the break develops. Crude palm oils are higher in F.F.A. than the usual run of other crude oils and refining losses are high. Wherever possible, palm oil should be run through the continuous system.

Crude Corn oil should always be laboratory refined prior to plant refining. On low acid and relatively clean oil the water refine is usually the better. Quite often crude corn oils are high in lecithin and "Waxy" materials and give better results by straight refining.

The foregoing covers the general procedure of batch refining. A plant may differ in detail as a result of variation in equipment design and the individual operator's opinion of correct procedure.

Art still plays a major role in batch refining.

Continuous Refining of Edible Oils

In contrast to the batch refining process, where separation of the refined oil and soapstock is accomplished by gravity separation with long periods of settling time, the continuous system employs high speed centrifuges to bring about the separation rapidly and continuously.

With these machines separation times are reduced by increasing the "Gs". Usually too, less neutral oil is entrained with reduction in losses.

Unlike batch refining where various methods are required for different oils, the centrifugal system is more or less "set".

The mechanical equipment, put in motion, follows a pattern which does not, and cannot, be varied.

Variables that can be controlled are only temperature, volume of oil flow and alkali amounts.

The plant consists of sets of centrifuges, in duplicates, giving a capacity of 10,000 lbs. per hour.

The primaries separate the soap stock; the secondaries permit a second treat with alkali for further colour reduction, and the water wash centrifuges clarify the oil of residual soap.

Prior to the centrifuges, mechanical mixers distribute the alkalis in the oil. Following the water washers the oil is freed of moisture in a vacuum drier.

With the exception of low lecithin soyabean oils, the crudes are run through the three stages. Requiring a small alkali treat, the soya may be satisfactorily run through the secondaries and water washers only, by-passing the primaries.

Too, with the exception of cottonseed oil, oils given the full system are not always treated with caustic in the secondaries. Cotton requires a second treat for colour reduction but the colours of most other oils do not respond to this. In the latter cases the bottom flush only is used, acting as a primary washer. It has proven of advantage to use caustic on the second stage with some dark, high gum, rapeseed oils.

As in the batch system no hard and fast rules can be set for the treatment in the continuous systems. Too, we have no laboratory equipment to duplicate plant conditions and experimenting is required to be done on full scale production. Fortunately, the centrifugal action is so high that even poorly separating stocks are removed to a sufficient degree to permit adjustments in the treat for optimum conditions in the continued run.

The crude oil enters the system to be mixed with caustic followed by soda ash solution to condition and weight the stock. The mix then enters the centrifuge system.

With oils of light colour the caustic treat is held slightly above the F.F.A. neutralization equivalent. With dark oils, which respond in colour reduction to excess caustic, this may be used at 100% to 200% above neutralization. Crude oils high in gums and "bottoms" of storage tanks require additional caustic.

The soda ash conditions the soapstock and the amount employed is based on the appearance of the stock. This should be only liquid enough to flow readily and show no free oil when a small amount is robbed dry in the palm of the hand.

If caustic is employed on the secondaries the amount is determined by the colour reduction. 2% of 20° is usually adequate.

Water wash temperature is held at 180°F. Rapeseed oil, always, and soyabean oil, whenever high in lecithin, are treated in the feed tanks with 0.1% phosphoric acid (85% Food Grade) for 30 minutes with continual agitation prior to refining. This has been found to produce refined oil bearing only traces of residual lecithin.

With low lecithin soybean oils, 0.10 - 0.15%, we have found 1.7% of 20° caustic adequate, employing only the secondary and water wash centrifuges.

Samples, every two hours of refined oil, are analysed for colour, F.F.A., and residual soap. The latter must show a maximum of 50 p.p.m.

Each batch of crude oil is checked for F.F.A. If there is a change in shipment it is advisable to examine the crude oils for excess gums and lecithin.

Bleaching

Bleaching of oils is carried out for several reasons.

- (1) To obtain the lightest color possible.
- (2) To remove traces of soaps present from the alkali refining process which can affect hydrogenation by making it erratic, non-selective and difficult to control.
- (3) To remove traces of nickel from hydrogenated oils. Nickel will catalyze undesirable reactions in the deodorization step which create undesirable flavour and color in the finished product.

Bleaching is generally carried out in open-top kettles equipped with steam coils and good agitation. The oil is heated to 200 - 230°F and 1/4 - 1/2% activated bleaching clay is added all at once, depending on the oil. This is then recirculated through a filter where samples are taken every few minutes for color and/or marker tests. When the required specification is met, the oil is immediately

diverted to storage or further processing.

It is advantageous at this temperature to finish the bleaching as quickly as possible, as the oil will oxidize on recirculation and eventually darken rather than become lighter in color. Once this happens, there is no point in adding more clay or heating further. A better course of action is to blend with a lighter batch of the same oil.

Hydrogenation

Usually, this process is carried out dead-end style in a batch converter.

Nickel catalyst is used, of the common commercial type, consisting of 25% nickel on a carrier such as Kieselguhr.

Converters are pressure vessels equipped with turbine-type agitation, gas inlet, vacuum, heating and cooling coils and auxiliary slurry tanks for adding catalysts.

The oil is introduced and heated by steam as high as possible. Heat of reaction is relied on to raise the temperature higher, if this is necessary.

Some oil is pumped to the slurry tank and, after having the catalyst added and dissolved, is pumped back to the converter. A second, more usual, method is simply to place the converter under vacuum and suck the dry catalyst into the batch through a pipe on the side of the vessel.

Usually, the operator will have a small refractometer nearby for control purposes. Occasionally, he will check a refractive index and when he sees that the batch is nearly finished, will take samples more frequently and take them to the laboratory for a more accurate check. This may be iodine value, solid fat index, Wiley Melting Point, or, simply a more accurate refractometer.

Most common hydrogenation fractions are controlled on the basis of current experience. The ultimate control is usually solid fat index, at several temperatures, but this test is somewhat lengthy for control purposes. However, this can quite accurately be correlated to faster tests such as refractive index or iodine value, provided the raw material and catalyst-temperature-pressure conditions are the same. Therefore, the first batch from a particular run of oil will be checked out and controlled very carefully by the longer, more accurate methods. Succeeding batches can usually be controlled sufficiently accurately by refractive index or iodine value.

Once the hydrogenation has reached its end-point, bleaching clay is added to the converter then the oil is cooled to 180°F and filtered, then sent to storage.

For good, consistent hydrogenation results on a run of oil, a light bleach should be carried out beforehand. If this is not possible, addition of 50 lbs. of bleaching clay to a 20,000 lbs. batch of oil in the converter before hydrogenation will have the same effect.

Selectivity can be varied by changing the amount of catalyst and varying temperature and pressure conditions. Temperature and hydrogen pressure can be varied from 250°F and 50 psig for a very non-selective reaction to 450°F and 5 psig for a very selective reaction.

Winterization

This is performed on salad oils in order to preserve cold temperature clarity and emulsion stability in the case of those oils used for salad dressings.

Basically, the process consists of chilling oils in brine-cooled tanks to 40°F over a sufficient time to seed out solids or "stearine" as it is usually called, then removing these solids by filtering.

Operation of this process is an art rather than a science and it takes a skilled man with a practised eye in most cases to determine the best time to filter; that is, that time when cold test specification can be met yet not enough stearine is seeded out to cause excessive losses.

Oils such as cottonseed and touch-hydrogenated soybean oil, which form a true stearine, must be cooled, stage-wise, over a period of two days in order to properly seed out stearine. In the case of sunflower and corn oils where one is removing waxes only, a quick chill over the period of a few hours is usually enough.

Deodorization

This is usually carried out either of two ways: batch or semi-continuous. In the case of some operations where only one oil is handled and feed does not change, continuous equipment can be used.

Feedstock is usually at least refined and bleached oil. If hydrogenated oil is being fed to the process, care must be taken that no nickel is present; otherwise, oil will darken in the deodorizer.

The oil is heated by the use of "Dowtherm" heating medium to deodorizing temperature, usually 475 - 525°F. Lauric acid oils are usually deodorized at 425°F or else there is a danger that the lighter glycerides will be stripped off with the fatty acids.

The oil is held under a vacuum of about 3 mm Hg. absolute pressure throughout this process.

When cooled, the oil is pumped through a polishing filter then to storage ready for shipping.

CHAPTER IV

QUALITY CONTROL: ITS FUNCTION AND IMPACT ON THE PRODUCTION PROCESS

Introduction

Many years ago, before the advent of our modern industrialized environment, the Western Man's food fat requirements were very simple. The North American pioneer housewife satisfied her requirements by rendering animal fats in a pot on the kitchen stove. A product hardly much more sophisticated served the commercial needs of the day quite adequately.

However, modern industrial concerns, which are the major users of finished fat and oil products, no longer accept such crude ingredients for their products. In general, these companies issue long lists of chemical and physical specifications for materials which they use and have the necessary laboratory facilities and techniques available for checking out each lot to ensure that it meets their rigid standards.

The modern housewife has also upgraded her standards. When she buys a shortening product for use in her kitchen, it must be a pleasing color, odorless, and of the proper consistency for her use. Margarine, in order to be sold, must resemble butter as closely as possible. Cooking oils must be a pleasing golden yellow color and odorless. Any variation in physical and organoleptic properties from one week to the next will lead her to believe that there is something wrong with the product and she may purchase another brand.

It can be seen, therefore, that producers of fat and oil products must have proper laboratory techniques, facilities and personnel available at all times in order to produce products that meet customer requirements and in order to hold their share of the market in this highly competitive business.

Laboratory control in the oilseed and edible oil industries have other benefits as well. Properly organized and operated, the laboratory can increase returns to the processor, both by detecting deficiencies in performances of equipment and enabling upgrading of same and operating personnel.

An obvious example of this is in the solvent extraction process itself. By running a regular spot check on residual fats in the spent meal, the laboratory is often the place where a problem with flaking rolls or solvent pumping can be first detected and, by immediate feed back, corrected in a minimum of time. It can also be the place where darkening of oils can indicate to operators that they are bleaching for too long a period of time.

Organization of a Quality Control Laboratory

In organizing the staff for a quality control laboratory, careful consideration must be given to the lines of authority and responsibility. One danger to be avoided is to make absolutely sure that the technical personnel responsible for laboratory operations does not attempt to work separately from production personnel. Too often the emphasis in the laboratory is exclusively directed

to technical excellence. This, of course, is important but should not be considered an end in itself but rather a means to an end, namely the efficient production of products of the highest quality possible.

If the responsibility lines for quality control and production merge at too low a level, say the Plant Superintendent, then a situation may arise where compromise on quality in the interest of production volume or performance could very easily occur. In order to prevent this, the responsibility for Quality Control should be regarded as a separate function and reporting should be made to the Executive level of management.

Another point to watch is the tendency of the technical staff to confine its interests solely to technical matters in a very narrow sense. By bringing them responsibly into direct contact with top management this will encourage a market and management orientation rather than a purely technical one. It will also serve to broaden and deepen their understanding of the total operation as it relates quality control to production, marketing, finance, etc.

The Control Laboratory should be an excellent base from which to operate an "on-the-job" training program in the areas of management and marketing. Commercial staff trained in such a manner would be superiorly equipped to handle their particular functions. By the same token, technical personnel would benefit immeasurably by exposure to some formal commercial training.

The technical or professional qualifications for the staffing of a Quality Control Laboratory will vary with the complexity of the operations and if any Research and Development is to be included. If the quality control function is simply defined in terms of supplying a service to the operating personnel who must assume ultimate responsibility for quality production in a continuous process, then obviously production supervisory personnel should have some technical training. If this is in fact the case, then Technical Institute graduates who have an appreciation of the variations which affect the chemical and physical properties of the finished products and thus a sound technical basis for decision-making are to be preferred over staff with no technical background. Further, it would be the responsibility of the person in charge of the Laboratory to see that the persons involved in processing should be trained and made aware of quality control. They should be made fully familiar with the different steps of the process such as sampling, testing, and reporting procedures established by the quality control department.

The degree of professional skill and experience required by the Control Laboratory personnel will be determined to some extent by the technical competence of the production staff. For a modest Laboratory in a small to medium-sized vegetable oil processing operation the staff might be something like this.

Chief Chemist:

A University graduate in Chemistry or Chemical Engineering with some experience in food technology, analytical chemistry and sanitation.

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His responsibilities will include, in addition to the administration of the quality control function, - planning and training, co-ordinating and supervision of the staff (technicians), performing physical, chemical and organoleptic tests and controls on all ingredients at various stages of the production process to ensure that the highest standards of quality are met.

Technicians:

Not necessarily University trained but with a solid background in practical laboratory techniques. We have had considerable success in this area with Technical Institute graduates.

Quality Control of Finished Products

Definition: Quality control of finished products can be defined as the establishing of quality standards for finished products and the process of ensuring that these standards are met.

Establishing of Quality Standards

There are two classes of customers for products from this industry: domestic and industrial.

Standards for industrial customers are established by providing their supplier with a list of the specifications they require. These have usually been established by testing which has been carried out by the customer.

In order to be successful on the retail market, a refiner must determine what type of product is acceptable and pleasing to an average housewife. In order to do this, he must relate organoleptic and performance characteristics to various physical and chemical tests which can be performed easily and quickly in the laboratory. For example, lovibond color can be related to whiteness of the solid shortening, peroxide value to taste and oxidative stability and performance in baking to solid fat index and melting point.

Maintenance of Quality Standards

In order to maintain established standards on finished products, related standards must be established for each step of processing. For example, if a color is abnormally dark after an oil is bleached, then one cannot expect a normal color after winter pressing and deodorizing. It is very important to detect this type of problem early, so that it can be rectified before the product reaches the packaging stage and must be rejected.

In continuous types of processing, the time factor is vitally important. Take for example the extraction of soybeans and assume that meal is worth 5 cents per pound and the oil 12 cents per pound. If an upset in processing occurs so that residual oil in the meal is 1.2% rather than a norm of 0.7%, each hour of delay can mean a loss of \$20.00 for the processor extracting 500 tons per day.

In this example, two things are apparent. The first is that continuous coverage by laboratory personnel is advantageous in order to minimize losses of this type. The second is that a quick analysis will save money for the processor. There are quick methods available to check residual fats which take between 30 minutes and one hour; the advantage over the traditional six-hour Soxhlet method for control purposes is obvious.

An Example: Rapeseed Processing

The following analyses and checks are suggested as a quality control system for a rapeseed processing operation, including refining, bleaching and deodorizing for end use as a salad or cooking oil.

Raw Material Receipts

In normal price structure, full price is paid for top grade seed, with discounts for the lower grades. Hence, each incoming shipment must be sampled and the grade determined on such criteria as percent moisture, percent foreign material, percent green and damaged seed.

Care must be taken to secure a representative sample. Here, an automatic continuous sampling device is best; however, failing this, samples taken at a number of points with a sampling probe and mixed are usually acceptable.

Also, on incoming seed shipments, care must be taken to detect excessively high moistures. In these cases, material should be processed immediately in order to prevent localized heating and fires in storage.

An organized program of oil and protein analyses on samples will help the processor forecast oil and meal yields and therefore, an expected return on his investment.

Heating-Drying

Rapeseed must be quickly heated and dried at this point in order to inactivate myrosinase and other harmful factors present in the seed. Usually, 6% exit moisture and 180°F exit temperature are the accepted values.

Here, spot checks should be carried out often in order to ensure that these values are being met; otherwise, sulphur compounds will be extracted with the oil and make hydrogenation very erratic and difficult. Here, a moisture meter, such as a "Steinlite", is of tremendous value as it gives results in several minutes.

Prepressing

Rapeseed, after being crushed in a flaking mill, is cooked and prepressed to 15 - 18% oil. An analysis for oil content should be performed on the cake from time to time in order to check the performance of the prepressing equipment.

Granulating

The press cake is then broken up by a hammer mill or similar piece of equipment.

At this point, occasional screen tests should be carried out in order that the operator may keep an eye on the amount of fines entering the extractor. If this is too high, suitable adjustments should be made in previous stages.

Extraction

Here, of course, the main concern is residual fat analyses. Please refer to Maintenance of Quality Standards section.

Distillation and Solvent Recovery

An occasional check should be made on the product oil to determine whether any solvent is present. If so, then the oil should be collected and re-run through the solvent removal process.

Here, A.O.C.S. Flash Point, closed cup method, is usually employed. This must be watched very closely during plant start-up.

Each shipment of incoming solvent should be checked for boiling range and residue upon arrival. Proper control of these parameters will ensure that solvent is completely removed from oil under normal operating conditions.

Degumming

Occasional checks must be made to ensure that the proper amount of water is added in order to hydrate the gums. The stream of oil and water entering the centrifuge should regularly be checked for moisture and adjustments made; otherwise, excessively high refining losses will be incurred.

Crude, Degummed Oil for Storage

Degummed oil should be dried and stored at a moisture content of 0.1% max., and normally 0.05%. This point should be checked regularly and kept in line, otherwise gums will hydrate and settle in the tank, creating a loss and cleaning problem.

Refining

In refining, F.F.A. (Free Fatty Acid) on crude oil is normally checked in order to determine the proper amount of alkali necessary for refining.

F.F.A. should be checked on the refined oil in order to determine whether the standard of 0.05% max. has been met. Soap content and color are usually checked as well on each batch.

Bleaching

Colors should be read every few minutes as the bleaching is progressing. Once the color standard has been met, the operator should be advised IMMEDIATELY in order that the process can be stopped before the oil is unduly oxidized.

Deodorizing

Deodorizer feed stock should be checked regularly for F.F.A. and color so that any problems which arise can easily be traced.

Deodorized oil is checked regularly for F.F.A., color and flavour. F.F.A. should be approximately 0.05% and flavour should be completely bland if the deodorization has been performed properly.

Any batch which does not meet standards should be re-deodorized.

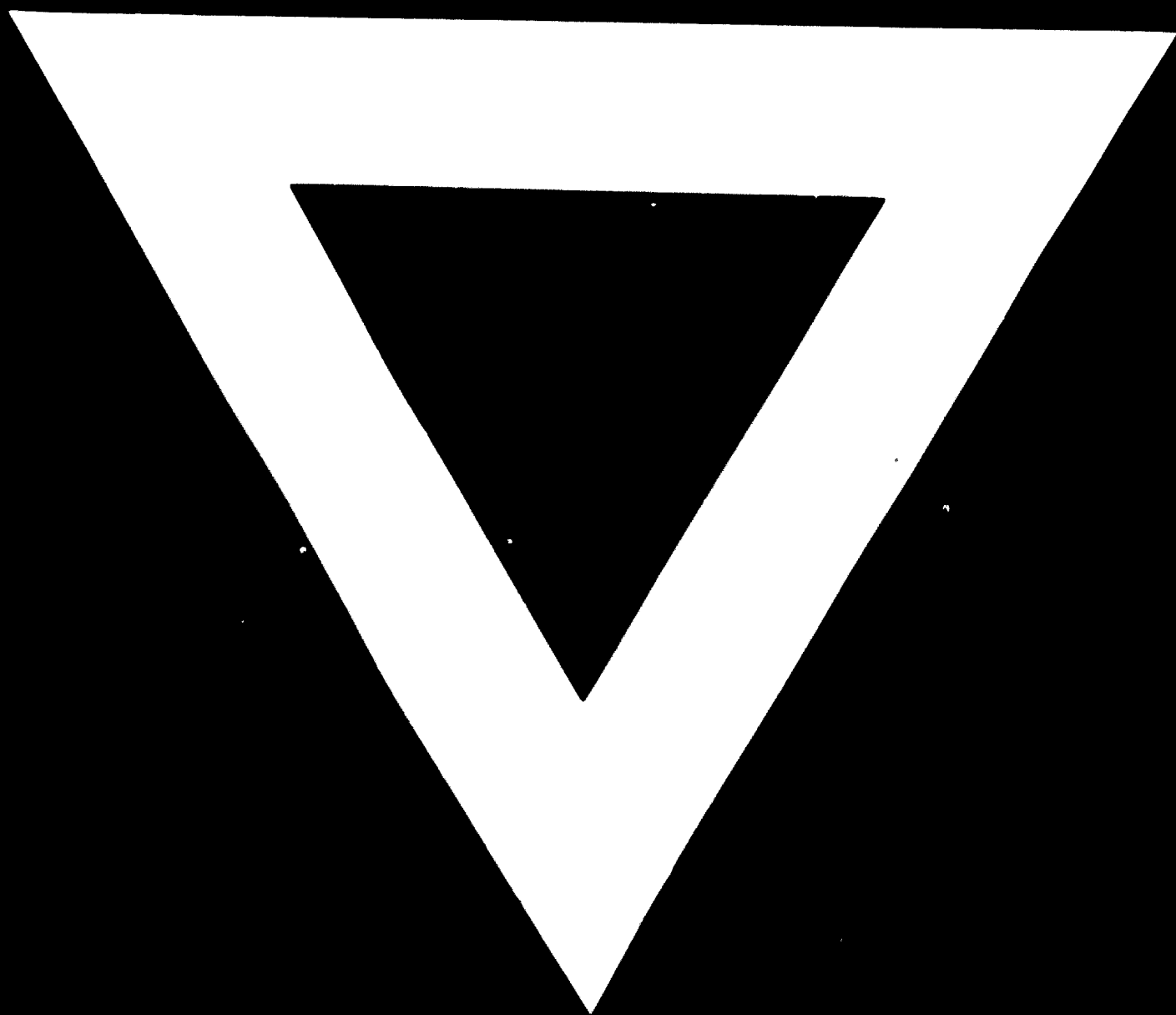
Meal

Finished meal is usually analyzed for moisture, protein, oil and fiber.

Protein and fiber analyses on outgoing rapeseed meal are for information only, as these are dependent on analyses of the seed being processed. Moisture, on the other hand, is more important, as it can be controlled by drying or water addition to give a desired yield.

Screen tests should also be performed on the meal in order to check the performance and condition of grinding equipment.





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