SYMPOSIUM: SAMPLING AND PROCESS CONTROL IN THE OILSEED INDUSTRY

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Sampling and Measurement in Soybean Processing Plants[1]

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ABSTRACT

Several soybean processing plants were involved in a plant survey to determine (a) material sampled, (b) method of sampling, (c) sample locations, (d) frequency of sampling, (e) variables checked, (f) method of sample evaluation, and (g) instruments used in sample evaluation. Errors in sampling occur more frequently than in sample analysis. It is difficult to obtain a material stream grab sample that is representative of the stream. The only accurate sampling and analytical method would be to sample the entire throughput tonnage of the plant. Since this procedure is not feasible, regular and consistent sampling of product streams must be maintained.

[1]One of four papers being published from the Symposium "Sampling and Process Control in the Oilseed Industry," presented at the AOCS Meeting, New Orleans, April 1970.

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SAMPLING AND MEASUREMENT

Initial samples of whole beans at unloading points, interim products and samples of finished meal and oil determine the general plant operating efficiency. Cooling water, solvent and steam are sampled as required to maintain proper operating control.

Foreign matter in whole soybeans as received is one of the major problems facing any processor. The trading rules allow a maximum of 1% by weight foreign material without penalty to the seller. This rule encourages the seller of soybeans to include enough foreign matter to approach the upper limit. Foreign material above the maximum of 1% is treated only as non-harmful dilutent. This practice costs the processor many dollars in seed cleaning equipment as well as unavoidable cash losses of oil and meal. A grain dockage sieve with round perforations 8/64 in. diameter is used to determine the foreign matter present in whole soybeans. Whole beans are also analyzed for moisture and volatile matter, oil, protein and free fatty acid in accordance with official methods of analysis. Continuous automatic samplers are available for monitoring an accurate cross section of the stream of incoming beans to the plant. Although standards are set for sampling trucks, cars and barges, the human element is ever present.

Cracked beans sampled at 60 min intervals are checked for moisture and size. Some type of direct reading moisture indicator is generally used for in-plant checking. Ten to 12% moisture is considered satisfactory. The standard screen analysis of 6% on 6 mesh, 65-75% on 10 mesh, 5-12% on 20 mesh, and 0-3% through 20 mesh is considered necessary for good extraction (1).

Grab samples of raw flakes taken each hour are checked for flake thickness, moisture and cracked or unflaked beans. A manual micrometer is most often used to gauge flake thickness, while a direct reading moisture balance is often used for in-plant moisture determinations. Flakes

TABLE I

In Plant Survey,[a] Solids Only

Sample	Location	Method	Frequency	Per cent companies surveyed taking sample
Whole beans	Bean scale	Grab	30 min	14
		Grab	120 min	14
	Unloading station	Probe	60 min	14
	Unloading station	Probe	Per dump	44
Cr. Beans	Cr. rolls	Grab	30 min	14
	Cr. rolls	Grab	60 min	58
	Cr. rolls	Grab	120 min	14
	Cr. rolls	Grab	240 min	14
Raw flakes	Fl. roll	Grab	30 min	14
	Fl. roll	Grab	60 min	58
	Fl. roll	Grab	240 min	14
Spent flakes	Sp. flk. conveyor	Grab	60 min	14
	Sp. flk. conveyor	Grab	120 min	29
	Sp. flk. conveyor	Grab	480 min	14
Toasted meal	Desolventizer toaster			
	Discharge	Grab	60 min	14
	Discharge	Grab	120 min	14
	Discharge	Grab	480 min	14
Finished meal	Meal loadout station	Automatic	Each shipment	71
	Meal cooler			
	Discharge	Grab	120 min	29
Hulls	Hull gndr.	Grab	30 min	14
	Hull gndr.	Grab	120 min	29
	Hull gndr.	Grab	480 min	14
	Load-out station	Automatic	Each shipment	29
Solvent	Work tank	Grab	60 min	14
	Work tank	Grab	120 min	14
	Work tank	Grab	Each week	14
	Unloading station	Grab	Each load	14
Full miscella	Full misc. pump	Grab	60 min	14
	Full misc. pump	Grab	120 min	14
	Full misc. pump	Grab	480 min	14
	Full misc. pump	Automatic	Continuous	14
Crude oil	Finished oil pump	Automatic	60 min	14
	Finished oil pump	Grab	60 min	29
	Finished oil pump	Grab	120 min	14
	Finished oil pump	Grab	240 min	29
	Finished oil pump	Grab	480 min	14
Cooling water	C. Tower	Grab	Daily	14
	C. Tower	Grab	Weekly	14
	C. Tower	Automatic	Each shiftq	14
Steam	Boiler	Automatic	60 min	14

[a]Allied Mills Inc., Chicago, Illinois (1970); Archer-Daniels-Midland Co., Minneapolis, Minnesota (1970); Arkansas Grain Corp., Stuttgart, Arkansas (1970); Canadian Vegetable Oil Processing, Ltd., Hamilton, Ontario, Canada (1970); Central Soya Co., Inc., Fort Wayne, Indiana (1970); Minnesota Linseed Oil Co., Minneapolis, Minnesota (1970); Southern Soya Corp., Estill, South Carolina (1970); Yazoo Valley Oil Mill Inc., Greenwood, Mississippi (1970).

0.008 to 0.012 in. thick containing 10% moisture at 140 F will generally produce the highest oil yield. The method in which the sample is taken from the flaking roll discharge is extremely important. Flakes from the outer ends of the rolls as well as the middle of the roll must be taken. Flakes found to be thinner at the extremity of the roll chills than in the center indicate that the rolls should be ground at the outer extremity. Thicker flakes at one end of the roll than at the other indicate misalignment or improper application of roll pressure. An even full-width feed to the rolls must be maintained in order to prevent unnecessary roll wear. Dams or check plates must be maintained in order that cracked beans cannot by-pass the flaking roll, resulting in high urease activity and residual oil in finished meal.

Spent flake samples are analyzed hourly for residual oil in accordance with standard AOCS procedures. In most commercial operations soybean flakes are extracted to less than 1% residual oil. Since spent flakes contain approximately 35% solvent, sampling of spent flakes is somewhat hazardous and increases solvent loss. In many plants this practice has been abandoned.

Moisture, protein, crude fiber and urease activity are checked in toasted meal samples using official methods. In high protein, low fiber meal the detection of high urease activity is important. The index of urease activity is determined by a pH comparison between a blank and test sample.

Toasted meal analysis for residual oil could replace residual oil analysis in untoasted spent flake samples thus reducing the hazard, assuming a glyceride oil analysis would yield a residual oil on a phosphatide-free basis. We know changes take place in the meal during desolventizing and toasting. We think there is correlation between residual oil in spent untoasted flakes and toasted meal. This should be established from large scale survey. Once an acceptable phosphatide-free residual oil level in toasted meal is determined, process machinery manufacturers will change processing guarantees to a toasted meal basis.

Finished meal samples taken as required on shipment basis and by prescribed procedures are analyzed for a moisture and volatile matter, oil, protein, crude fiber and urease activity in accordance with official AOCS methods. The results of the analysis form the basis for meal sales as well as a cross reference for cost accounting procedures. While grab samples are often the method used in obtaining finished meal samples, automatically samplers are available on the market and are much more reliable and consistent than grab samples.

Ground hull samples, present only when a front end dehulling system is used, are taken on a basis quite similar

to finished meal. Hulls are 33% crude fiber while the hull-free bean is 2.5% crude fiber. Since high protein, low fiber meal is traded on a maximum fiber content in finished meal of 3.0%, it is essential to remove 95% to 99% of the available hulls. A properly designed front end dehulling system will separate hulls and meats efficiently enough to maintain less than 2% residual oil in ground hulls (1).

Solvent is checked periodically for free water on an in-plant basis. New solvent being delivered to the plant is checked for purity using the official AOCS specification. It is important to sample solvents at the lowest point in the pipe line and to take a large enough sample so as not to be misled by accumulated water. Sample point should not be located on the high side of a solvent pipe line.

Full miscella flow rates are measured so as to balance the extractor between incoming fresh solvent and outgoing full miscella. Occasionally full miscella grab samples are checked for specific gravity which is a good indication of the oil concentration.

Crude oil (sample each hour and uniformly mixed to make a shift sample) is checked for residual hexane by using a flash point tester. Flash points less than 300 F indicate the presence of excessive solvent. A daily composite sample of crude oil is checked for free fatty acid using official AOCS methods. The results of this test is used to predict refining losses. Crude oil samples taken from storage tanks must be taken so as to assure an accurate sample. Contents of storage tanks should be agitated and sample points should not be at the lowest point in the tank.

Cooling water may be continuously monitored or spot checked for the pH concentration. pH level influences heat exchanger tube life as valve, pipe and fitting life in cooling water lines. Excessive scale build up in pipe lines and condenser tubes will result from untreated or improperly treated cooling water. The rapidity of scale formation depends upon the source and type of contamination.

Steam is checked by observing temperature and pressure at various points throughout the plant. When wet steam is encountered, a throttling or separating calorimeter may be used to determine the percent of free water in steam. Inline steam separators may be used to remedy wet steam problems.

INTERPRETATION OF SAMPLE ANALYSIS

Cost accounting is the purpose for product analysis. Profit and loss sheets are based on the official analysis which determine the efficiency and yield in the plant as well as cash penalties on meal and oil sales. Whole bean scales located in the preparation area should be used to record raw material input to the plant, and scale interpretation should be adjusted for any seed cleaning which might follow or precede measurement. This method of measuring plant capacity is much more efficient than depending upon oil yields for plant tonnage.

Process control criteria are established based on intermediate sample analyses as well as end product analysis. Comparison of analytical results based on good and bad operation may be used to diagnose operational problems, probably equipment malfunctions, and changes in incoming material.

Preventative maintenance schedules may be drawn up based upon probably cause and effect and remedy from past experience. It is important to draw relevant conclusions from past experience prior to scheduling.

REFERENCES

1. Hutchins, R.P., JOCS 45:624A-628A (1967).

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