Automatic Monitoring and Cutoff of Peanut Dryers

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ABSTRACT

A method for automatic cutoff of full-scale peanut dryers when peanuts approach a prescribed moisture content without periodic moisture sampling is described. Final weight is mathematically predicted from initial weight and moisture content. Peanut weight loss is monitored and dryer operation subsequently controlled through electronics. Six of 8 drying wagon loads of peanuts dried with the method were dried to a satisfactory moisture content at grading. Additional drying was required on 2 loads. Test results indicate that the method will require less labor, provide better moisture control, and reduce the danger of overdrying compared to conventional methods.

Key Words: Peanuts, drying, dryer control, automatic dryer cutoff.

Mechanical peanut drying requires close supervision to prevent irrecoverable peanut quality damage (2,3,4,5,6). During drying, peanuts must be manually sampled frequently for moisture control requiring considerable labor and expense. This manual method of monitoring often results in overdrying that critically lowers the quality of the peanuts and wastes energy.

Blankenship and Davidson (3) have described an electro-mechanical system for drying peanuts in the laboratory which automatically cuts off when the peanuts become dry. The system is based on predicting and monitoring for an after-drying sample weight calculated from initial weight and initial moisture content. This system reduces management time for moisture control by eliminating periodic moisture sampling. The purpose of this paper is to report the development of a similar electronic system for automatic monitoring and cutoff of full-scale peanut drying equipment.

Materials and Methods

This study was conducted in cooperation with Cargill International at their peanut drying, cleaning and receiving station in Parrott, GA.

Partially dried Florunner peanuts for each series of tests were obtained from local farmers and placed in Peerless 4.3 m x 2.4 m x 1.4 m drying trailers. The trailers were jacked up, placed on top of 3 load cells (Figure 1), and connected to Peerless Model 153, 3.73 kW single trailer, propane gas-fired dryers with flexible, canvas ducts.

Before drying was initiated, a 0.5 to 0.9 kg sample was removed for moisture determination by probing the load of peanuts, top to bottom, with a sample probe at 3 to 4 locations. Moisture content and dry weight of kernels and hulls in the subsample were determined as specified by the American Society of Agricultural Engineers Standard S410.1 (1).

After removal of the moisture sample, drying was initiated. The initial weight of the peanuts and continuous weight measuring during drying were provided by the load cells interfaced with an electronic, microprocessor based, weight monitoring system. The monitoring system consisted of a Consolidated Controls Model 90 MC Data Acquisition System programmed to periodically monitor the 3 load cells and indicate the measured weights separately or in combinations. The front axle was rigidly strapped to the drying bin during drying to prevent the axle from tilting or rotating to the ground.

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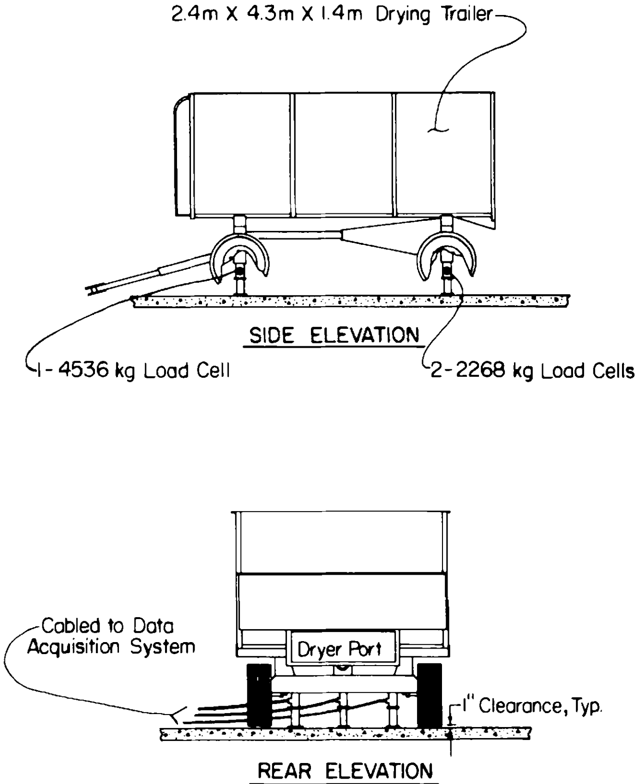

Fig. 1. Schematic of drying apparatus.

After the moisture content of the initial moisture subsample was determined, the predicted cutoff weight (PCW) of the trailer load of peanuts was calculated with the following equation:

$$PCW = \frac{W_{ti}}{W_{si}} \left[\frac{W_{dk}}{1-M_{kf}} + \frac{W_{dh}}{1-M_{hf}} \right] + W_{tr} \qquad (1)$$

Where W_{ti} = Initial weight of the peanuts in the load
W_{si} = Initial moisture sample weight
W_{dk} = Dry weight of kernels in moisture sample
W_{dh} = Dry weight of hulls in moisture sample
M_{kf} = Final kernel moisture; decimal form; wet basis (w.b.); value used in these tests, 0.10
M_{hf} = Final hull moisture; decimal form; w.b.; value used in these tests, 0.11
W_{tr} = Empty weight of the drying trailer

The empty weight of the drying trailer had been previously determined so that W_{ti} could be calculated. Once calculated, the value of PCW was entered into the electronic monitoring system. The monitoring system alarmed and cut off the dryer when the peanuts dried to the PCW. When the PCW was reached and drying discontinued, an after-drying moisture sample was obtained and processed as the initial. The peanuts were then graded by the Federal-State Inspection Service and handled accordingly.

Results and Discussion

Moisture content and weight data for the peanuts dried during the tests are presented in Table 1. Initial kernel moisture contents ranged from 14.8 to 36.5% w.b. The average after-drying kernel moisture content was 12.1% w.b. with a standard deviation of 0.98%.

Table 1. Comparison of initial, after drying, and grade moisture contents and initial, predicted cutoff, and final weights for the peanuts dried during the tests.

Moisture Content, % w.b.					Foreign Material Content at Grading % w.b.	Load Weights, kg		
Initial 1/		After Drying 1/		At Grading 2/				
Kernels	Hulls	Kernels	Hulls	Kernels		Initial	PCW	At Grading
36.5	26.1	12.7	12.0 3/	10	10	5833	4335 4/	4282
33.9	25.1	10.9	10.1	9	10	5869	4375 4/	4273
23.5	22.0	13.4	13.9	10	5 5/	5843	4979	4373
21.7	17.6	11.0	12.3	10	2	5240	4615	4609
20.4	17.3	11.2	12.5	10	9	5321	4794	4754
17.4	15.4	12.4	--- 3/	9	6 5/	5434	5024	4245
17.0	14.5	12.2	11.6	10	3	5194	4868	4772
14.8	13.9	13.2	13.6	10	5	5167	4932	4872

1/ ASAE S410.1 Oven Test

2/ Moisture meter test

3/ Required additional drying after cutoff weight reached before peanuts could be graded. Moisture content according to Federal-State Inspection Service moisture meter was >10.5%.

4/ Weight monitored under one axle only. Cutoff weight calculated proportionately.

5/ Peanuts cleaned before grading.

The electronic system used to cut off the dryers when the peanuts reached a PCW was fairly effective even though there was a mean zero drift of 12.1 kg with a standard deviation of 15.4 kg. The zero drift was considered insignificant since it amounted to only an average 0.3% of the total after-drying peanut weight. Excluding the 2 loads that were cleaned before grading, final peanut weights at grading averaged 1.3% lower (standard deviation of 0.78%) than the PCW. Differences in PCW's and grade weights were attributed to error introduced by the presence of foreign materials in the peanuts, load cell errors and error introduced because grade weights were not determined immediately after dryer shut off. The peanuts may have continued to lose weight after the dryer stopped.

Peanuts in 6 of the 8 loads were dried to a marketable moisture content (kernels less than 10.5% moisture w.b. according to a Federal-State Inspection Service moisture meter) when the dryers were turned off. None of these loads had pods with after-drying kernel moistures less than 11.0% or grade moistures less than 9%. Differences between after-drying and grade moisture contents were attributed to continued moisture loss by the peanuts as they cooled down to ambient temperatures and to moisture equilibration between kernels and hulls. As with the laboratory method (3), there appeared to be little danger in overdrying with this method.

Peanut kernels in 2 of the loads had not reached the required 10.5% w.b. kernel moisture content for marketing when the dryers turned off. Some additional drying and moisture sampling was required for these loads. However, even though not completely successful for these loads, the method required considerably less moisture sampling and labor compared to conventional drying procedures. The method should provide more efficient use of drying facilities, prevent overdrying, reduce moisture control time and allow dryer operators to devote more attention to managing other quality aspects.

The actual range of after-drying kernel moisture contents varied from 10.9 to 13.4% w.b. (oven test). The two loads of peanuts that were not sufficiently dry at cutoff probably had a large initial moisture sampling error or load weight loss predictions were incorrect because of hygroscopic foreign materials in the peanuts.

Foreign material in the peanuts ranged from 2 to 10% at grading. Two of the loads were cleaned before grading. The control system cut off prematurely on one of these two. The other load on which the dryer prematurely cut off had 10% foreign materials at grading.

Conclusions

This study demonstrated that the concept developed for automated drying of laboratory samples of peanuts can be adapted to full-scale drying. The procedure reduced moisture sampling time considerably during the drying process and reduced the potential of overdrying peanuts. The procedure offers better moisture control than currently obtained with conventional methods and consequently will better maintain peanut quality.

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