The Effect of Mash Moisture Content on a Pellet Mill Operation

Abstract:

The Grain Prep Auto Delivery System®, a new technology for accurately monitoring and precisely controlling feed ingredient moisture content on-line, was evaluated for accuracy and for its effect on pellet mill performance. The Auto Delivery System included a new moisture sensor designed for mounting directly in the ingredient mixer. Fully automated adjustments to ingredient moisture content were based on real time assays.

Introduction:

Since the beginning of modern feed manufacturing practices, grain and ingredient moisture content has played a significant role in both equipment operation and final product quality. Options available to the feed mill operator for either monitoring or controlling ingredient moisture content on-line have been quite limited. The Grain Prep Auto Delivery System® has been developed for monitoring and controlling ingredient moisture content on-line, in either batch or continuous flow processes. This study evaluated the potential effect of a precisely controlled ingredient moisture content on pellet quality and pellet mill operation.

Equipment and Materials Used:

Facility	Research Feed Mill at Kansas State University
Mixer	Sprout Waldron Model B-37, double ribbon mixer with a shaft speed of 34 rpm and a capacity of 1000 pounds
Pellet Mill	CPM Master Model HD Series 1000 with a 3/16" x 1.5" die
Moisture Control	Grain Prep Auto Delivery System® with a moisture sensor mounted directly in the mixer
Feed Type	Non-medicated corn-soy hog finishing ration
Moisture Source	Water-Grain Prep® surfactant solution

Experimental Design:

The study was conducted in two parts. The objectives of the first phase were to determine the moisture control accuracy of the Grain Prep Auto Delivery System® and to do a preliminary evaluation of the effect mash moisture content has on pellet production. Five moisture levels were selected for evaluation. Each level was replicated three times, for total of 15 separate replications. Mash feed rates through the pellet mill conditioner were held as constant as possible.

The second part of the study was designed to evaluate the possible interaction between moisture content and pellet production rates. Two separate moisture levels were pelleted at three different mash feed rates through the pellet mill conditioner, for a total of 18 separate replications.

Data collected were mash moisture content, pellet durability (PDI), production rates and pellet mill energy consumption.

Results and Discussion:

A summary of data gathered in the first phase is presented in Table 1. The top row of the table, "Target Mash Moisture", shows the five mash moisture contents selected as the experimental variable. The "Untreated Mash Moisture" was determined by laboratory oven-dry procedures performed on samples taken from the mixer after the dry ingredients had been mixed for three minutes. The "Treated Mash Moisture" was also determined in the laboratory from samples taken after the Grain Prep Auto Delivery System® had adjusted the mash moisture content and the mash was mixed for an additional three minutes before sampling. The "Specific Energy" is the difference in power demand between the pellet mill running empty and under the load imposed by the particular mash being pelleted.

Table 1: Summary of Data from Phase 1

Target Mash Moisture (%)	12	13	14	15	16
Untreated Mash Moisture (%)	11.95^{a,b}	11.81^{a,b}	11.51^{b}	12.44^{a}	12.02^{a,b}
Treated Mash Moisture (%)	11.64^{a}	12.65^{b}	13.80^{c}	14.77^{d}	15.94^{e}
Pellet Durability Index (PDI)	85.4	84.8	88.6	84.5	86.0
Specific Energy Use (HP/ton)	8.5	8.1	7.7	14.1	19.7
Pellet Bulk Density (lb/ft^3)	37.8	36.3	37.8	36.2	34.3
Conditioner Discharge Temp (^{0}F)	180.2	180.3	181.0	179.7	180.7
Pellet Mill Discharge Temp (^{0}F)	182.5	181.7	182.5	181.2	185.0

^{a,b,c,d,e} Values with different superscripts in a row differ ($P<0.05$)

These data indicate that for this feed formulation processed in this pellet mill, 14% moisture produced the best combination of pellet quality and pellet mill operation. Figure 1 is a graphical presentation of the production data, which clearly indicate that there is not much room for error in moisture management. When the mash moisture was raised above 14%, power demand increased sharply, production dropped sharply, and the PDI returned to the control levels.

The data generated in the second phase of this study are presented graphically for the 13% moisture mash in Figure 2. Figure 3 presents the 14% mash data. Shown are production rate (Production) in pounds per minute, average specific horsepower (Sp HP) per minute, and PDI. The three different mash feed rates are clearly indicated in the specific horsepower plots.

Patterns shown by production data frequently provide a more accurate picture of the process being monitored than do isolated data points, particularly when large continuous flow processes are being monitored. Figures 2 and 3 indicate the trends observed in part two of this study, where the 14% mash consistently produced a harder and more uniform pellet at all three production rates than did the 13%. These observations are substantiated by the data plotted in Figure 4. Shown as bar charts are the maximum, minimum and average PDI values for each production rate and moisture level. A summary of these plotted data is shown in Table 2.

Figure 1: The Effect of Mash Moisture Content on a Pellet Mill Operation

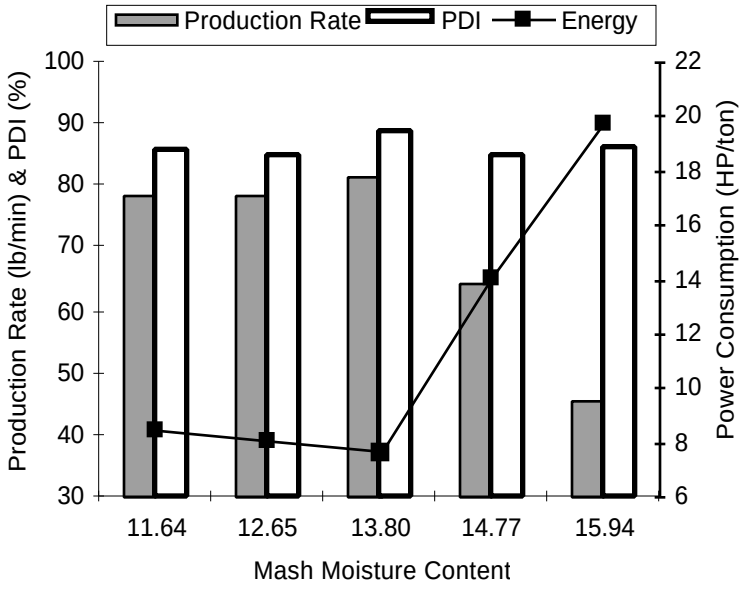


Figure 2: Production Data from Pelleting 13% Moisture Mash

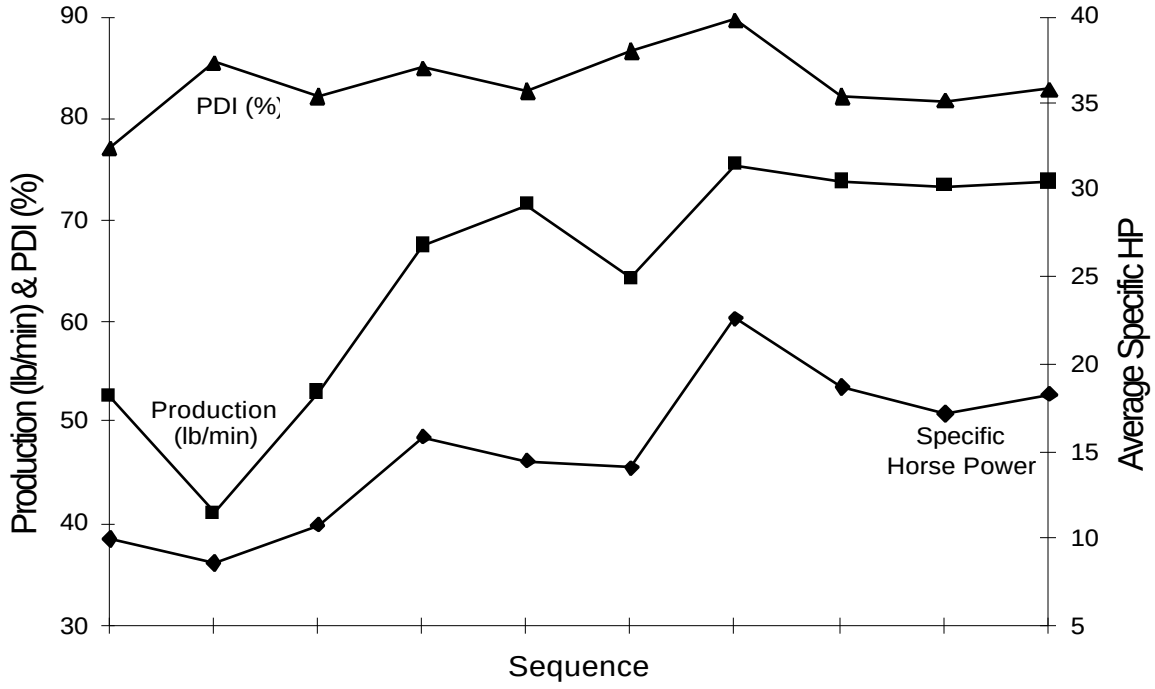


Figure 3: Production Data from Pelleting 14% Mash

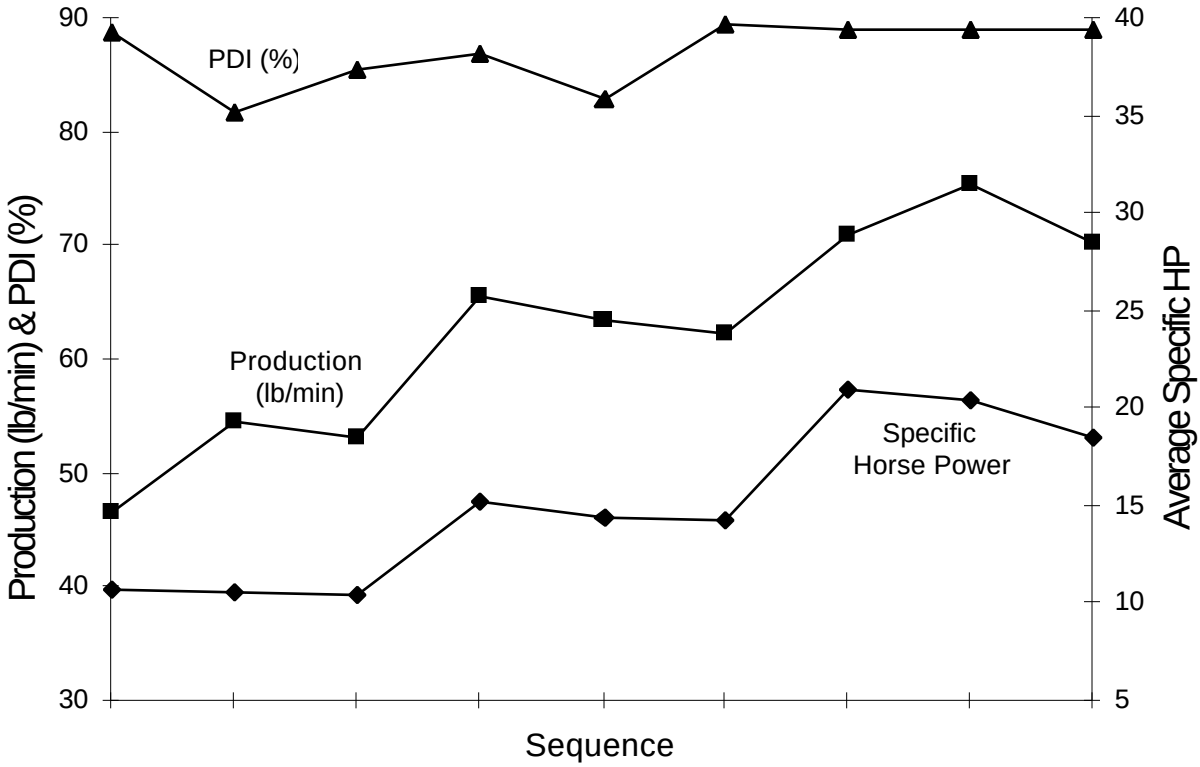


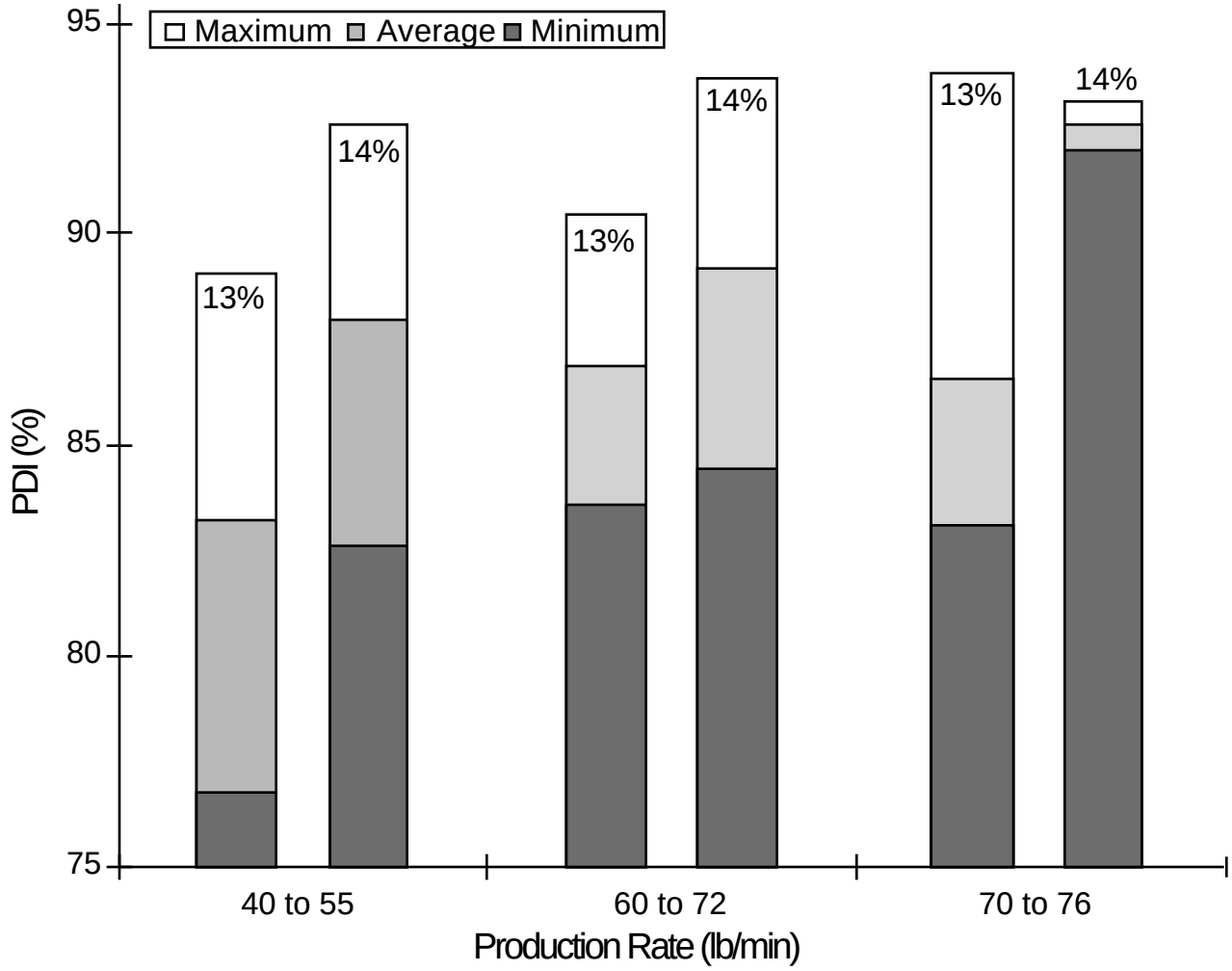
Table 2: The Effect of Mash Moisture on Pellet Production

Production Rate (lb/min)		40 to 55	60 to 72	70 to 76
13% Moisture	Maximum PDI	86.30	87.37	90.12
	Minimum PDI	76.44	81.88	81.48
	Average PDI	81.61	84.80	84.26
	Std. Dev.	3.65	1.78	3.36
	Ave. Sp. HP	9.90	14.87	19.27
14% Moisture	Maximum PDI	89.10	90.02	89.54
	Minimum PDI	81.09	82.54	88.57
	Average PDI	85.42	86.41	89.10
	Std. Dev.	3.01	2.85	0.33
	Ave. Sp. HP	10.63	14.63	19.97

These data indicate that small changes in mash moisture content will have a significant effect on pellet mill operation and on pellet quality, as measured by PDI. In this particular combination of feed formulation and equipment there appears to be a very definite optimum combination of mash moisture content and production rate, as indicated in Figure 4. The 13% mash had the least variation in the PDI at the mid

production range and the average PDI appeared to hit a plateau. By contrast, the 14% mash continued to show gains in PDI at the higher production rate plus variations in pellet PDI were greatly reduced.

Figure 4: The Effect of Mash Moisture on Pellet PDI



Conclusions:

The Grain Prep Auto Delivery System® provides precise mash moisture management, which in turn can improve pellet quality and consistency, as measured by PDI. The optimum moisture content is a narrow band that appears to be less than one percent wide, making an accurate and precise process moisture control system critically important to moisture management success.

The data also suggest that the effect of precise moisture control appears quickly. A large quantity of feed is not required for precise moisture control to produce a positive effect on pellet PDI.