Cold mash moisture control boosts pellet quality

by Dave Greer and Fred Fairchild

Moisture in feed pelleting tends to be a random variable, rather than a precisely controlled feed ingredient. It enters the pelleting process primarily through the moisture content of feed materials and during conditioning-and proves very difficult to monitor or control. However, by controlling the moisture content of the cold mash in the mixer-upstream from steam application-we can significantly and consistently improve the durability of finished pellets.

These conclusion are the result of recent studies using the research feed mill of Kansas State University (KSU) in Manhattan, Kansas, where we installed new technology to precisely control mash moisture content in the mixer. Configured for the studies, the experimental manufacturing process included:

- Mixer-Sprout Waldron Model B-37, double ribbon mixer with a shaft speed of 34 rpm and a capacity of 1000 lbs. (454 kg);
- Pellet mill-California Pellet Mill (CPM) Master Model HD Series 1000 with a 3/16 in. x 1.5 in. (4.8 mm x 38.1 mm) die; and
- Automatic moisture control-an online commercial moisture monitoring and control system with a moisture sensor mounted directly in the mixer (see box).

The moisture source used in the studies was a solution of water and commercial surfactant (see box) and the feed type was a non-medicated corn-soybean meal hog finishing ration.

Experimental variable: Cold mash moisture

Cold mash moisture content in the mixer was the experimental variable, using five moisture leves-12$, 13%, 14%, 14.5% and 15%. Three replications of each moisture level were processed, for a total of 15 separate batch replications. The main ingredient, corn was purchased from a single source dried to approximately 11% moisture. The cold, untreated mash also had a moisture content near 11%.

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The dry feed ingredients were completely blended in the mixer during the initial mixing cycle before a sample of he untreated, incoming mash was taken for laboratory moisture assay. Mash moisture content was automatically adjusted in the mixer by the on-line moisture control system. The system sensed the original moisture in the mash and added the correct amount of the water surfactant solution to achieve the targeted moisture content. The moisture sensor was mounted directly in the mixer and provided an on0line assay. Following moisture addition and a second mixing cycle, a second sample of the treated mash was taken for laboratory moisture assay.

Pelleting was performed at a constant pellet mill horsepower and a constant conditioned mash temperature. Samples were taken of hot conditioned mash, hot pellets and cooled pellets for laboratory moisture assay. Following cooling, quadruple pellet durability (PDI) determinations were performed for each batch, using the standard KSU “tumbling can” technique. Production data generated by batch were: Weight, total power consumption, run time, conditioned mash temperature and hot pellet temperature (Table 1).

Cold mash moisture up, pellet durability up.

Our analysis focused on the observed correlation between mash moisture content-“cold” in the mixer versus “hot” from the steam conditioner-and pellet durability)Figure 1). We found a very high correlation between cold mash moisture content and PDI (R^2 = 0.97). Within the experimental cold mash moisture range of 12% to 15%, the relationship is best described by a second order equation indicated by the curved plot. by contrast, the correlation between hot conditioned mash moisture content and PDI (R^2 – 0.86) is less than for the cold mash moisture and is best described by a linear equation, as indicated by the straight line plot.

An analysis of covariance (Table 2) clearly shows that cold mash moisture content has a very significant effect on PDI (P = 0.007), which is consistent with the plotted data (Figure 10. the coefficients indicate that there is a 2:1 ratio in the relative impact on the PDI of the cold and hot conditioned mash moisture contents, respectively. that is, moisture in the cold mash has twice the beneficial effect on pellet durability than moisture in the hot mash.

Moreover, both statistical treatments of the data indicate that the moisture added from steam in the conditioner introduces variability to the process. This appears as a lowered correlation coefficient (Figure 1) and P-value (Table 2) for the hot conditioned mash.

Operation of the pellet cooler was held as constant as possible throughout the day when the 15 experimental feed batches were pelleted. We plotted the observed correlation between mash moisture content and cooled pellet moisture content (Figure 2) and analyzed the covariance of mash moisture content with cooled pellet moisture content (Table 3).

Both data sets indicate that moisture added to the mash in the conditioner from steam condensate had neither significant nor consistent impact on cooled pellet moisture content. The coefficients indicate an 8:1 ratio in relative contribution (cold vs. hot) to the final pellet moisture content. the cold mash contribution was very highly significant, while that of the hot mash was not significant statistically.

Moisture application point critical

Quite clearly, cold mash moisture content in the mixer has a very high correlation to both PDI and finished pellet moisture content, which suggests that moisture behavior is significantly changed by its point of application in the process. Certainly, more research is necessary in the areas of moisture migration and “free” versus “bound” water in the heat processing of feeds.

However, our data suggest that moisture added cold to the feed in the mixer becomes bound in the various heat-related reactions, such as starch gelatinization. One important result is an increase in pellet durability. Also, this moisture is not as easily removed from pellets as moisture added in conditioning. by contrast, extra moisture from conditioning is more “free” to migrate to the pellet surface, which can result in a significant molding hazard. A slightly higher moisture content in the cold mash would not be expected to present the same problem because the moisture is not as free to migrate.

using on-line automated moisture control technology currently available for industrial scale feed manufacturing, it is possible to control moisture content of cold mash in the mixer within 0.5% of the target (P<0.05). This enables the operator to achieve greater control over both pellet durability and final pellet moisture content. Our studies demonstrate that:

- The effect of moisture on pelleting depends on its point of application in the process;
- Between 12% and 15% moisture content there is a very high correlation between cold mash moisture content in the mixer and pellet durability (PDI);
- Moisture added in the conditioner affects PDI less and introduces more variability than moisture added in the mixer;
- Assuming a consistent cooler operation, cooled pellet moisture content is also significantly affected, but not by the hot conditioned mash moisture from steam; and
- Precise moisture management in the mixer can affect both production rates and energy use at the pellet mill.