Particle Size Reduction

Hammermills and roller mills

- *Grinding grains preparation*:
  - If corn cleaner is available remove broken corn and foreign material (BCFM) by sending grain or corn through a screener prior to grains entering the grinding step.
  - **Add grates over the receiving pit to remove large physical hazards. Magnets placed in the receiving flow can remove ferrous metals. Check magnets daily.**
- *Hammermills*: Factors that influence corn particle size include hammer tip speed, hammer pattern, hammer setting, screen hole diameter, and air assist. Determine appropriate settings.
  - Screen inspection should be done weekly, and magnets cleaned daily.
  - Hammers should be rotated every 2 to 4 weeks.
  - Inspect higher production mills more frequently.
- *Roller mills*: Roller mill particle size is influenced by number of roll pairs, roll gap and roll speed.
  - Roll parallel and gap width should be evaluated daily.
  - Depending on wear, the re-corrugation of rolls should be done yearly and increased to 3 to 4 times a year with increased wear.
  - Perform routine gap adjustments and confirm adjustment with particle size analysis.

Monitoring and Testing Particle Size

- *Sample collection:* Daily grab sampling should be performed to visually assess particle size looking for evidence of whole grains or larger than expected particles.
  - **Particle size should be evaluated daily for roller mills and weekly for hammermills with at least the 3-sieve short stack and monthly using the full 13-sieve stack.**
  - Large deviation of target particle size or changes in grain moisture calls for particle size evaluation using the 13-sieve method.
  - Collect sample away from any air assist or movement of the cut stream. Areas with air movement will cause fine particles to become airborne and will lead to in inaccurate measurement of the particle size.
- *Testing Preparation:* Equipment needed for particle size testing includes Ro-tap sieve shaker, scale accurate to at least 0.01 gram, sieves, sieve balls (13 or 2 total) and brushes (8 or 3 total), dispersion agent (i.e. silica powder; read safety data sheet before product use), brass sieve brush, and nylon sieve brush.
  - The standard method for determining the particle size is conducted using wire cloth, stainless steel or brass sieves and sieve shakers (ANSI/ASAE S319.4 FEB 2009 R2012).
  - Alternative methods such as the 3-sieve short stack can be used.
  - Document which particle size method was used. Only particle size results obtained with the same method should be compared.
  - Cleaning of sieves and sieve balls and brushes must be done between each sample run with a soft brass wire brush, circular vacuum attachment brush using light pressure or compressed air.
  - If ingredients become caked or hard to remove, sieves, sieve brushes and balls should be washed in warm soapy water and completely air-dried before completing analysis.

Interpreting particle size results

- *Particle size and standard deviation*: Once sieves have been weighed back those weights can be used to determine geometric mean diameter d_{gw} and geometric standard deviation S_{gw}..
    - The d_{gw} will determine the specific micron size which will represent the target particle size where S_{gw} will provide the standard deviation.
    - Excel spreadsheet calculators for 3-sieve and 13-sieve can be found at ksufeed.org. When using these calculators, after “sieve + sample” and “sieve weight” are entered. Results can then be copied from “results” to “results archive” for consistent monitoring of particle size.
    - Percent of sample recovery should be 100% ± 5%, samples should be rerun if outside of those limits.
    - Particles < 150 microns are the particles seen in the bottom 3 sieves of a 13-sieve stack. Therefore, when sample recovery from analysis shows most of the material in the bottom 3-sieves for a 13-stack or the pan of a 3-sieve stack this requires further evaluation.
    - Having too many fine particles can increase the amount of dust in a facility and lead to challenges such as flowability.