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Critical issues to reduce the cost of extrusion and drying processes

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Processing Cost Reduction is a Complex Equation

Direct Cost Control Variables

- Formulation design and finished product spec's
  - Nutrient targets
  - Unique ingredient and fresh meat inclusion
  - Density, shape, size
- Raw material quality and blended ration variation
  - Moisture
  - Grind size and coefficient of variation
- Processing technique and hardware
  - Thermal vs. Mechanical
  - Preconditioner design, single screw or twin, control devices
  - Dryer design, condition, and operating parameters

Indirect Cost Control Variables

- Resource planning and production scheduling
  - Efficiency
  - Production run length
- Change-over times
  - Milling
  - Extrusion
- Predictive and preventative maintenance programs
- Quality programs and demands
  - Daily clean breaks, hold and release, and lot definition
  - Cleaning and sanitation

Processing Cost Reduction is a Complex Equation *SO*……"What is in my control?"

Critical Variables to Control

- Dry ration variability and particle size
- Extrusion processing technique
- Drying system optimization
- Production planning
- Communication and coordination with maintenance and sanitation
- Process auditing and continuous improvement programs

Ration Variability and Grind Size

- Target batch mixer coefficient of variation <10%
- No particle to exceed 1.5 mm (1/16")

Results in….

- *Greater ease of cooking*
- *Reduced product breakage and fines*
- *Higher throughputs for given extruder and preconditioner*
- *Less wear on extruder components for a given rate*
- *Improved product appearance*
- *Reduced incidence of die orifices plugging*

Extruder Process Efficiency

- It takes a certain level of energy to create a given product via extrusion
- Thermal and mechanical energy are the major sources of energy in the extrusion process
- What are the effects of changing the ratio of mechanical to thermal energy?

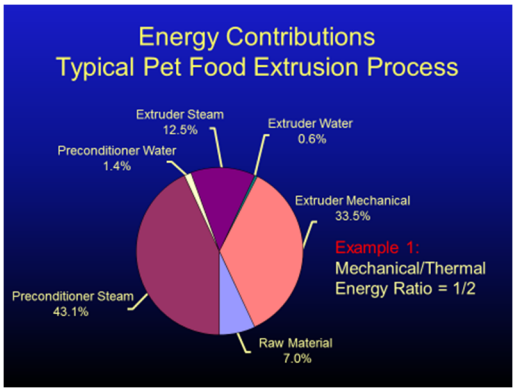
1st Law of Thermodynamics = "Energy can be changed from one form to another, but it cannot be created nor destroyed."

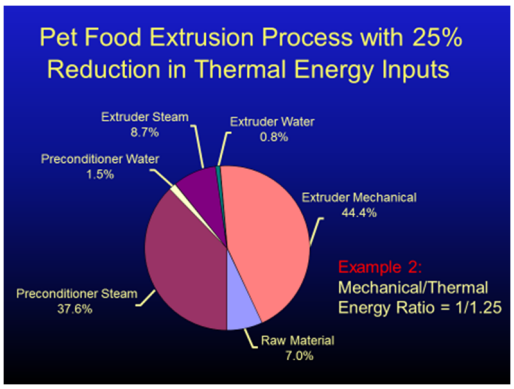
Average Energy and Wear Costs

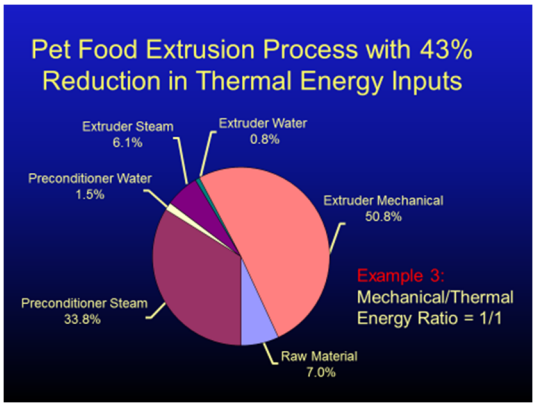
- Thermal energy costs = $7.32 / million kJ
- Mechanical energy costs = $18.06 / million kJ
- Wear costs = $1.25/ton for every 22 kW-hr/ton SME

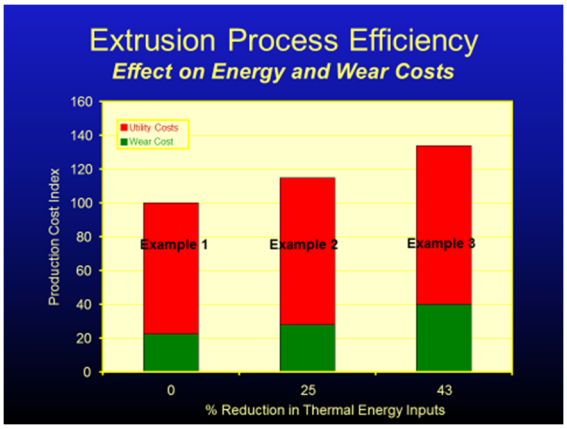
Energy Contributions

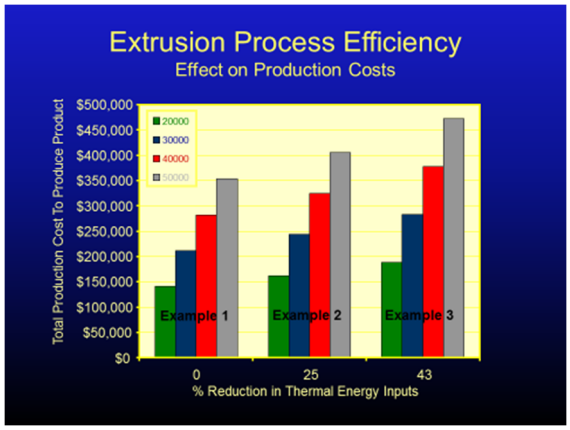
Typical Pet Food Extrusion Process







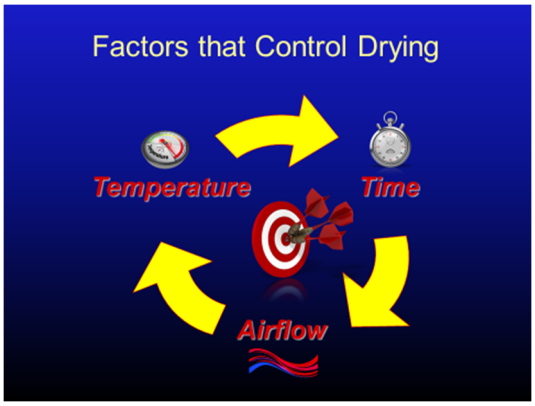




Guide for Controlling Mechanical to Thermal Energy Ratio

- High Intensity Preconditioner technology
  - Maximize steam inclusion
  - Optimize mixing CV = 2.65
- Thermal twin extrusion technology – allows for significantly higher levels of steam inclusion
- Utilization of variable speed extruder to optimize mechanical energy to formulation
- Finely ground dry ration = 100% through a 400 micron screen
- Well maintained process equipment

Dryer process optimization



Drying Time

Shorter Retention Times (1 min. – 30 min.)

- Roasting / Toasting
- Drying

Longer Retention Times (30 min. – 6 hrs.)

- Dehydrating
- Baking

Drying time directly controls product *Bed Depth*

- Shorter time – decreases bed depth (thinner)
- Longer time – increases bed depth (deeper)

Drying Time Adjustment

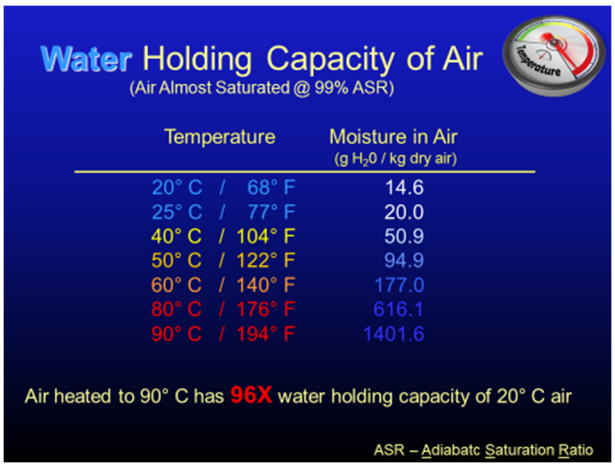
- Temperature and Airflow may need to be adjusted to achieve final product target.

Drying Temperature

Used to "*FINE TUNE*" product moistures

Lower Temperatures (70° F – 250° F)
- Drying
- Dehydrating

Higher Temperatures (250° F - 600° F)
- Roasting / Toasting
- Baking



Temperature too *High*
- Burnt or Scorched
- Brittle Product
- Case Hardening (mold internally)

Temperature too *Low*
- Not Dry
- Chewy Product
- Short Shelf Life (stale or mold)

Product Cooling
1) Eliminate moisture condensation during storage
   - 80°C air - holds 616 g water / kg dry air
   - 20°C air - holds 15 g water / kg dry air
2) Typically cool 5 - 7°C above storage temperature
3) High ambient temperature
   - Mechanically cool process air

Airflow
1) Last variable to be adjusted
2) Most important factor – Air Through Product Bed

Too much Airflow
- Blow product around
- Short circuit air
- Product not dry

Not enough Airflow

- Product clumps
- Uneven drying
- Product not dry

Dryer Bed Depth

- Bed Depths directly affect Airflow

Bed Depth limitations

- Soft or fragile products
- Sticky products
- Extremely wet products
- Product bulk density
- Product size

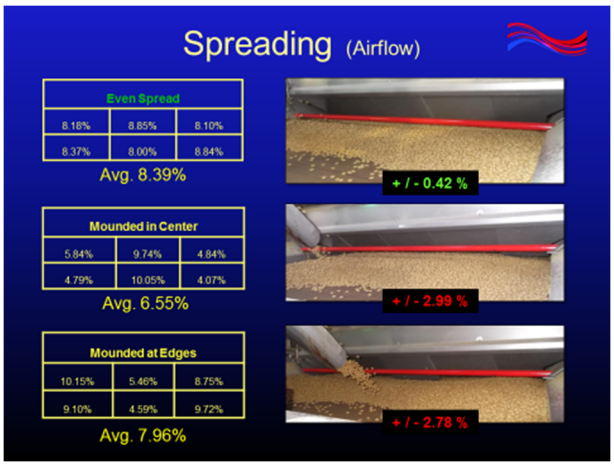
Dryer Spreading

- Most underestimated factor!!

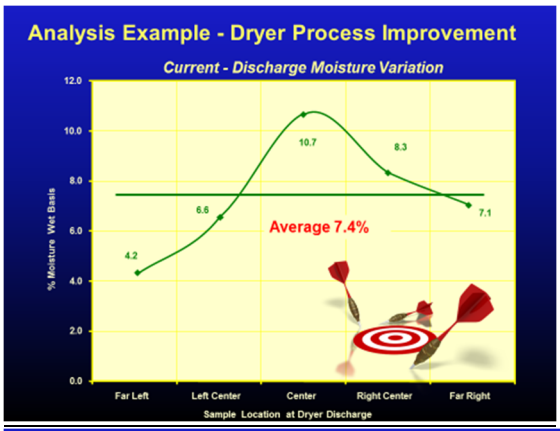
Spreading
directly
affects
Airflow!

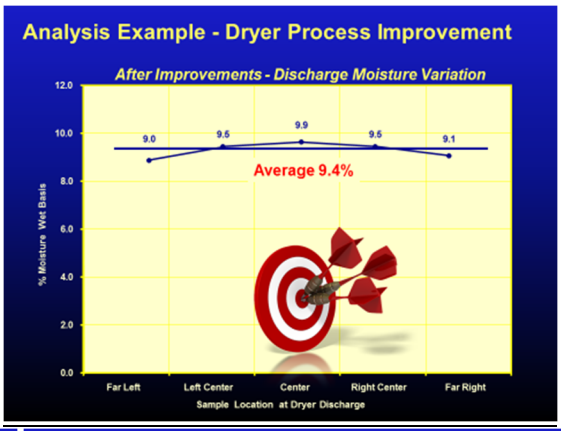
Results from uneven spreading

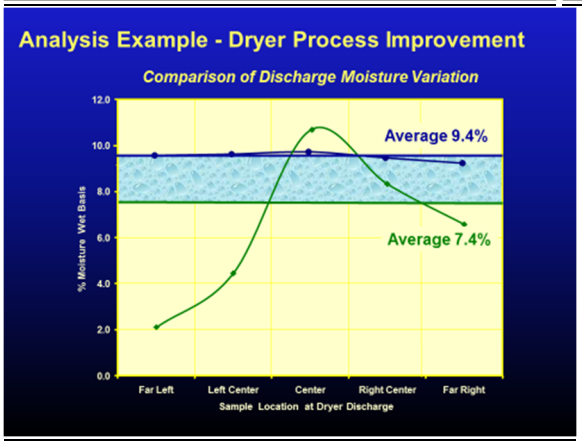
- Moisture variations in final product
- Excessive fines in dryer (low density products)

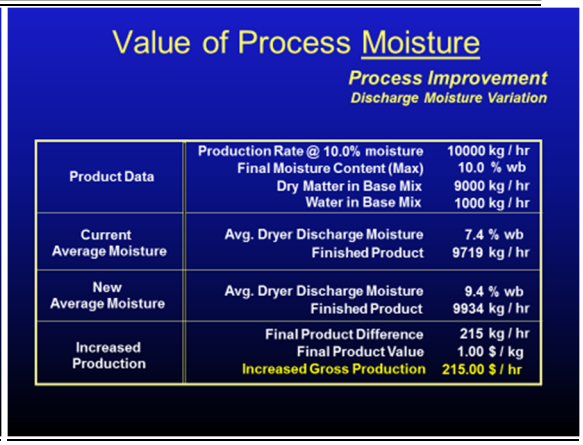


Dryer Moisture Uniformity











Production Scheduling

- Milling process considerations
  - Screen changing – run product types back to back
  - Raw material delivery
- Product specific production sequencing
  - Export requirements
  - Organic
  - Specialty product
- Extrusion process considerations
  - Die size and shape
  - Product running prior to a shutdown for cleaning and maintenance

Communication and Coordination

- Scheduled downtime coordination and preparation

  - What are we working on, cleaning, etc.
  - What parts, tools, cleaning utensils, etc. are required
  - What human resources are required
- Last product run before shutdown – will that impact cleaning or maintenance time???
- Develop a team approach with maintenance and sanitation
- What is the value of efficiency and time - $$$

Continuous Improvement Programs

- Process Auditing
  - Evaluation of each individual process
  - Set parameters for control
  - Measure against those metrics
  - Audit and Reset
- Evaluation of how to clean and maintain to reduce downtime
  - Milling
  - Extrusion
- Utilize 3rd party auditing for support
  - Specific expertise
  - Fresh set of eyes

Cost Reduction Summary

- Grind size and CV key control point in milling
- Manage your process to more thermal than mechanical energy where possible
- Train operators on the dryer operation and appropriate changes
- Operational efficiency is more than just equipment optimization
  - Production planning and communication is key
  - Perform process audits and develop live action plans
- Make processing adjustments one step at a time ~ evaluate and adjust

Thank You!!!

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