Liquid Application at the Feed Mill: Macro and Micro Ingredients, Pre and Post Pelleting Application

Colégio Brasileiro de Nutrição Animal
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Application of Liquid Additives

• This presentation will review the both Mixer Liquid Application (MLA) and Post Pelleting Liquid Application (PPLA) of specific liquid additives

• Review the challenges and opportunities associated with some of those liquids

• Highlight the effect some liquid ingredients can have on manufacturing rates and product quality

Application of Liquid Additives

• Liquids have been used in feed manufacturing for numerous years primarily supplemented at the batch mixer pre pelleting and in recent years post pelleting

• Administering liquids at the batch mixer can be regarded as MLA and those liquids applied following the hydrothermal conditioning processing as PPLA

• The differentiation between the liquids can be categorised as non-heat liable (MLA) and heat liable liquids (PPLA) a further categorisation would be macro (MLA) and micro (PPLA) liquids
Application of Liquid Additives

- For the purpose of this presentation ‘macro ingredients’ would be an additive >1-Kg/t (0.1%) and ‘micro ingredients’ <1-Kg/t
- Macro liquids would be; fats/oils, analogues of amino acids (methionine, lysine and choline chloride), molasses, betaine….
- Micro liquids would be; enzymes (nsp and phytase), flavours….
- ‘Acids’ could be applied to either category

Application of Liquid Additives

- What liquids provide to the milling process
  - dense form of energy for the targeted animal
  - reduce dust and segregation during conveying
  - provide lubrication for the pelleting process
  - improved feed quality
  - alternative method of application

Application of Liquid Additives

- Perceived advantages of liquid additives;
  - less expensive than dry products
  - minimal handling at the feed plant
  - fully automated addition
  - flexible dosing
  - reduced packaging
  - reduced waste
  - automated stock control and deliveries (external)
What is MLA?

- **Mixer Liquid Application**
  - Advantages;
    - technology is understood
    - lower capital cost
    - lower product cost
    - consistent homogeneity (mixing)
    - easily installed to existing mill process
    - fully integrated into mill control system

What is PPLA?

- **Post Pelleting Liquid Application**
  - Advantages;
    - eliminates risk associated with heat and moisture due to the conditioning/pelleting process for dry products
    - lower product cost
    - easily installed to an existing PPLA fat coater
    - integrated into mill control system (?)

Application of Liquid Additives

- The most common form of liquid addition is **fat/oil**
- Fat/oil is unique in that it is / can be applied to the feed prior to and after pelleting
- In the past 20 years feed producers have utilised the PPLA fat addition system to piggyback the addition of feed enzymes
- More recently feed millers are installing PPLA systems for the addition of feed enzymes with the fat application being secondary in markets where PPLA addition of fat/oil has not been common place
Elements to consider

- Common factors to consider for both MLA and PPLA design
  - rheology properties of the liquids to be administered
  - location and positioning of components
  - maximum and minimum addition rates
  - manufacturing capacity at the application point
  - application of the liquid to the feed
  - spray nozzles
  - how to measure the liquid
  - hygienic aspects of the system

Rheology Properties of Liquids

<table>
<thead>
<tr>
<th>Additive</th>
<th>Description</th>
<th>pH</th>
<th>Density Kg/Litre</th>
<th>Viscosity*</th>
<th>Solidification Point °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methionine</td>
<td>Amber</td>
<td>3.0 – 2.0</td>
<td>1.22 – 1.24</td>
<td>1000 cP</td>
<td>-</td>
</tr>
<tr>
<td>Choline</td>
<td>Clear</td>
<td>5.5 – 9.0</td>
<td>1.20 – 1.25</td>
<td>20 cP</td>
<td>-</td>
</tr>
<tr>
<td>Spray</td>
<td>Dark brown</td>
<td>10.0 – 11.0</td>
<td>1.13 – 1.15</td>
<td>600 cP</td>
<td>-</td>
</tr>
<tr>
<td>Soy Oil</td>
<td>Light yellow</td>
<td>7.0</td>
<td>0.90 – 0.95</td>
<td>55 cP</td>
<td>~20</td>
</tr>
<tr>
<td>Phytase enzyme</td>
<td>Light yellow</td>
<td>5.0</td>
<td>0.68 – 0.90</td>
<td>30 cP</td>
<td>~50</td>
</tr>
<tr>
<td>NSP enzyme</td>
<td>Brown</td>
<td>3.5 – 4.5</td>
<td>1.10 – 1.12</td>
<td>10 cP</td>
<td>~30</td>
</tr>
<tr>
<td>Phytase enzyme</td>
<td>Brown</td>
<td>4.5 – 5.0</td>
<td>1.10 – 1.12</td>
<td>10 cP</td>
<td>~30</td>
</tr>
</tbody>
</table>

*ref motor oil 100 to 400 cP or honey 2,000 to 10,000 cP
Data available from suppliers

Location and Positioning of Components

- **Macro liquids**
  - External bulk storage tanks (delivery tank with discharge mechanism)
  - Dosing pumps neighbouring the storage tanks
  - Flow meter / weigher adjacent the batch mixer
  - Interconnecting pipework

- **Micro liquids (enzymes)**
  - IBCs, drums and canisters
  - Transfer pump to enzyme dosing system (day tank)
  - Dosing system positioned locally to application point c/w flow meter and dosing pumps
  - Spray panel adjacent PPLA
MLA Schematic

Bulk storage tank (30mt) with bund wall and level monitoring

Intake line c/w with connection coupling, filter and manual and automated valves

Continuation of dosing line c/w flow meter, calibration line, automated valve and spray bar assembly

Dosing line c/w dosing pump, NRV and maintenance valves

PPLA Schematic

Dosing system positioned in the vicinity of the application point (below)

Intermediate bulk container (IBC) c/w transfer pump

PPLA applicator for fat/oil and micro liquids
Maximum and Minimum Application Rates

<table>
<thead>
<tr>
<th>Additive%</th>
<th>Methionine</th>
<th>Choline</th>
<th>Citrate</th>
<th>Lysine</th>
<th>Oil/Fat</th>
<th>Enzymes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td>MLA</td>
<td>MLA</td>
<td>MLA</td>
<td>MLA</td>
<td>MLA</td>
<td>MLA</td>
</tr>
<tr>
<td>NAM</td>
<td>0.20 – 0.30</td>
<td>0.40 – 0.50</td>
<td>0.15 – 0.25</td>
<td>1 – 2</td>
<td>1 – 2</td>
<td>0.01 – 0.03</td>
</tr>
<tr>
<td>LAM</td>
<td>0.10 – 0.50</td>
<td>0.05 – 0.10</td>
<td>0.10 – 0.15</td>
<td>1 – 5</td>
<td>Not common</td>
<td>0.01 – 0.03</td>
</tr>
<tr>
<td>EU</td>
<td>0.15 – 0.30</td>
<td>0.05 – 0.10</td>
<td>0.10 – 0.30</td>
<td>0 – 3</td>
<td>1 – 3</td>
<td>0.01 – 0.03</td>
</tr>
<tr>
<td>Asia</td>
<td>0.20 – 0.30</td>
<td>0.05 – 0.10</td>
<td>Not common</td>
<td>0 – 3</td>
<td>Not common</td>
<td>0.01 – 0.03</td>
</tr>
</tbody>
</table>

– What’s the range?
– What’s the impact?
– What can I do?

Manufacturing Capacity at the Application Point

- **Macro liquids**
- **Micro liquids (enzymes)**
- **Mixer size and batch size(s)**
- **Batch cycle times (dry mix 30s, wet mix 90s)**
- **Application time - rule of thumb minimum 50% of the wet mix cycle**
- **Pump capacity**
  - 3 t * 20-Kg/t = 60-Kg/batch
  - 60 / 45 * 3600 = 4800-kg/hour
  - 4800 / 0.88 = 5500-Ltr/hour
- **Type of PPLA and operating capacity (cooler transfer rate)**
- **Varying capacity?**
- **Pump capacity**
  - 25-t * 300-g/t = 7.5-Kg/hour
  - 7.5 / 1.10 = 6.80-Ltr/hour

Liquid Application at the Batch Mixer

- **Type of mixer, ribbon or paddle will dictate application**
- **Following dry mix**
- **Addition time is critical (50% rule) for both macro and micro liquids**
- **Approximately 5% of the mixer capacity can be added as liquids - rheology and materials being mixed**
- **Limit build-up in the mixer**
- **Consult the mixer manufacturer**
Liquid Application at the PPLA

- Pre or post fat
- Broad spectrum of droplets
- Pellets in suspension
- Proportion of sprayed pellets
- Prolong exposure
- Post application mixing

Effect of Spraying Order

**Effect of fat level and fat temperature on the recovery of a liquid enzyme.**

<table>
<thead>
<tr>
<th>Fat Temperature, °C</th>
<th>Enzyme recovery % in feed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>Fat level: 1.5%</td>
</tr>
<tr>
<td>60</td>
<td>Fat level: 2.0%</td>
</tr>
<tr>
<td>68</td>
<td>Fat level: 2.5%</td>
</tr>
</tbody>
</table>

**Effect of spraying fat before or after enzyme addition on measured enzyme recovery.**

<table>
<thead>
<tr>
<th>Diet</th>
<th>Enzyme recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Before fat spray</td>
</tr>
<tr>
<td>Enzyme sprayed before fat spray</td>
<td>98</td>
</tr>
<tr>
<td>Enzyme sprayed immediately after fat spraying</td>
<td>98</td>
</tr>
<tr>
<td>Enzyme sprayed 30 minutes after fat spraying</td>
<td>98</td>
</tr>
</tbody>
</table>

*50% barley based. 2 litres Xylanase LC per ton of feed

Engelen; 1998

Engelen; 1998

Effect of Spraying Order

**Effect of fat addition location on pelleting production characteristics (Adapted from Richardson and Day, 1976).**

<table>
<thead>
<tr>
<th>Fat Addition %</th>
<th>Pelleting Production Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>After PPLA</td>
<td>Mixer Prod Rate Energy Cons</td>
</tr>
<tr>
<td>1.0</td>
<td>% % tph kWh/t</td>
</tr>
<tr>
<td>1.0</td>
<td>18.0 11.6 11.0</td>
</tr>
<tr>
<td>2.0</td>
<td>22.0 13.2 9.7</td>
</tr>
<tr>
<td>3.0</td>
<td>31.6 13.2 7.9</td>
</tr>
<tr>
<td>4.0</td>
<td>31.6 13.2 7.9</td>
</tr>
</tbody>
</table>

Feed Tech 10.8 2006 – Adding liquids to the feed after pelleting Jare Froetschner, DSM
Spray Nozzles

- Multitude of spray nozzle type and spray patterns
- Spray pattern will change with capacity and pressure
- Air atomising will afford a greater degree of control and hygiene
- Don’t over atomise!

Addition of Liquid Enzymes via the Batch Mixer?

- Mixer Liquid Application
- Advantages;
  - technology is understood
  - lower capital cost
  - lower product cost
  - consistent homogeneity (mixing)
  - easily installed to existing mill process
  - fully integrated into mill control system
  - reduced power consumption at the pellet press or increased throughput
  - environmental credibility

MLA of liquid enzyme can reduce power consumption in the feed mill

<table>
<thead>
<tr>
<th>Trial</th>
<th>Control</th>
<th>Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH Commercial Trial 2012</td>
<td>7.3%</td>
<td>4.0%</td>
</tr>
<tr>
<td>NLA 2008</td>
<td>10.8</td>
<td>10.4</td>
</tr>
<tr>
<td>IFF 2009</td>
<td>24.3</td>
<td>23.8</td>
</tr>
<tr>
<td>UK Commercial Mill 2013</td>
<td>30.0</td>
<td>9.15</td>
</tr>
</tbody>
</table>

Data from AB Vista

7.3% reduction 4.0% reduction 10.4% reduction 23.8% reduction 9.15% reduction
MLA of liquid enzyme can reduce power consumption in the feed mill

<table>
<thead>
<tr>
<th></th>
<th>Basal</th>
<th>Basal + Water</th>
<th>Basal + Water + Enzyme</th>
<th>Basal + Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity TPH</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Temperature °C</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Production Tonne</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Moisture Diff %</td>
<td>4.33</td>
<td>2.67</td>
<td>3.67</td>
<td>3.67</td>
</tr>
<tr>
<td>Temperature Diff °C</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Air °C</td>
<td>15.7</td>
<td>15.46</td>
<td>18.52</td>
<td>18.52</td>
</tr>
<tr>
<td>Holmever %</td>
<td>88.6</td>
<td>95.0</td>
<td>94.6</td>
<td>93.4</td>
</tr>
<tr>
<td>kWh</td>
<td>90</td>
<td>88</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>kWh/t</td>
<td>10.00</td>
<td>9.77</td>
<td>9.55</td>
<td>9.55</td>
</tr>
<tr>
<td>kWh/t Diff v Basal %</td>
<td>-</td>
<td>2.3</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Recovery %</td>
<td>-</td>
<td>-</td>
<td>110</td>
<td>128</td>
</tr>
<tr>
<td>CofV % meal/pellets</td>
<td>-</td>
<td>-</td>
<td>18/11</td>
<td>13/10</td>
</tr>
</tbody>
</table>

Application of Liquid Additives

- Dosing equipment must be installed at the correct location
- Eliminate fluctuations in feed and liquid flow rates
- Size components correctly
- Choose the correct materials
- Ensure uniform and prolonged exposure
- Do not overcomplicate the system
- Final design and specification is to meet your requirement
- Choice of liquid application systems vary in cost and in accuracy
- Select the equipment based on present and future requirements, and flexibility to apply different products