Value of Selected Flowability Agents for DDGS

Lee Johnston, John Goihl, Jerry Shurson

University of Minnesota, Morris and St. Paul
Agri-Nutrition Services, Shakopee
Seen this?

Photo credit: National Corn to Ethanol Center
Speaking of Hassles!
DDGS does not consistently flow through commercial feed systems
Problem worse in summer
Problem worse with wetter product
May limit use of DDGS in swine diets
Factors that may affect flowability of DDGS

- Moisture (humidity)
- Temperature
  - Related to moisture content
  - Above freezing not a real issue
- Pressure (compaction)
- Fat content
- Particle size
- Bulk density

Ganesan et al. 2005
Potential Solutions

Dry the product more
  Cost?
  Regain moisture?
  Packaging?

Change the particle size

Change solubles addition

Add flow agents
  Which ones?
  How much?
Using flow agents with DDGS

Very little controlled data reported
  Most in laboratory settings
  None under commercial situations
Anecdotal experiences seem encouraging
Flow agents used routinely in SBM trade
Objective:

To determine if selected flowability agents effectively improve flow of DDGS in practical commercial conditions

To identify physical and/or chemical characteristics of DDGS that might be responsible for poor flowability of DDGS
Procedures

Conducted study at BushMills Ethanol, Atwater, MN

Erik Osmon (General Manager)
Ryan Carruth (Lab Manager)

Double B Trucking, Blue Earth, MN

Joe Bell
Treatments Imposed

Moisture level of DDGS:
- 9% moisture
- 12% moisture

Flowability agents:
- Control
- 5 lbs/ton DMX-7 (Delst, Inc.)
- 2% Calcium carbonate (Unical-P, ILC Resources)
- 1.25% zeolite (St. Cloud Mining, NM)
Procedural Details

Treated 5,000 lb lots of DDGS
Each treatment loaded in one truck compartment
Treatments imposed on 4 different days: Sept. 1, 15, 29 and Oct. 27
Truck traveled 150 mi., sat 60 hrs, traveled 150 mi. back to plant
Data collected at the plant

At loading:
- Max. angle of stability
- Angle of repose
- Temperature of DDGS at loading
- Environmental temperature and humidity at loading
- Drier temperatures and solubles addition rate
Data collected at the plant

At unloading:
- Unloading occurred after transport
- Temperature of DDGS at unloading
- Unload rate corrected for truck flow
- Subjective flow score
<table>
<thead>
<tr>
<th>Data Collected in the Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
</tr>
<tr>
<td>Water activity</td>
</tr>
<tr>
<td>Bulk density</td>
</tr>
<tr>
<td>Particle size</td>
</tr>
<tr>
<td>Proximate analysis</td>
</tr>
<tr>
<td>Residual sugars</td>
</tr>
<tr>
<td>Hunter color</td>
</tr>
<tr>
<td>Angle of repose</td>
</tr>
<tr>
<td>Max. angle of stability</td>
</tr>
</tbody>
</table>
Statistical Analysis

Least squares analysis of variance using the PROC GLM of SAS
Model 1 included effects of replicate day, moisture level, FA, and 2-way interactions.
Model 2 included effects of moisture level, FA, and moisture by FA interaction.
Environmental Conditions during the Experiment

- Temp (F)
- Humidity (%)

<table>
<thead>
<tr>
<th>Date</th>
<th>Temp (F)</th>
<th>Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/1/06</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>9/15/06</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>9/29/06</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>10/27/06</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>
Production Conditions during the Experiment

Syrup addition (gal/min) vs Exit temp (F)
Flow Rate and DDGS Moisture across Replicate Days

9/1/06  9/15/06  9/29/06  10/27/06

Flow rate (lb/min)

1061\textsuperscript{a}  1271\textsuperscript{b}  890\textsuperscript{c}  1231\textsuperscript{b}

Flow rate (lb/min)

10.4\%\textsuperscript{a}  9.8\%\textsuperscript{c}  10.8\%\textsuperscript{b}  10.4\%\textsuperscript{a}

\textsuperscript{abc}(P < 0.05)
Effect of Moisture Trts on Moisture and Temp. at Loading

9% Moisture (%)

85.2

11.6

9a

82.8

12% Moisture (%)

ab (P < 0.05)
Effect of Moisture Treatments on Flow Rate and Score

![Bar chart showing flow rate (lb/min) at 9% and 12% moisture.]

- 9%
  - Flow rate: 1368a
  - Score: 3.7a

- 12%
  - Flow rate: 859b
  - Score: 7.3b

(ab(P < 0.05))
Effect of Moisture Treatments on Drained Angle of Repose

9%

At loading (degrees) After storage (degrees)

57.7\textsuperscript{a} 64.6\textsuperscript{a}

12%

65.7\textsuperscript{b} 67.6\textsuperscript{b}

\textsuperscript{ab}(P < 0.05)
Effect of FA Trts on Moisture Content and Temperature

- Control: 10.3
- DMX-7: 10.6
- CaCO3: 10.2
- Zeolite: 10.3

Moisture (%):
- Control: 83.3
- DMX-7: 84.2
- CaCO3: 84.2
- Zeolite: 84.4
Effect of FA Trts on Flow Rate and Score

- Control: 1123<sup>ab</sup>
- DMX-7: 973<sup>a</sup>
- CaCO3: 1129<sup>ab</sup>
- Zeolite: 1229<sup>b</sup>

Flow rate (lb/min)

**ab** (P < 0.05)
Effect of FA Trts on Drained Angle of Repose

<table>
<thead>
<tr>
<th></th>
<th>At loading (degrees)</th>
<th>After storage (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>61(^a)</td>
<td></td>
</tr>
<tr>
<td>DMX-7</td>
<td>65.1(^b)</td>
<td></td>
</tr>
<tr>
<td>CaCO(_3)</td>
<td>60.4(^a)</td>
<td></td>
</tr>
<tr>
<td>Zeolite</td>
<td>60.3(^a)</td>
<td></td>
</tr>
</tbody>
</table>

\(^{ab}(P < 0.05)\)
What have others reported?

Ganesan et al. (2006)

Moisture level above 15% (10-30% range) decreased floodability index

Up to 2% CaCO$_3$ had no effect on AOR and a slight negative effect on floodability index

All work under laboratory conditions
Conclusions

Clearly, increasing moisture content from 9 to 11.5% decreases flow.

Where is the critical moisture level?

The FA’s and levels used provided only numerical differences in flow rate which provide little confidence that a consistent, repeatable effect can be realized.
Acknowledgements

John Goihl
Adrienne Hilbrands
Sarah Schieck
Mark Smith

MN Pork Board
Checkoff
Delst, Inc.
ILC Resources
St. Cloud Mining