Outline

- History of Bulk Solids Handling at Salina
- About BSIC
- Industry Partnership
- Vision
- Research Capabilities
- Training Programs/Certified Courses
- Under-Graduate and Graduate Programs in Bulk Solids
- Consultancy (Contract Research)
- Networking Opportunity
History of Bulk Solids Handling at Salina, Kansas

Entrepreneurial – Inventive – Collaborative

1940’s:
• Salina was one of the largest flour milling centers in the US.

1950’s:
• Bulk transit being developed for human consumption.
• Western Star Mill millers experiment with pneumatic conveying.
• Collaboration with local business-Salina Manufacturing Company
• Develop flour conveying algorithms based on science and physics.
• Product lines for pneumatic conveying are developed.

1960’s:
Salina Manufacturing further develop conveying algorithms for plastics, minerals, and chemicals
History of Bulk Solids Handling at Salina, Kansas

1970 to 2000:

Salina Flour Mills → ADM

Salina Manufacturing → Coperion K-Tron, Vortex

Kansas State University → KSU-Polytechnic
History of Bulk Solids Handling at Salina, Kansas

2009:
There was a talk by a group of people from KSU, Salina Chamber of Commerce, K-Tron and Vortex about creating a center for bulk solids handling research and education.

2014:
With the help of federal, state and local government support along with $2.5M of equipment donation from 25 different companies, at a cost over $5M Bulk Solids Innovation Center ground was broken.

2015:
KSU Bulk Solids Innovation Center was opened.
Open House at BSIC
• Two story Building (13,000 ft$^2$)
• Six laboratory Spaces for University and Industry Sponsored Research
• Training/Education, Conference and Lecture Rooms
• Material Property Test Lab
• Full Scale Bulk Solids Test Bay
BSIC: Plan View

Full Scale Bulk Solids Test Lab
Full Size Silo

Allows study of full sized storage and gravity flow, along with vertical conveying up to 65 feet to the top of silo.
Different Size Systems

Dense Phase System

Dilute Phase System

Receiving Hopper

Feeding Hopper
Different Size Bins

Allows study of variable discharge geometries and flow aids
Gravity flow study
Sophisticated Controls and Sensors

- Fluidizers
- Level Sensor
- High Pressure Rotary Valve
- Weighing System
- Airflow Sensor
Different Type Feeders
Conveying Lines

Horizontal distance conveying up to 950 ft
Vertical distance conveying up to 65 ft

3”, 4” and 6”
Vacuum Sequencing Set-up
Pilot-Scale Pneumatic Conveying Demo System - Teaching Tool

Can visualize dilute and dense phase conveying
Different Type of Feeders
Materials for Testing

The center can handle materials received by rail, truck, box, bags and bulk bags
BSIC: Plan View
BSIC: Plan View
Experimental Data
Monitoring & Acquisition

• It has controls, interfaces, monitoring, and data acquisition of all parameters.
• Real-time data from hundreds of sensors measuring parameters such as pressure, temperature, flow rate, velocity, amperage, power consumption, weight, and time.
• Data is stored on a server from which raw data, trending information, and graphs can be displayed.
Material Property Test Lab

Powder Flow Tester

- Flowability
- Wall Friction
- Bulk Density
- Time Consolidated flow function
Material Property Test Lab

Particle Size Analyzer

- Particle Size
- Particle Distribution
- Particle size range from 20 μm to 4,750 μm
Material Property Test Lab

Powder Characteristics Tester

- Angle of repose
- Cohesion
- Compressibility
- Aerated and packed density
- Uniformity
- Dispersibility
Partnership: University, Government, Industry

Salina Area Chamber of Commerce
Collaborative Partnership

<table>
<thead>
<tr>
<th>Salina Economic Development Corporation</th>
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</thead>
<tbody>
<tr>
<td>• Owner of the KSU-BSIC</td>
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<tr>
<td>• Responsible for capital improvements and insurance</td>
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<table>
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<tr>
<th>Industry partner commitment:</th>
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<tbody>
<tr>
<td>• Provide and install all equipment and controls</td>
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<tr>
<td>• Maintain all equipment</td>
</tr>
<tr>
<td>• Maintain the facility</td>
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<tr>
<td>• Pay expenses: utilities, maintenance, upkeep, housekeeping, groundskeeping</td>
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KSU’s Role at BSIC:

Coordinate all **Research, Education, and Publicity**

- Provide top level Research Candidates: Fellows, Doctoral Candidates, and Students
- Solicit research with industry
- Develop curricula and teach college courses on Bulk Solids
- Organize and publicize continuing education short courses for industry
- Coordinate publicity for the Center
- Maintain the website: [bulksolids.k-state.edu](http://bulksolids.k-state.edu)
Vision

The Kansas State University Bulk Solids Innovation Center will be a valued resource to companies that use or produce bulk solids or design systems for handling bulk solids.

The center will study and gain understanding of how to handle bulk solids, enhance efficiency and productiveness in those businesses operations.

The center will do research, teaching and consultancy on bulk solids problems.
Dry Bulk Solid Materials

Examples:

<table>
<thead>
<tr>
<th>Plastics</th>
<th>Chemicals</th>
<th>Food</th>
<th>Compounding</th>
</tr>
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<tbody>
<tr>
<td>Polyethylene</td>
<td>Calcium Carbonate</td>
<td>Flour</td>
<td>Clay</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>Metal Oxides</td>
<td>Sugar</td>
<td>Wood Flour</td>
</tr>
<tr>
<td>PVC</td>
<td>Stearates</td>
<td>Coffee</td>
<td>Mineral Fillers</td>
</tr>
<tr>
<td>Nylon</td>
<td>Dicalcium Phosphate</td>
<td>Peanuts</td>
<td>Titanium Dioxide</td>
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</table>
Conveying Systems

The following flow types can be studied at this center:

Dilute Phase
1. Vacuum
2. Pressure
3. Vacuum Sequencing

Problems in Dilute Phase Conveying:
Attrition and wear
Segregation
Research Capabilities

Particle properties affect:

A. Conveying Systems

Dense Phase
1. Vacuum
2. Pressure Vessel
3. Rotary Valve

Research on Dense Phase Conveying
Reducing velocity to eliminate degradation and wear

Optimizing the pressure and airflow
Research Opportunities: Problems in Bulk Solids Handling

- Cohesive Arching
- Ratholing (Piping)
- Interlocking Arch
Research Capabilities

Particle properties affect:

B. Process Systems
1. Feeding, Weighing, Scaling
2. Silo Blending / Segregation
3. Gravity Flow
4. Particulate Air Filtration
C. Bench Scale Material Characterization and Properties Testing

- Particle size,
- Particle size distribution,
- Particle shape,
- Loose and compacted bulk density,
- Particle density,
- Angle of slide, Angle of repose,
- Angle of external friction,
- Angle of internal friction,
- Moisture content
Research Capabilities

Particle properties insights:

- Friability
- Agglomeration
- Adhesiveness
- Cohesiveness
- Abrasiveness
- Hardness
- Air retention
- Terminal velocity
- Saltation velocity
- Flowability
- Fluidizability
- Permeability
Research Capabilities

D. Modeling

CFD, FEM and Discrete Element Modeling of Bulk Solids Handling

- Flow patterns
- Stress distribution
- Velocity profile
- Segregation patterns
- Particle distribution
- Power consumption
Why Study Dry Bulk Solids?

- It is not well defined, like gases or liquids
- The fundamentals of bulk solids properties are not well understood
- Both Applied and Basic Research are needed
- A better understanding of bulk solids handling will help many industries
Continuing Ed / Professional Development Short Courses: Each course is 3 to 4 days, with comprehensive in-depth training from the most experienced instructors in the country. Courses include lectures, discussion, laboratory time, and considerable full-scale hands-on training.

**Current course offerings** (see [www.bulk-solids.k-state.edu/profdev](http://www.bulk-solids.k-state.edu/profdev))

- Online Fundamentals of Bulk Solids Handling
- Pneumatic Conveying of Powders and Bulk Solids
- Refresher Course on Bulk Solids Handling
- Storage and Flow of Bulk Solids
The following company where people enrolled in the short courses

**Company Names:**

A Schulman
ACME Constructors, Inc
Archer Daniels Midland Co.
Ascend
Bergquist Company - A Henkel Company
Bestolife Corp.
BioMatrix Inc.
Bonar Inc.
Bridgestone
BUNGE MILLING
Buenge Milling
Burrow Global
Cargill
Carlisle Syntec
Cascade Eng. /noble polymer
ChäDa Sales, Inc.
Chemstress Consultant Co
Chevron Energy Technology
COLOR MASTER
Continental Contitech
Coorsteck
Coperion K-Tron
CP Kelco
Custom Equipment Design
Ensign Equipment
ExxonMobil Chemical
Firestone Building Prod.
Green Dot
GSK
Horizon/Miocene

**Refresher Course:** 52

**Pneumatic Conveying Course:** 49

**Storage and Flow Course:** 6

**Online Course:** 7

**Company Names:**

J&M Tank Lines
Kellogg Company
Kice Industries
Kiewit Engineering and Design Co
Mars Chocolate NA
Nestle Purina
NOVA Chemicals (Canada) Ltd.
Nutrilite
Omya
Phibro Animal Health Corp
POET
PolyOne
POWER Engineers, Inc.
Pulva Corporation
Rehrig Pacific Company
Saint Gobain
Sasol
Schenck Process
Shell
Styrolution
Styrolution Americas LLC
Teknor Apex
Tinsley Company
Traditional Medicinals
Uniform Color Company
University of Minnesota
Vortex Valves
WAM USA Inc
Washington Mills
Washington Penn Plastic Co
Wenger Manufacturing Inc
Target People

• Technicians and Operators
• Engineers and Technical Directors
• Students
• Managers
• Researchers
• Manufacturers

Courses can be customized for a particular customer’s need
Near Future:

Undergrad Program
BS (Mechanical Engineering Technology) specialized in Bulk Solids

Graduate Program
• MS (Powder and Bulk Solids) (regular, part-time and distance learning)
• PhD (Powder and Bulk Solids) (regular)

Student will work as part-time staff in the center and learn hands-on bulk solids problem and solution by working on different industrial projects
Consultancy

Contract Research:

Do research on specific problems for a particular industry and give recommendation for process improvement such as improving reliability and reducing the operational cost.

The research activity involves:

• Material property testing
• DEM modeling
• Large-scale flow study
Networking

BSIC - a place of networking:
• Industry equipment details and demonstration
• Bulk solids handling experts and users
Thank You

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