Biomass – Material Handling Considerations

Overview of the Efforts in Feedstock & Materials Handling - Key Technical and Economic Challenges Identified for Different Processes

Biorefinery Optimization Workshop October 2016 DOE

Carrie Hartford, P.E.
Senior Project Engineer

chartford@jenike.com
BIOMASS “FLOWABILITY”

Biomass types can vary significantly!
- Particle size, shape, and moisture variation
- Differences affect material flowability

Flowability is a function of the material AND the equipment
- “Poor flowing” material can be handled easily in properly designed equipment
- “Easy flowing” material can present flow problems in poorly designed equipment
EXTENT OF HANDLING PROBLEMS

Average Startup time, months

Type of Feedstock

- Planned startup time
- Actual startup time

<table>
<thead>
<tr>
<th>Type of Feedstock</th>
<th>Planned startup time</th>
<th>Actual startup time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid-gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solids-refined</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solids-raw</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RAND STUDY CONCLUSIONS

- 80% experienced solids handling problems
- Average startup time 18 months
  - vs. 3 months for liquids
  - Average cost per month delay ≈ $350,000\(^1\)
- Typical performance 40 to 50% of design
- Problems related to “physics and mechanics of processes rather than to chemistry”

\(^1\) $350,000 in “1988 dollars”; today’s value ≈ $1,000,000
Key reasons that specific technology development programs fail are 2:

- Lack of strategic alignment with business → lack of adequate support and resources
- Lack of a disciplined phasing during development → projects progress that should not
- Lack of a corporate champion to maintain momentum over the years
- Not bringing the best possible minds and experience to the program

3 Wellwood, Grant. “Fail to plan!; Plan to fail!-The case for Capability Mapping”, LinkedIn Post March 2016.
COST OF MODIFICATION

Ability to Influence Cost, Quality, Schedule

Cost of modification

Scope frozen

Testwork & Concept Development
Feasibility Studies
Detailed Design
Procurement
Construction


www.jenike.com
GRAVITY FLOW SYSTEMS
FLOW PROBLEMS – NO FLOW/ERRACTIC FLOW

Arching

Ratholing
FUNNEL FLOW

Issues

- Some material is stagnant
  - Biomass may oxidize, ferment/have runaway bioactive reactions, smolder, ignite
- Arching, ratholing, and erratic flow can occur
- Limited live capacity
- Varying bulk density

Features

- Low headroom
- First-in, last-out
- Ratholes may develop
- Fine powders will flood
MASS FLOW

- Allows for uniform velocity of the material
- Can design for even distribution of air injected into the moving bed of material
- Constant bulk density at the outlet
- Reliable flow
TEST & DESIGN

- Test to measure relevant properties
- Set design spec window of acceptable material
- Determine appropriate flow pattern
- Use proven design methodology
- Consider different approaches if gravity flow is not possible
- Consider processing and storing in one bin design (purge vessel)
CONSTANT PITCH SCREW FEEDER
MASS FLOW SCREW FEEDER

Be aware of insufficient torque!
CONCLUSION

- Set aside sufficient money and time to measure the flow characteristics.
  - If material changes mid project – test again!
- Establish an acceptance criteria for incoming material
- Reliable handling silos can also act as a processing vessel
- Don’t forget the feeder design!
- Get a bulk materials expert involved early on
Carrie Hartford, P.E.
Senior Project Engineer
+1 805 541 0901
chartford@jenike.com