‘Dry Materials Handling’ an overview of guidelines and practices

Edyta Margas and Karel Mager*

SOLIDS, BASEL 2015
Bühler AG at a glance

<table>
<thead>
<tr>
<th>Food</th>
<th>Advanced Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain processing</td>
<td>Electronics</td>
</tr>
<tr>
<td>Snacks, Rice &amp; Pasta</td>
<td>Optics</td>
</tr>
<tr>
<td>Chocolate, RTE cereals, nuts</td>
<td>Automotive</td>
</tr>
</tbody>
</table>

- Group turnover (sales) 2014: CHF 2,332 million.
- Around 10,600 employees.
- Present in nearly 140 countries.
- Today, 80 service stations globally, +12 stations compared to 2013.
- Production sites in all regions.
- Up to 5% of turnover invested in research & development.
- Consistently high quality standard worldwide.
- 100% family-owned.
Working group Dry Materials Handling:

SprayDryConsult

Equipment suppliers:
- Zeppelin – Reimelt
- Glattt Ingenieurtechnik
- J-Tec Material Handling
- Hosokawa
- Bühler
- Coperion Waeschle
- Hecht Anlagenbau

Food producers:
- DSM Food Specialties
- Danone
- Cargill
- Givaudan
<table>
<thead>
<tr>
<th>Document</th>
<th>Title</th>
<th>Description</th>
<th>Date</th>
<th>Update</th>
</tr>
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<tbody>
<tr>
<td>1 - Doc. 22</td>
<td>General hygienic design criteria for the safe processing of dry particulate materials</td>
<td>(2001). <strong>Updated 2014!</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - Doc. 26</td>
<td>Hygienic engineering of plants for the processing of dry particulate materials</td>
<td>(2003)</td>
<td></td>
<td></td>
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<tr>
<td>3 - Doc. 31</td>
<td>Hygienic engineering of fluid bed and spray dryer plants</td>
<td>(2005)</td>
<td></td>
<td></td>
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<tr>
<td>4 - Doc. 33</td>
<td>Hygienic engineering of discharging systems for dry particulate materials</td>
<td>(2005)</td>
<td></td>
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<tr>
<td>5 - Doc. 36</td>
<td>Hygienic engineering of transfer systems for dry particulate materials</td>
<td>(2007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 - Doc. 38</td>
<td>Hygienic engineering of rotary valves in process lines for dry particulate materials</td>
<td>(2008)</td>
<td></td>
<td></td>
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<tr>
<td>7 - Doc. 40</td>
<td>Hygienic engineering of valves in process lines for dry particulate materials</td>
<td>(2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 - Doc. 41</td>
<td>Hygienic engineering of diverter valves in process lines for dry particulate materials</td>
<td>(2011)</td>
<td></td>
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</tr>
</tbody>
</table>
Dry Materials Handling

What are Dry Materials??

The working group Dry Materials Handling started in 1998 with EHEDG-document 22 and decided to focus on:

Dry Particulate Materials
Dry Materials:

- Powders (milk-powder, cacao, flour, .....)
- Granulates (salt, sugar, wheat, ......)
- Agglomerates (coffee, soups, sauces, .....)

\[ \text{Diameter} < 1\mu m \quad \ldots\ldots 4000 \mu m \]
Typical 150\mu m

No cakes, slurries, bakery products
BUT........ WHAT challenges the Hygienic Design criteria for dry particulate materials (powders)?

- Product characteristics (e.g. free flowing, sticky, particle size distribution)

- Typical processes (e.g. milling, drying, etc.)

- Typical issues (open process, dust, moisture content, condensation!)

- Cleaning procedures (wet or only dry)
Humidity and stickiness versus moisture content in powder
Salmonella killed in the product at 70°C . . . ?

As a trend and depending on product and type of Salmonella:

<table>
<thead>
<tr>
<th>Aw</th>
<th>Time needed for 6 log reduction of Salmonella</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,995</td>
<td>&lt; 36 seconds</td>
</tr>
<tr>
<td>0,94</td>
<td>3.6 minutes</td>
</tr>
<tr>
<td>0,85</td>
<td>17 minutes</td>
</tr>
<tr>
<td>&lt;0,6</td>
<td>Hours!</td>
</tr>
</tbody>
</table>
Reason for foodborne outbreaks associated with *Salmonella* in dry foods

- **GMP failure** (21 outbreaks)
  - zoning
  - equipment
  - maintenance
  - handling

- **Lack of kill step** (15 outbreaks)
  - validation
  - raw product
Salmonella is the game changer for the dry food industry

- Can survive in dry environment
- Are relatively heat stable
- A few cells can cause illness
- They are difficult to detect
- They are not homogenously distributed

Janice Haney Carr, Centers for Disease Control and Prevention, USA
Factors needed for microorganisms growth

- condensation
- product
- wet cleaning

A generation time of 20 min is possible
Dry cleaning

Applicable for dry material contact surfaces where:

- Dry material remaining in the equipment as deposits or as light powder layers does not present any risk of degrading the quality of the dry material subsequently produced.

- Possible cross-contamination of dry material during a production change to another material presents no problem to the safety of the dry material subsequently produced (e.g. Allergens!)

- Dry material remaining in the equipment does not present any risk of microbial growth occurring due to prevailing moisture content, temperature, and humidity conditions.
Equipment design:

Should ensure that after wet cleaning the equipment is dry within 2 hours!!!.

Also at critical areas (e.g. behind seals)

Probably a forced hot air drying is required
Smooth flanges without centering, with flat gasket

→ Conglomeration of product

Not hygienic!

Centered flange connection, sealed metallically or with O-ring

→ Only suitable for dry cleaning

Only for dry processes / dry cleaning

Hygienically designed flange connection with sealing for wet cleaning

Wet cleaning possible
Transfer of energy migration of chemicals to soil in a crevice is extremely difficult.
Flexible connections in powder process lines
Clamp sheet to avoid the crevice

end of pipe

fixing clamp

flexible sleeve

crevice possible

end of pipe

fixing clamp

clamp to avoid crevice

flexible sleeve

avoided crevice

end of pipe

flexible sleeve

hose clamp
Surfaces roughness and cleanability

- Large areas of product contact surface should have a surface finish of 0.8 µm Ra, or better, although the cleanability strongly depends on the applied surface finishing technology, as this can affect the surface topography.

- A roughness of Ra >0.8 µm Ra is acceptable if test results have shown that the required cleanability is achieved because of other design features, or procedures such as a high flow rate of the cleaning agent.

- For dry materials and dry cleaning protocols (!!!!!) it might be more than Ra = 0.8 µm Ra.
Hygienic zoning

- **Basic Hygiene Zone**
- **Medium Hygiene Zone**
- **High Hygiene Zone**
Critical area in the process line is the border between wet and dry.

Important:

- The dry part should stay dry
- Physical separation
- Easy dismantling
- Easy to dry
Insulation

Outside cladding

Spray dryer wall
Insulation

Drying chamber

Slightly under pressure

Contamination
<table>
<thead>
<tr>
<th>MOD</th>
<th>EN 779</th>
<th>ARRESTANCE (%)</th>
<th>EUROVENT 4/5</th>
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</thead>
<tbody>
<tr>
<td>PREFILTER</td>
<td>G 1</td>
<td>60 - 65</td>
<td>EU 1</td>
</tr>
<tr>
<td></td>
<td>G 2</td>
<td>70 - 80</td>
<td>EU 2</td>
</tr>
<tr>
<td></td>
<td>G 3</td>
<td>80 - 85</td>
<td>EU 3</td>
</tr>
<tr>
<td></td>
<td>G 4</td>
<td>85 - 95</td>
<td>EU 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERMEDIATE FILTERS</th>
<th>EFFIC. COLOR. (%)</th>
<th>EUROVENT 4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 5</td>
<td>50 - 55</td>
<td>EU 5</td>
</tr>
<tr>
<td>F 6</td>
<td>60 - 65</td>
<td>EU 6</td>
</tr>
<tr>
<td>F 7</td>
<td>80 - 85</td>
<td>EU 7</td>
</tr>
<tr>
<td>F 8</td>
<td>90 - 95</td>
<td>EU 8</td>
</tr>
<tr>
<td>F 9</td>
<td>&gt; 95</td>
<td>EU 9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EN 1822</th>
<th>EFFIC. ON PARTIC. 0,3µm(%)</th>
<th>EUROVENT 4/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 10</td>
<td>&gt; 95</td>
<td>EU 10</td>
</tr>
<tr>
<td>H 11</td>
<td>&gt; 96</td>
<td>EU 11</td>
</tr>
<tr>
<td>H 12</td>
<td>&gt; 99,99</td>
<td>EU 12</td>
</tr>
<tr>
<td>H 13</td>
<td>&gt; 99,997</td>
<td>EU 13</td>
</tr>
<tr>
<td>H 14</td>
<td>&gt; 99,999</td>
<td>EU 14</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>ABSOLUTE FILTERS</th>
<th>EFFIC. ON PARTIC. 0,12 µm (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEPA AND ULPA</td>
<td></td>
</tr>
<tr>
<td>U 15</td>
<td>&gt; 99,9995</td>
</tr>
<tr>
<td>U 16</td>
<td>&gt; 99,99995</td>
</tr>
<tr>
<td>U 17</td>
<td>&gt; 99,999995</td>
</tr>
</tbody>
</table>

Hot drying air should be filtered with a filter class > EU = 7

Cold transport air should be filtered with a filter class > EU = 10

EN779 test is efficiency with particles of 0,4µm
EN1822 (for HEPA-filters) is the test with particles of 0,3µm
Soil/dust falls directly in product!
2005 - Doc 33 Discharge Systems
Dust exhaust pipe (provided with butterfly valve)

Static dust filter in lid

Dust exhaust pipe

CIP-balls

Hygiene Risk

Correct
2005 - Doc 33 Discharge Systems

Adhesion and dead space

Dead area  Adhesion
Hygienic Engineering versus process suitability (will the product be transported by only vibration?)

Screw transport

Vibrating transport (easy to clean)
Rotary Valves are used for:
- Dosing
- Shut-off between separate stages in the process
- Explosion barrier
- Combination of the three
Closed rotor

Open Rotor

Bolted blades
Stiffened blades
Bolted scraper blades
Dynamic seal
Valves in powder handling (?)
Flange not hygienic (horizontal surface)!

Protection of bottom side valve
Challenge in powder handling:

This is not according document 8 !!!!
After retraction of the rotor the seal comes free from the slightly conical housing and allows water / air to pass the seals.

Water or drying air

Draining of cleaning liquid

The rotor is retracted during the cleaning operation and allows the cleaning to pass the seals.
2013/2014:
Current project of the subgroup
Dry Materials Handling

9 – EHEDG Doc. Nr.??

Hygienic Engineering of
Pack-off Systems in
process lines for dry
particulate materials
Thank you for your attention

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