Solids Mass Flow Measurement
Utilizing Centripetal Force
# Types of Flow Measurement

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Image 1</th>
<th>Image 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centripetal Measurement</strong></td>
<td>Force on curved plate</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Impact Meters</strong></td>
<td>Momentum change</td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Coriolis</strong></td>
<td>Torque change</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Weigh Belts</strong></td>
<td>Loadcell measurement</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>
The CentriFlow®
Centripetal Force
Mass Flow Measurement

- Accurate
- Reliable
- Compact
CentriFlow® Meter
CentriFlow® Technology

- Based on the Principle of Centripetal Force (not impact)
- Friction Canceling Patented Design

Centripetal force is the inward force required to keep an object moving in a circular path. It can be shown that an object moving in a circular path has an acceleration toward the center of the circle along the radius. This radial acceleration, called the centripetal acceleration, is such that, if an object has a linear or tangential velocity when moving in a circular path of radius R, the centripetal acceleration is $v^2/R$. If the object undergoing the centripetal acceleration has a mass (M), then by Newton’s second law of motion the centripetal force ($F_c$) is in the direction of the acceleration. This is expressed by the formula:

$$\text{Force} = \text{Mass} \times \text{Velocity}^2 / \text{Radius}$$
CentriFlow® Meter
Utilizing the Principle of Centripetal Force

\[ F = \frac{mV^2}{R} \]
(Formula for Centripetal Force)

\[ F = \frac{mV^2}{R} \]
(Velocity Energy and Radius Remain Constant)

\[ \therefore F \cong m \]
Advantages of the CentriFlow
Centripetal Force Based Mass Flow Meter
Advantages Over Other Technologies

• The meter offers a typical accuracy of ±0.25% of reading at calibrated flow rate and is repeatable within ±0.10%

• CentriFlow® Meter is easy to install and calibrate
  – Reduced installation cost
  – Quick and Convenient verification of performance

• CentriFlow® Meter is scalable for a variety of flow rates
  – Multiple applications for one meter

• CentriFlow® Meter’s measurement independent of density and particle size variances
  – Responsiveness to Process changes
  – No need to re-calibrate if parameters change
  – Changes in parameters do not cause “drift”
Maintenance Advantages
Minimized Movement, Minimized Maintenance

- Minimal maintenance (minimal moving parts) resulting in substantial cost savings and less down time
- No dust build up on rollers as with a Weigh Belt
- No belts to tighten and adjust
- No parts to oil/grease

Beryllium Copper Flexure
(0.015" x 0.5" x 2")
Attached to Pan Arm and Backplate

- Beryllium Copper (BeCu)
  High Quality Spring Material.
- Arm Rotation is less than a second of a degree, therefore, BeCu never passes its yield point.
- No need to grease or oil the Pivot Point.
- No Wear Points.
Sanitation and the CentriFlow

• **CentriFlow® Meter is easy to clean**

  – Ideal for Food Processing Facilities
  – Saves time and money (no need for disassembling during cleanings)
  – All Stainless Steel Construction
  – All Welded/Food Grade Pan available

Sanitation problem with Weigh Belt
• **CentriFlow® Meter** can be installed with minimal change to customer’s existing process
  – Can be installed using a **Variety of feed devices**
    • Rotary Valve
    • Screw Conveyor
    • Rotary Airlock
    • Slide Gate/Orifice
    • Belt/Vibratory Conveyor
Where can the CentriFlow® Meter be Installed???

• Before and After Extruders
• Load Out/Load In
• Blending/Mixing
• Inventory Control
• Flow Control
• Packaging
• Ratio Control
• After Rotary Valves, Airlocks, Screw Conveyors, Slide Gates/Orifices, Belt & Vibratory Conveyors
Configurations
CentriFlow® Meter
Type I Configuration
Installations with Belt Conveyor

REVERSE DIRECTION FLOW

<table>
<thead>
<tr>
<th>CONDITIONS</th>
<th>STANDARD</th>
<th>PREFERRED</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DROP HEIGHT</td>
<td>3.75 [95]</td>
<td>3.75 - 5.0 [95 - 127]</td>
<td>11.50 - 16.00 [143 - 1170]</td>
</tr>
<tr>
<td>HORIZONTAL DIMENSION</td>
<td>2.50 [64]</td>
<td>2.50 - 3.0 [64 - 76]</td>
<td>2.50 - 10.00 [64 - 254]</td>
</tr>
<tr>
<td>CONVEYOR SPEED</td>
<td>1 ft/sec [0.31 m/sec]</td>
<td>1 - 2 ft/sec [0.31 - 0.61 m/sec]</td>
<td>-</td>
</tr>
<tr>
<td>CONVEYOR ROLL DIAMETER</td>
<td>2.66 [66]</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

CONVEYOR SPEED

HORIZONTAL DIMENSION

CONVEYOR ROLL DIAMETER

IN-LINE FLOW

CENTRIFLOW® TYPE I METER (RECLINED UP TO 20°)

NOTES:
1. MINIMUM FLOW SHOULD MAKE CONTACT WITH THE TANGENTIAL PLATE AT ALL TIMES AND MAXIMUM FLOW SHOULD NOT FLOW OVER THE TANGENTIAL PLATE.
2. THE METER SHOULD NOT BE MOUNTED DIRECTLY TO THE CONVEYOR SO AS TO MINIMIZE VIBRATION.
3. MATERIAL FLOWING DIRECTLY TO THE PAN SECTION WITHOUT CONTACTING THE TANGENTIAL PLATE WILL RESULT IN INACCURACY.
CentriFlow® Meter
Type II Configuration
Type II Installation with Slide Gate
Type II Installation with Screw Conveyor and Rotary Valve

**NOTES:**
1. FLEXIBLE CONNECTIONS ARE RECOMMENDED FOR INTAKE AND DISCHARGE TO ISOLATE METER FROM VIBRATION AND KEEP FEED AND DISCHARGE DEVICES FROM APPLYING FORCE TO METER ENCLOSURE.
2. MUST SUPPORT METER USING THE MOUNT SIDES ONLY, THE TYPE II ENCLOSURE IS NOT DESIGNED TO SUPPORT WEIGHT OF FEED OR DISCHARGE DEVICES.
3. THE DROP HEIGHT SHOULD BE MINIMIZED AND REFERENCED AS PER CONDITIONS ABOVE.

**CONDITIONS**

<table>
<thead>
<tr>
<th>CONDITIONS</th>
<th>STANDARD</th>
<th>PREFERRED</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DROP HEIGHT</td>
<td>14.50 [368]</td>
<td>14.00 - 22.00 [356 - 559]</td>
<td>13.50 - 46.00 [343 - 1170]</td>
</tr>
<tr>
<td>HORIZONTAL DIMENSION</td>
<td>2.50 [64]</td>
<td>(SET BY AN INTERNAL DIVERTER PLATE)</td>
<td></td>
</tr>
</tbody>
</table>
Engineered-to-Order Options
Improving Flowability of Product and Results

• Flow Contact Surfaces and Liners
• Flow Aids
  – VibraWeigh®
  – Pulsed Air
• Custom Transitions
• Custom Enclosures
• Explosion Proof Systems
CentriFlow® Meter
“Electronics Options”

Digital CentriFlow® Electronics Package
Standard Digital Electronics Package

- White Carbon Steel NEMA 4 Enclosure (12”x14”x8”)
  - Stainless Steel NEMA 4X Enclosures available
- CentriFlow® DCE (Digital CentriFlow® Electronics Module)
- 4-20mA Output (Flow Rate Proportional-Current Sourced-Fully Isolated)
- Frequency Output (Flow Rate Proportional 0-500Hz)
- Large, convenient, color touch screen HMI
- Universal Power Supply (85-264 VAC)
- Remote Reset Capabilities
- Flow Rate and Totalization Alarm/Preset Capabilities
- Data Storage – 2 Gigabyte Compact Flash Card
- HMI Programmed Meter Calibration including:
  - Zero Adjustment
  - Static Calibration
  - Dynamic Calibration
  - Field Calibrations
- HMI Onscreen Plotting/Trending
- Internal Temperature Monitoring of Meter Casing
Questions