G M W

3-Dimensional Image Processing for Gob Measurement & Weight Control

Glass Forming Technology Team
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NIHON YAMAMURA GLASS CO., LTD.
Development Concept
High Quality Bottle Production

3 Dimensional Image Processing for Gob Measurement & Weight Control

Repeatable & Stable Gob Weight · Shape

Stable Gob Loading

Improvement in Machine Setting Accuracy

Glass Composition

Delivery Process

Repeatable & Stable Gob Weight

Repeatable Swabbing Film Function

Stable Gob Loading

Glass Composition
Importance of Gob Weight & Shape

Gob Weight Variation During Production

Variations and Changes in Filling Level

Changes in Gob Shape, Fall Angle, Gob Loading, Heat Capacity, etc

Non-repeatable Gob Shape During Job Change

Results in Breakdown of Forming Conditions and Non-repeatable Quality

Can Cause
1. Glass Defects (laps, uneven thickness, gauge, finish defects, etc)
2. Machine Downtime

Adjustment of:
Gob & Mould Temperature, Forming Timing and Pressure, etc
Gob Measurement Principle
3 Dimensional Measurement Principle

Calibration Post  Gob  Calibration Post

Camera 1  Camera 2  Camera 3

Coordinates (0,0,0)

Image

Wire Frame Image
3 Dimensional Gob Wire Frame Image
3 Dimensional Gob Wire Frame Image (Zoom)
Numerical Representation of Gob

1. Continuous volume calculation from gob image
2. Automatic volume (calculated) control
   = Automatic Weight control
4. From the 3 dimensional coordinates: Gob length, fall angle, drop consistency are numerically calculated.

Feeder Plunger
Feeder Tube

H-1, H-2 measurement
H-1, H-2 average data used for Tube height control
Volume Measurement Accuracy

Image Processing of Water, Oil, Shear Spray Particles on Gob Edge
Volume Measurement Accuracy

Relationship between Measured Volume and Actual Gob Weight

- Measured Volume (mm³) vs. Actual Gob Weight (g)
- Scatter plot with a linear trend line
- $R^2 = 0.9711$
System Structure
GMW System

Processing Speed: 1.5 sec/gob
(Trigger Signal - Measurement - Calculation - Output - Signal Standby)
Automatic Control for all process: BB, PB, NNPB

3-D Measurement
Display, Control PC

Camera: Water Jacket, Lens: Air Purge System
System Features & Performance
GMW Features & Performance

Automatic Gob Weight Control

- Fully Automatic System (no need for periodic weight sampling for calibration)
- Weight Variation R of below 1% of control weight

Gob Shape Recording • Retrieval • Comparison

Gob Measurement Trend Data • Recording • Retrieval

- Gob Volume
- Gob Length
- Gob Fall Angle
- Feeder Tube Height Adjustment
- Drop Consistency

Alarm Functions

- Trend Graph Data
- Camera Water Jacket Temperature
- Camera Lens Air Purge Pressure
Automatic Control Performance

![Graph showing weight variations over gob weight](image)

- **GMW**
- **Manual**
- **Plunger Base System**

Target below 1%
Gob Volume & Trend Graph

- Standard Weight: 200.0 ± 10.0 (g)
- Production Weight: 202.0 ± 1.0 (g)

- Scale Adjustment
- Tube Height Adjustment
- Drop Consistency (mm)
- Gob Length (mm)
- Gob Fall Angle (°)

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Tool Bar Function

![GMW Tool Bar](image)

- **LAN-Link**: Green
- **Glass Volume**: 155.24 (cm³)
- **Gob Shape**
- **Fall Angle**
- **Alarm**
- **Historical**
- **Detail**
- **Product**
- **Trigger**
- **Weight**
- **Density**
- **Control**
- **Job Change**
- **Close**
## Gob Shape Window

<table>
<thead>
<tr>
<th>Product Name: Product A</th>
<th>Production Date: October 12, 2000 10:05:12</th>
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<tbody>
<tr>
<td></td>
<td>(H-1)</td>
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<tr>
<td>Volume</td>
<td>185.20 cm³</td>
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<tr>
<td>Drop Angle</td>
<td>2.5 °</td>
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<tr>
<td>Gob Length</td>
<td>145.2 cm³</td>
</tr>
<tr>
<td></td>
<td>(H-2)</td>
</tr>
<tr>
<td>Volume</td>
<td>181.50 cm³</td>
</tr>
<tr>
<td>Drop Angle</td>
<td>3.2 °</td>
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<tr>
<td>Gob Length</td>
<td>150.2 cm³</td>
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<table>
<thead>
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<th>Production Date: October 15, 2000 13:10:14</th>
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<tbody>
<tr>
<td></td>
<td>(H-1)</td>
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<tr>
<td>Volume</td>
<td>170.30 cm³</td>
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<tr>
<td>Drop Angle</td>
<td>2.5 °</td>
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<td>Gob Length</td>
<td>142.1 cm³</td>
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<tr>
<td></td>
<td>(H-2)</td>
</tr>
<tr>
<td>Volume</td>
<td>168.10 cm³</td>
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<tr>
<td>Drop Angle</td>
<td>2.7 °</td>
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<tr>
<td>Gob Length</td>
<td>147.8 cm³</td>
</tr>
</tbody>
</table>
Gob Fall Angle

Furnace

Lehr

Left Side View

Front View

Fall Angle

Left Side View

Front View

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### Alarm Setting Window

#### GVIS Alarm Settings

<table>
<thead>
<tr>
<th>Weight</th>
<th>Length</th>
<th>Fall Angle</th>
<th>Drop Cons.</th>
<th>FT Control</th>
<th>Data Comm</th>
</tr>
</thead>
</table>

**Control Limit:** ± 20.0 (g)

**No. of times:** 010

#### Alarm

**Gob Weight Alarm, Feeder Control Alarm**

- [Ok]
- [Cancel]
- [Confirm]
Historical Trend Data

![Graph showing production trend data for Product A over different scale adjustments (1, 8, 16, 24 hours).](image-url)
Job Change Data

Product Data

- **Product**: Product C
- **Standard Weight**: 206.0 ± 10.0 (g)
- **Production Weight**: 206.0 ± 1.0 (g)
- **Glass Density**: 2.2649 (g/cm³)
Job Change Database

<table>
<thead>
<tr>
<th>Product List</th>
<th>Standard Weight</th>
<th>Production Weight</th>
<th>Glass Density</th>
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</thead>
<tbody>
<tr>
<td>Product A</td>
<td>247 ± 10 (g)</td>
<td>247 ± 1 (g)</td>
<td>2.26 (g/cm³)</td>
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<tr>
<td>Product B</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Product C</td>
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<td></td>
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<tr>
<td>Product D</td>
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<td>Product E</td>
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<tr>
<td>Product L</td>
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<tr>
<td>Product M</td>
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</tbody>
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Modify | Delete | Upload | Close
Summary
GMW System

Compact Housing Unit

Control Panel

3D Wire Frame Image

Trend Graph
Summary

1. The GMW system helps contribute to stable production and improve quality.

• **Fully Automatic System**
  No need for periodic weight sampling for calibration. This means more time for defects correction.

• **Stable gob weight control**
  Applicable for BB, PB, NNPB process
  Weight variation R of below 1% of control weight

• **Job change repeatability**
  Gob images and other numerical parameters helps facilitates job change setup

• **Better gob loading & delivery**
  Continuous monitoring of gob length, fall angle & drop consistency for early identification of loading & delivery problems
Summary

2. Repeatable gob shape & weight, stable gob weight are important factors in achieving light weighting and non-swabbing technology.

3. By linking the gob image data with servo-driven mechanism, automatic gob forming is possible.