CHEMICAL APPLICATION GUIDE
MASS BALANCE

Improve Overall Mass Balance with Improved Measurement Integrity.

Close mass balance gaps with reliable and accurate data from key input and output streams.

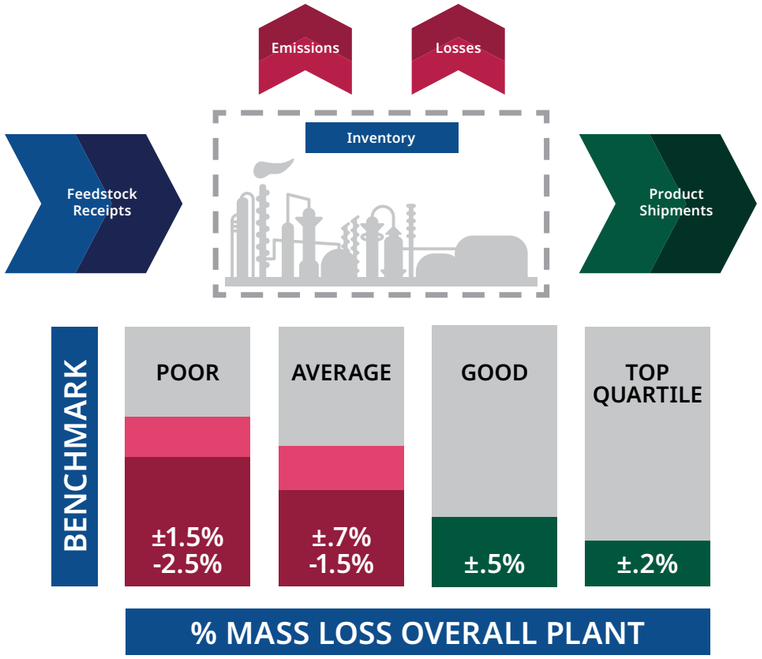
EMERSON

Industry Facts
You Need to Know

GAIN VISIBILITY INTO YOUR PLANT'S PERFORMANCE

- **By auditing and benchmarking your mass balances you can track the overall percent loss of input and output streams; therefore, have a better understanding as to what is causing errors in your mass balance calculations**
- **Typical plant mass balance goals:**

(Source: Solomon Associates)



IMPROVE PROFITABILITY WITH MEASUREMENT ACCURACY

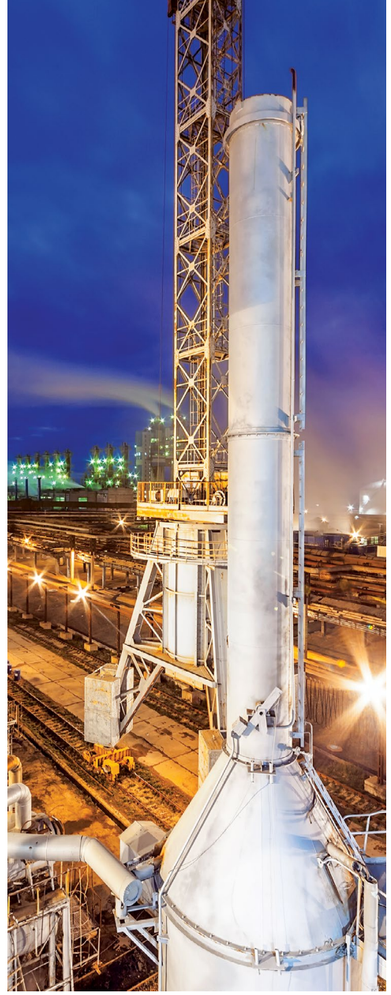
- **Customer examples of mass balance improvements**
  - — A butadiene manufacturer upgraded their legacy custody transfer meter with a Micro Motion™ Coriolis meter. In the first six months of operation, the mass balance was within 0.185% – equivalent to a loss reduction of approximately $300,000 in the first year of installation
  - — Implementing an automatic tank gauging system improved plant mass balance by reducing truck scale reconciliation to as little as 4 lb. (2 kg) per full load

Improve Plant Profitability
With Effective Mass Balance Reconciliation

Accurate data is needed to make better operational decisions that, in return, result in reduced losses and optimized processes. Utilize Emerson™ solutions to significantly impact any area that has measurement errors and missing data.

Production accounting is performed to close the gap between booked shipments and receipts as compared with the operating plan. It also accurately assesses margins and profitability. The challenges with closing mass balances occur from measurement errors, data entry errors, or missing data.

We can help audit what is causing errors in your mass balance calculations, and offer a wide range of measurement solutions to help reduce costs and losses and increase production.



APPLICATION CHALLENGES

Accurate and timely financial reporting is your goal.
We can help you with these challenges, so you can improve your measurement integrity and meet your mass balance goals.

- **Improve plant profitability**
- **Minimize losses**
- **Manage rising raw material costs**
- **Achieve sustainability metrics**

The Value of Emerson's **Comprehensive Solutions**

Accurate and reliable measurement of all streams in and out of a plant, defined by the system boundary, is critical for accounting, profitability, and regulatory reporting. Emerson offers a mass balance and production accounting study to help identify mass balance errors. The study can be facility wide or for an individual process unit.

Emerson can help you gain more reliable and accurate measurement of the key material streams. We take existing measurements and procedures and compare them against applicable standards and industry best practices. Then we make recommendations to improve the balance and reduce the financial risk associated with losses.

- **Improvements in custody transfer measurements** ensure accurate and fair material-and-financial exchanges are occurring between parties. Accurate mass balance is critical to ensure traceability and chain of custody standards are met for sustainability certification purposes.
- **Accurate process unit mass balance measurements** can enable process unit engineers to better evaluate and optimize performance. This leads to better yield management and process optimization, ensures safety by not operating above design limits, and allows for more accurate emissions calculations to avoid penalties and fines.

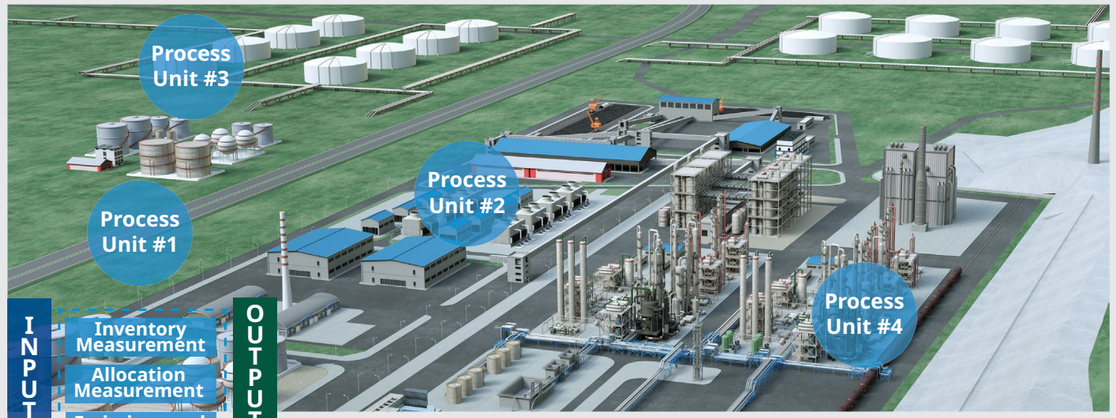
Overall Plant Mass Balance

*Accurate and reliable measurement of all streams in and out of the entire **Chemical Plant***

Coriolis Mass Flow | Gas Density | Liquid Density | Tank Gauging | Tank Inventory

System Boundary

INPUTS
Custody Transfer for Feedstock Receipts



INPUTS: Inventory Measurement; Allocation Measurement; Emissions and Losses

OUTPUTS

Process Unit Mass Balance

*Accurate and reliable measurement of all streams in and out of each **Process Unit***

Vortex Flow Meter | Process Level | DP Level | DP Flow | PRV Monitoring

OUTPUTS
Custody Transfer for Finished Products, Scrap, Waste & Emissions

Please contact your Emerson sales representative to discuss solutions to meet your goals.

Product Solutions

Emerson is a collaborative partner. Our team works along with you to meet your mass balance goals.

On the next few pages, see how our product solutions have helped customers meet their goals of **improving plant and operating unit mass balances, improving data collection and accuracy, and minimizing measurement errors.**

Let's start a conversation on how we can work together to achieve your goals.

IMPROVING PLANT AND OPERATING UNIT MASS BALANCES

IMPROVING DATA COLLECTION & ACCURACY

MINIMIZING MEASUREMENT ERRORS

GOAL: IMPROVING PLANT AND OPERATING UNIT MASS BALANCES

Issues	Solutions	Featured Products
Unable to identify the sources of raw material and product losses that lead to mass balance errors	Improve measurement accuracy for liquid, gas, or slurry product streams	 **Micro Motion Coriolis Meters -** - measures mass directly, along with density and temperature, to significantly improve the accuracy of both mass and volumetric flow measurements, independent of composition changes - two-phased flow capability reduces measurement error
		 **Rosemount™ 3051S Differential Pressure Flow Transmitter -** - reduces the risk of measurement errors by retrofitting an existing DP transmitter with an upgraded DP flowmeter with pressure and temperature compensation
		 **Rosemount 8700 Series Magnetic Flow Meter Sensors -** - reduce the risk of measurement errors with Smart Meter Verification (SMV) and coating detection - SMV identifies the health of the meter and if there have been any calibration shifts
		 **Rosemount 8800 MultiVariable Vortex Flow Meter -** - reduces risk of measurement errors with a non-wetted sensor design that can be easily verified without shutting down the process - all-welded, non-clogging design further eliminates measurement errors
		 **Rosemount Ultrasonic Flow Meters -** - multipath ultrasonic meters are utilized for custody transfer applications, especially in the transfer of natural gas - no moving parts, high accuracy, high turndown, and little pressure drop - gas density and temperature measurements are needed to use the ultrasonic meter for mass balance purposes
		 **Rosemount 708 Wireless Acoustic Transmitter and Plantweb™ Insight Pressure Relief Valve Monitoring Application -** - enables immediate identification and response to pressure release events - reduces impact and duration of losses from pressure release events impacting plant mass balance

GOAL: IMPROVING PLANT AND OPERATING UNIT MASS BALANCES, CONTINUED

Issues	Solutions	Featured Products
Inconsistent accounting for material accumulation in tanks as they are filled and emptied simultaneously	Continuously measure product transfers to/ from storage and in-process tanks	 **Rosemount 5900S Radar Level Gauge, Rosemount 2410 Tank Hub, Rosemount 2240S Multi-input Temperature Transmitter with Rosemount 565 Multiple Spot Temperature Sensor -** - provides the best level custody transfer measurement accuracy for tank volume and mass - high precision, maintenance-free, non-contacting radar technology combined with multi-spot temperature measurement reduces measurement uncertainty for improved mass balance calculations
		 **Rosemount 3308 Wireless Level Transmitter - Guided Wave Radar, Rosemount 5302 Level Transmitter – Guided Wave Radar and Rosemount 5408 Level Transmitter - Non-Contacting Radar -** - ideal to replace mechanical float and tape tank gauging for smaller storage tanks or in tanks where custody transfer accuracy is not required - high precision, maintenance-free radar technology combined with spot temperature measurement reduces inventory measurement uncertainty for improved mass balance calculations
		 **Rosemount TankMaster™ Inventory Management Software -** - off-the-shelf Windows™-based inventory management software package that collects real-time tank gauging data such as level, temperature, water interface level, and pressure - automatically calculates volume and mass for inventory and custody transfer for bulk liquid storage tanks according to API and ISO standards - provides simple integration to a host system that is custody-transfer certified with batch-transfer handling and mass-balance reporting
		 **Rosemount 3051SAM Scalable ERS Measurement Transmitter and Rosemount 3051SAL Level Transmitter -** - Rosemount DP level technologies deliver an unsurpassed product offering that improves performance, simplifies installation and provides more insight into level measurements - ideal for taller vessels and distillation towers - provides a 90% reduction in response time and reduces measurement error in extreme ambient temperature swings
		 **Micro Motion Coriolis Meters -** - measures mass directly, along with density and temperature, to significantly improve the accuracy of both mass and volumetric flow measurements – independent of composition changes - two-phased flow capability reduces measurement error

GOAL: IMPROVING PLANT AND OPERATING UNIT MASS BALANCES, CONTINUED

Issues	Solutions	Featured Products
Frequent billing disputes with suppliers or customers	Improve custody transfer measurement accuracy for liquid, gas, or slurry	 **Rosemount 5900S Radar Level Gauge, Rosemount 2410 Tank Hub, Rosemount 2240S Multi-input Temperature Transmitter with Rosemount 565 Multiple Spot Temperature Sensor -** - provides the best level custody transfer measurement accuracy for tank volume and mass - high precision, maintenance-free, non-contacting radar technology combined with multi-spot temperature measurement reduces measurement uncertainty for improved mass balance calculations
		 **Rosemount 3051SFC Compact Orifice Flow Meter-** - reduces the risk of measurement errors by retrofitting an existing DP transmitter with an upgraded DP flowmeter - optimizes performance by eliminating impulse lines to improve the accuracy and repeatability of flow measurement
		 **Micro Motion Coriolis Meters -** - measures mass directly, along with density and temperature, to significantly improve the accuracy of both mass and volumetric flow measurements – independent of composition changes - two-phased flow capability reduces measurement error

GOAL: IMPROVING DATA COLLECTION & ACCURACY

Issues	Solutions	Featured Products
Incorrect production accounting and inadequate data reconciliation tools	Use data reconciliation software to validate and reconcile measurement data	 **Aspen Unified Reconciliation and Accounting (AURA)™ Software -** provides a comprehensive solution that helps validate and reconcile data and quality of field measurements for custody transfer and overall plant mass balance
Manual process measurements and data entry that create errors in mass balance calculations	Evaluate current mass balance practices and data gathering	 **Facility-wide/Process Unit Mass Balance Consulting Study -** evaluates existing measurements and procedures against industry applicable standards and best practices. Provides recommendations to improve the mass balance and reduce the financial risk associated with losses
Inaccurate sustainability statements caused by inaccurate traceability and chain of custody standards not being met	Improve measurement accuracy and monitor the health of critical devices	 **Micro Motion Coriolis Meters -** - measures mass directly, along with density and temperature, to significantly improve the accuracy of both mass and volumetric flow measurements – independent of composition changes - two-phased flow capability reduces measurement error
		 **Rosemount 5900S Radar Level Gauge, Rosemount 2410 Tank Hub, Rosemount 2240S Multi-input Temperature Transmitter with Rosemount 565 Multiple Spot Temperature Sensor -** - provides the best level custody transfer measurement accuracy for tank volume and mass - high precision, maintenance-free, non-contacting radar technology combined with multi-spot temperature measurement reduces measurement uncertainty for improved mass balance calculations
		SMART METER VERIFICATION **Smart Meter Verification -** identifies the meter's health and determines if there have been any calibration shifts

GOAL: MINIMIZING MEASUREMENT ERRORS

Issues	Solutions	Featured Products
Unreliable instrumentation used to measure important incoming and outgoing product streams	Monitor the health of measurement instrumentation	SMART METER VERIFICATION **Smart Meter Verification -** identifies the meter's health and determines if there have been any calibration shifts
Difficulty converting volumetric measurements of product streams with varying composition to mass measurement	Continuously measure product composition via density measurement	 **Micro Motion Compact Density Meter (CDM) and Micro Motion Fork Density Meter (FDM) -** - provides precision liquid density and temperature for custody transfer and concentration measurements - combine with existing liquid volumetric flow meter to cost effectively improve both the volumetric and mass flow measurements
		 **Micro Motion Gas Density Meter (GDM) -** - update existing gas volumetric flow meters to improve both the volumetric and mass flow measurements with real-time gas density measurement; this can be a cost-effective way to significantly improve mass balance measurements - designed for fiscal metering, the GDM direct gas density measurement is compliant with AGA 3 and ISO 5167
Infrequent or erratic instrument calibration practices	Regularly monitor measurement instrumentation health	SMART METER VERIFICATION **Smart Meter Verification -** identifies the meter's health and determines if there have been any calibration shifts

Measurement Instrumentation

The broadest range of measurement and analytical technologies for the chemical industry.

To learn more about Emerson's solutions for the chemical industry

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