MILTON ROY

Criteria for Evaluating a Metering Pump's Turndown with Steady-State Accuracy

The chemicals used in water treatment, chemical manufacturing and other oil & gas processes are dosed via metering pumps – which are specifically designed for precise accuracy, within ± 1.0%.

Often times plants don't specify pumps and account for future scenarios when they specify pumps & pumping systems. Municipal water treatment plants might be built with expansion in mind (to account for population growth), while seasonal or cyclical operations such as refineries need flexibility to dial back production if demand declines. For various reasons, metering pumps need the ability to alter flow (and still maintain precise accuracy) as process conditions change. Turndown is an important specification that defines a metering pump's output.

What is Turndown?

Turndown is expressed as a ratio of a pump's output. If a metering pump is capable of 1,000 GPH maximum and it has a 1000:1 turndown ratio, then it can be adjusted to a flow rate as low as 1 GPH and it should still be expected to perform within its accuracy rating.

Why is Turndown Necessary?

Multi-stage processes require different volumes of different chemicals at different times:

For **municipal water treatment**, activities such as coagulation & flocculation; pH control; de-chlorination; disinfection, and various measures for taste and odor control require different chemicals that must be dosed in various combinations. The precise mix of chemicals is critical. Over-treating water is wasteful and expensive, while under-dosing chemicals in processes like disinfection could potentially harm people.

Turndown is important because the volume and quality of the incoming water can vary on a daily basis. Treatment plants located on rivers need flexibility to deal with storms that bring mud and sediment, while those on large lakes with smaller variations in turbidity may only require minimal dosage changes. Seasons also prompt demand for turndown because some chemicals lose concentration in higher temperatures.

In **chemical processing**, accuracy, flow repeatability and turndown are critical, because catalysts and polymers must be dosed at precise quantities in order to create the unique chemical bonds needed to manufacture plastics, pharmaceuticals and so many other products. These processes scale up and down regularly (to accommodate demand) so pumps must be flexible to scale up and scale back as needed.

Few industries see demand spikes and declines on the same order of magnitude as **Upstream Oil & Gas Producers**. The flow assurance chemicals (delivered by metering pumps) that keep well-heads flowing are very expensive, and they are usually stored onsite in high concentrations. During periods when the price of oil remains below the break-even point for some producers, flow assurance chemicals represent an opportunity for cost-cutting – so the ability to ensure their efficient distribution is critical, and metering pumps' turndown capabilities facilitate this efficiency.

MILTON ROY

Turndown Marketing Myths:

Highly questionable claims have been made in recent years regarding turndown for different pumping technologies, and their ability to act as metering pumps. In a “more-is-better” world, some manufacturers boast incredible turndown capabilities (as high as 1,000,000-to-1) relative to the pump’s maximum flow rate, and not its actual set point. What does this really mean?

Turndown ratios that aren’t expressed relative to set point can be useless – as any pump’s potential turndown can be described as infinite, in that it can operate from maximum flow to no flow at all. Figure 1 illustrates the flaws associated with describing turndown relative to maximum flow rate.

Turndown from Maximum Flow Rate

Pump Capacity Setting	100%	10%	1%	0.1%
Expected Flow	1000 GPH	100 GPH	10 GPH	1 GPH
Allowable Deviation vs Max Rating	±10 GPH	±10 GPH	±10 GPH	±10 GPH
Potential Deviation from Set Point	1%	10%	100%	1000%

Figure1: Pump with a 1000 GPH Max Capacity, featuring 1000:1 Turndown, at ± 1.0% accuracy

In this example, the pump can vary 1%, or 10 GPH at any setting. At lower flows, the margin of error increases to the point where the pump is no longer accurate. When operating at 1 GPH, this pump could deliver anywhere from 0 gallons to 10 gallons (±10 GPH) and still technically be within the manufacturer’s claim of 1% accuracy (from Max Flow rating).

Steady State Accuracy from Set Point

When the accuracy rating is based on set point, it will not matter what capacity the process requires over the pump’s turndown ratio. Figure 2 illustrates the difference in potential deviation when a pump’s turndown with steady-state accuracy is expressed in terms of the pump’s set point:

Turndown Expressed Relative to Set Point

Pump Capacity Setting	100%	10%	1%	0.1%
Expected Flow	1000 GPH	100 GPH	10 GPH	1 GPH
Allowable Deviation from Max Rating	±10 GPH	±1 GPH	±.1 GPH	±.01 GPH
Potential Deviation from Set Point	1%	1%	1%	1%

Figure 2

The difference is clear – particularly at lower flows. At minimum capacity settings (1%) where 1 GPH is expected

- The maximum actual allowable flow would be 1.01 GPH
- And the minimum actual allowable flow is 0.99 GPH.

What Does High Turndown Really Mean?

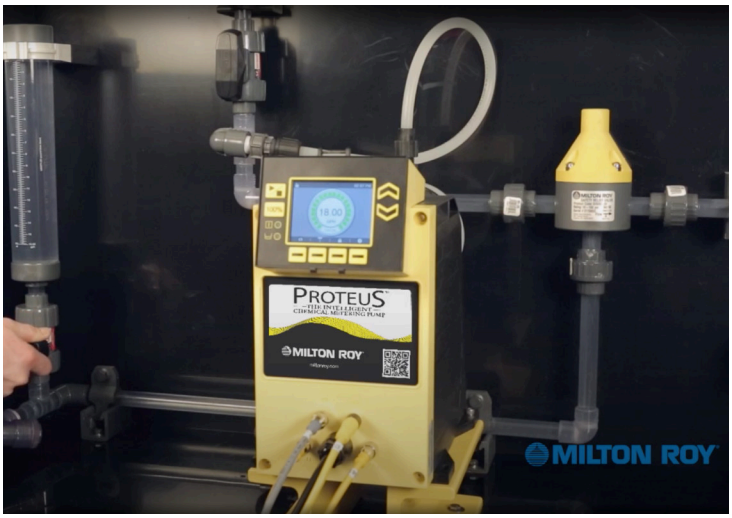
For this example, consider a pump rated for 100 GPH:

- At **10-to-1** turndown, the pump provides excellent performance across 90% of the pump's maximum range (between 100 GPH and 10 GPH).
- At **100-to-1** turndown, the range is extended to 99% of the pump's range (100 GPH to 1 GPH). The jump from 10-to-1 to 100-to-1 sounds like a 10-fold increase, but it only increases the usable range by an incremental 9% of the pump's full capacity.
- At **1000-to-1** the incremental increase is almost negligible, at just 0.9%: (100 GPH to 0.1 GPH). While 1000-to-1 could be marketed as a 10-fold increase over a 100-to-1 ratio, it actually only increases the turndown range (in this example) an additional 0.9 GPH, or 0.9% of full capacity.

How Much Turndown Does a Process Need?

Engineers need to answer this question when designing a process. One of the reasons they prefer high turndown ratios is that it can make up for variations or errors in dosage calculations.

While there is nothing wrong with acknowledging this possibility, it should be noted that most municipal and industrial processes only require 10-to-1 turndown. In general, applications specifying the need for greater than 100-to-1 turndown raise the possibility that the pump will be oversized – which means it will not be operating at its best efficiency point (BEP). This not only loses efficiency, but it could also decrease the Mean-Time-Between-Maintenance (MTBM) intervals.



How is Turndown Best Measured?

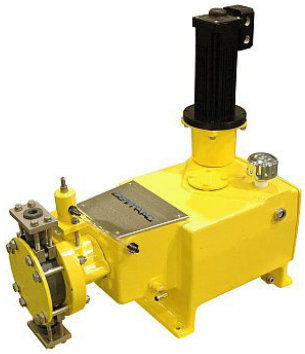
Calibration columns and flow meters provide a simple way to measure turndown – usually within a range of 100-to-1. But verifying steady-state accuracy at ratios of 1000-to-1 is best accomplished in a controlled setting at a manufacturer's testing facility.

Milton Roy validates the turndown of its metering pumps based on solid designs, 10 point curves (which validate output at 5 descending flow rates, 5 ascending flow rates, with comparisons between the two), and a host of other verifiable testing methods.

These methods are verified by independent third parties, such as the Hydraulic Institute ANSI/HI standard for Controlled volume Metering Pumps and the American Petroleum Institute standard API 675.

Metering Pumps Designed for Turndown with Steady State Accuracy

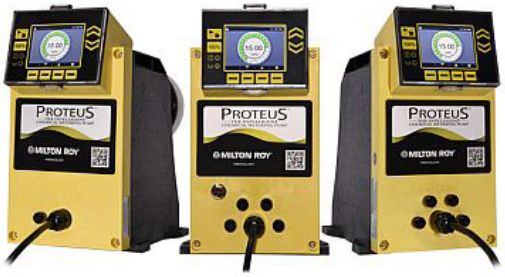
Two Options to Address any Metering Pump Need



For Large Scale Water Treatment, (20 million GPD or more) CENTRAC™ metering pumps are specifically designed to combine performance, accuracy, responsiveness and longevity. The Hydraulically Actuated Diaphragm design complies with API-675 standards, and is built to run reliably in large municipal water treatment plants or industrial wastewater facilities for decades with minimal maintenance.

CENTRAC pumps combine a constant stroke length drive mechanism with electronic variable speed drive technology and precise feedback signaling. Milton Roy's unique drive system delivers steady state accuracy of +/- 0.5% over a turndown range of 100-to-1, offering twice the accuracy of most metering pumps. A unique helical gear arrangement is specifically designed to minimize wear on the gears at lower speeds, ensuring consistent accuracy for years. With more than 25 years of proven reliability in the field, CENTRAC brings efficiency and tight controls to any chemical dosing process.

CENTRAC's flow ranges between 0.45 GPH, up to a maximum of 1,482 GPH, with discharge pressures reaching up to 9,000 psi (620 Bar) – and the pumps are also designed for duplex configurations. Additional specifications are available at miltonroy.com.



For non-API environments, the Mechanically Actuated Diaphragm PROTEUS® line is designed for intelligent sensing, immediate feedback, convenient navigation and communication in five languages (English, French, Spanish, Portuguese and Chinese).

Based on a proven design, PROTEUS is one of the newest and most advanced metering pumps ever built. The new Communications Model adds support for Modbus RTU and Profibus (Process Field Bus) DP protocols to facilitate high speed, 2-way communications – which allows plant operators to link devices from different vendors to a central SCADA (Supervisory Control And Data Acquisition) system for control, monitoring and troubleshooting activities.

PROTEUS is designed to effectively and affordably address municipal water and wastewater treatment applications, plus a wide range of chemical dosing applications in the agricultural, chemical, power generation, pulp & paper, food & beverage and textile industries.

PROTEUS pumps can deliver up to 53 GPH (201 LPH), and the innovative drive system achieves 1000:1 turndown with +/-1% steady-state accuracy. Additional specifications are available at miltonroy.com.

MILTON ROY

Summary

Turndown claims that cannot be verified provide very little benefit to the process. A professional metering pump company rates the turndown of its products based on solid design and verifiable testing methods. In tests, every pump manufactured should be verified at its published turndown ratings while maintaining repeatability and steady state accuracy.

The three questions that need to be asked related to turndown are:

1. What turndown does the process really require?
2. If it exceeds 100-to-1, what is the best and most efficient way to address it?
3. Will the pump selected provide the turndown needed with the accuracy expected, regardless of pressure fluctuations and the age of the equipment?

Pumps purchased based on non-validated turndown claims (which aren't even required by most processes) bring with them a number of ripple effects:

- Different pump designs require different maintenance. Peristaltic pumps, for example, often require hose replacements every few months (or even every few weeks), depending on the process.
- A true metering pump can run for years without maintenance: Hydraulically Actuated Diaphragm pumps have design life ratings as high as 96,000 hours (which is almost 11 years running 24/7).
- True metering pumps cost less over their total lifespan.
  - Residents should expect such performance from their local municipal water treatment plants.
  - For API environments, cost is not (nor should it be) one of the top criteria, given the cost-of-failure and the safety protocols that must be adhered to in refineries and petrochemical plants.
- Steady-state accuracy and repeatability assure accurate dosage – which leads directly to reducing chemical usage, while maintaining chemical treatment performance in the process. In potable water, for example, this assures compliant water in the distribution system. Only a true controlled-volume metering pump provides the performance required for this level of process integrity.

Different metering pump manufacturers describe the notion of turndown in different ways. By evaluating the criteria used to specify and purchase true metering pumps, operators can be assured they are bringing safety, reliability and validated steady-state accuracy to their process.

For more information, please visit: www.miltonroy.com