MANSCO PRODUCTS

Why "in-line"?

Viscosity is a rheological property . . . meaning a property involved with the deformation of flow. The key word is flow. The best location to measure and control a property of the flow is within the flow itself . . . not along side the flow (a sidestream) and not in a laboratory. The measurement and control of viscosity (and temperature) directly in the flow provides real time rheological data . . . no lag time and no process delays. In the end, plants will achieve the highest process efficiency while improving product quality.

TOV Viscometer System™ by MANSCO PRODUCTS

The TOV Viscometer System . . . what is it?

The Mansco Products TOV Viscometer System is a process viscometer designed and built for in-line use. It is the most sensitive, stand-alone control device for measuring viscosity and temperature in an in-line environment. It is unlike capillaries or laboratory viscometers in that the TOV is installed directly into the main process pipeline . . . no sidestream is needed. It is unlike any other viscometer because of its sensitivity, repeatability, robustness, and low maintenance requirements. And, Mansco Products provides installation, training, and comprehensive support services. In other words, the TOV System is the most effective process viscometer available and the TOV System has no peer.

What's Inside:

Why the TOV? . . . why is the TOV Viscometer System so much better?

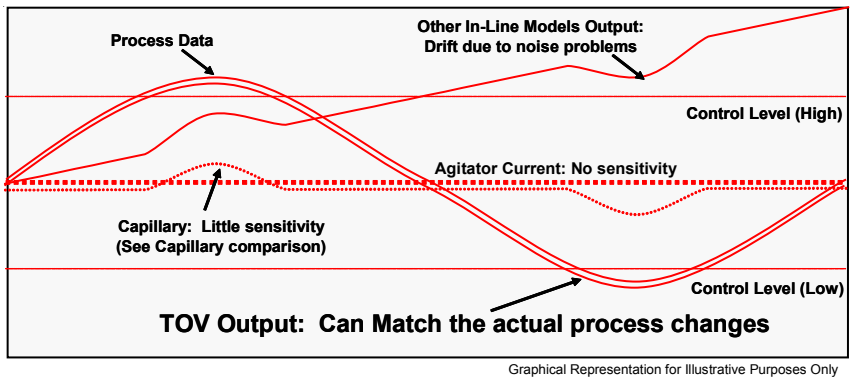
Quite simply, the engineering and "know-how" incorporated into each TOV System is what makes the TOV better. For example, the TOV operates at a low shear rate. By definition, viscosity is the ratio of shear stress to shear rate. In turn, the TOV measures shear stress of the process fluid to determine the process viscosity. Sounds easy, right? . . . Well, it's not that simple. The instrument must be engineered and designed to withstand the harsh operating environments of process lines while providing high sensitivity and repeatability levels for very reliable process control . . . all while eliminating the effects of the plant environment. The TOV does just that.

- Reliability & Repeatability: With a repeatability factor of over 99.5%, the TOV produces the same results over and over again, day after day, week after week, year after year.

- Very User-Friendly: After initial set up, the TOV requires little or no maintenance . . . including calibration.

- Durability: The TOV System is very durable. Many TOV's have been installed in pipelines for a decade or more without interruption.

- Lab-Like Results in Real-Time: The TOV is designed so the customer can measure viscosity and temperature within range and within the target viscosity level.

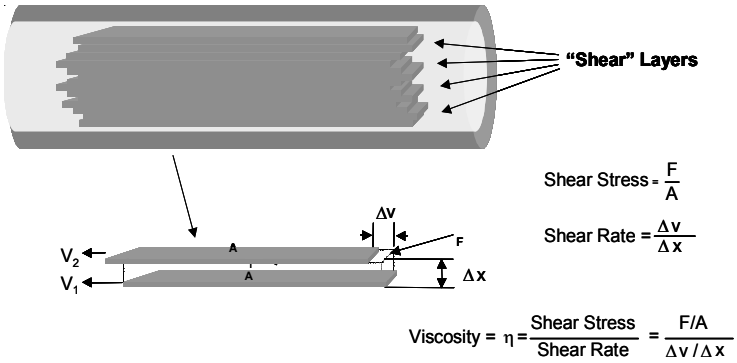


Graphical Representation for Illustrative Purposes Only

What is viscosity and why is it so important?

"All fluids possess a definite resistance to change of form and many solids show a gradual yielding to forces tending to change their form. This property, a sort of internal friction, is called viscosity; it is expressed in dyne-seconds per cm^2 or poises."* In terms of physics, viscosity is the ratio of shear stress to the shear rate. The viscosity of a polymer decreases as shear rate increases. This property is referred to as pseudoplastic behavior or shear thinning.

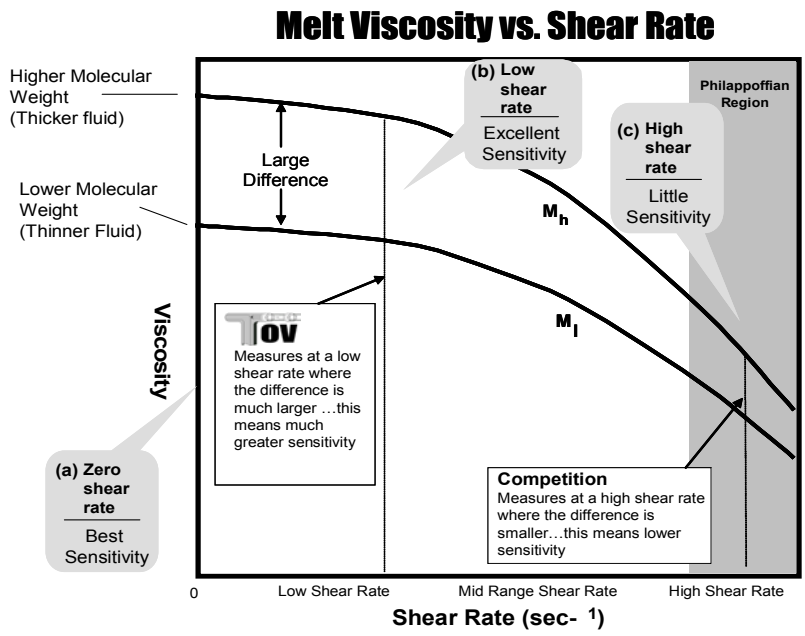
Viscosity is a rheologic property. Rheology is the science of deformation and flow of materials. Viscosity is just one of the many important rheological properties. Because of this inter-relation, viscosity can be used as an indirect measurement of properties such as crystal concentration, and other important properties. In other words, with the accurate measurement of viscosity, plants can tightly control thier entire process flow.



*CRC Handbook of Chemistry and Physics, 62nd Edition, Copyright 1981-82, pg. F-40, CRC Press.

More About Shear Rate:

Intrinsic Viscosity, Shear Rate, & the TOV Viscometer System

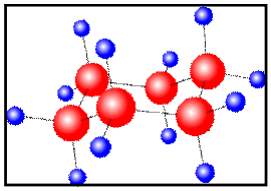


In a condensation polymerization process the material exits the "finisher" and moves slowly toward spinning with a shear rate of less than 10 sec^{-1}. To obtain the most reliable viscosity measurement apparent viscosity at different shear rates should be analyzed.

At low shear rates the viscosity remains near η_0, sometimes referred to as the intrinsic viscosity. But as the shear rate of measurement increases, the apparent viscosity drops until reaching another asymptotic plateau , called the Philappoffian region. The reason for the decrease of apparent viscosity with increased shear rate is not all segments of a molecule can respond to the more and more rapid motion of the measuring device. This is demonstrated in the accompanying curve "Viscosity vs. Shear Rate."

The TOV Viscometer System (TOV) measures viscosity well before the Philappoffian region, at much lower shear rates where the measurement of viscosity is much more significant. With its unsurpassed sensitivity at its operating shear rate, the TOV provides much more effective results on a more repeatable basis.

TOV Applications



The general rule is that: "If the fluid can be pumped, then it can be measured using the TOV System. Applications include, but are not limited to:

Polyester
Nylon
Acrylic
Polyethylene
Polyurethane
Polypropylene
Polycarbonate
Polysulfone
Spandex
Glass Fiber
High Viscosity
Special Polymers

Please note: Each TOV System is custom designed to meet each applications needs and specifications. The TOV sensor is selected and designed for optimal viscosity measurement while the Transducer is calibrated for optimal narrow ranges within the product specifications.

MANSCO PRODUCTS

The Key Components of the TOV Viscometer System

The TOV Probe

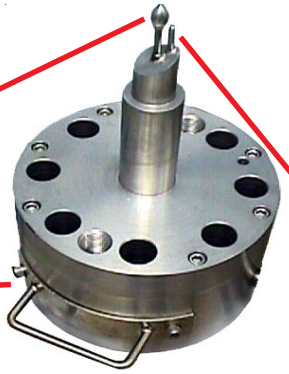
The superior design of the TOV Probe provides the most sensitive, accurate, and reliable viscosity measurement in the world.

The Probe's Sensor

The TOV Probe's sensor incorporates over 40 years of experience and know-how. The sensor is designed for minimal flow disruption while providing the most sensitive and reliable viscosity results.

Mass Flange

The Probe's massive flange provides a reference so that plant influences are eliminated.



Safety

TOV Probes models are approved for Class 1, Division II, Group A,B,C,D service by Entela and UL.

TOV Probe's Construction

The superior engineering and design incorporates decades of field and engineering experience leading to today's unmatched know-how. Each TOV Probe is custom designed to provide the most effective and reliable results on a repeatable basis.

Platinum RTD Element

The built-in Platinum RTD provide a very accurate temperature reading at the point where temperature is most significant . . . where the viscosity is measured.

Probe's Interior and Torsional System

The TOV Viscometer System operates utilizing the torsional principal. Each TOV Probe incorporates the most advanced engineering . . . from the torsional elements to the pickup to the electromagnets.

The TOV Transducer

The TOV Transducer makes up the electronic component of the TOV System. It supplies power to the probe, receives probe signals, and conditions these signals before outputting as 4-20mA signals..

Conditioned Signal

To reduce noise influences from the pipeline operation, the signal from the Probe is conditioned in the Transducer to provide a steady, distortion free signal.

Four Isolated Signals

- Compensated Viscosity
- Uncompensated Viscosity
- Broad Range Temperature
- Compensating Temperature

Pressure Compensation (optional for Model TOVL)

Pressure compensation is available to eliminate pressure influences caused by pipeline pressure changes (such as filter or pump changes).

Front Panel Access

All Transducer settings are made via the front door panel access.

On-line Probe Checks

Operational Probe Checks are included that allow for the testing of the Probe and Transducer functions without removal in the field making process troubleshooting simpler.

Power Checks

Model SC-03 Slide Chassis provides automatic and manual checking of all power supplies during TOV System operation. Also included is a true differential meter for making voltage measurements.

The TOV Adaptor

The TOV Adaptor, designed specifically for the Probe, is machined for a smooth interior transition between the Probe and Adaptor, minimizing build-up and disturbances.

Experienced Design

The Adaptor is designed based on customer and process specifications using the years of experience of Mansco engineers. Even if Adaptor drawings for customer manufacture are purchased in place of a Mansco built Adaptor, the same detail and experience are used to ensure the high quality of the TOV System.

Minimal Flow Disruption

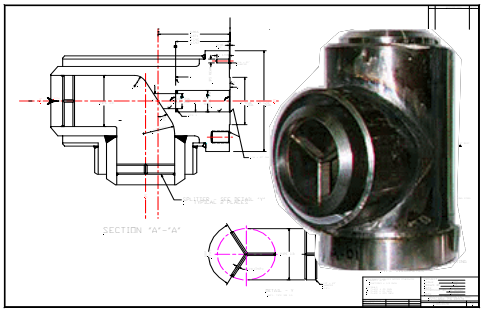
The Adaptor's specially machined internal contour allow smooth flow characteristics and minimized pressure drops.

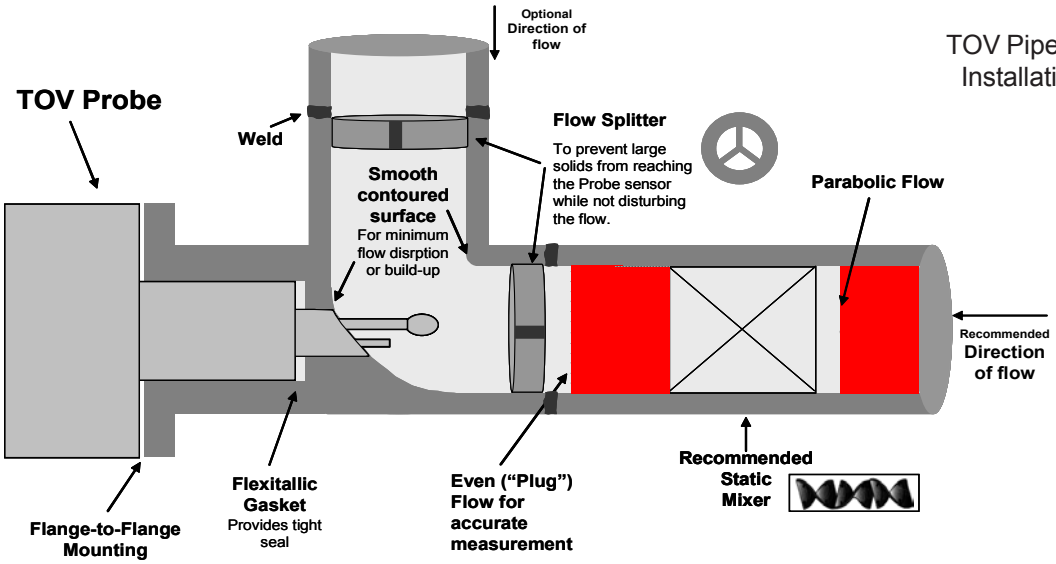
Any Core Pipe Size or Schedule

From the 1" unjacketed pipelines used in research and extrusion to the 8" jacketed pipeline adaptor (shown at left) used in CP's, the Adaptor can be designed for any core pipe size.

Flow Splitter

Special flow splitters are used for protection of the Probe.





TOV Pipeline Installation

TOV Installation:

Where Should the "TOV" Be Installed?

TOV Systems are custom designed. Characteristics of the process fluid, the Probe's installation location, and other specifics are important considerations:

Probe Location:

The most common pipeline installation of a TOV Probe is in a pipe elbow. Straightline locations are also acceptable. In either, the Probe is installed into the main process pipeline and in a location where viscosity control can take place as possible.

In vessel installations, the Probe is often located in a recycle line (pipeline installation) or into the vessel itself near the exit.

Features of note:

Adaptors are designed for minimal disruption to the process flow. The contours of the Adaptor are engineered and machined to match the pipeline. The Adaptor incorporates safety features such as the Flow Splitters to protect the TOV Probe.

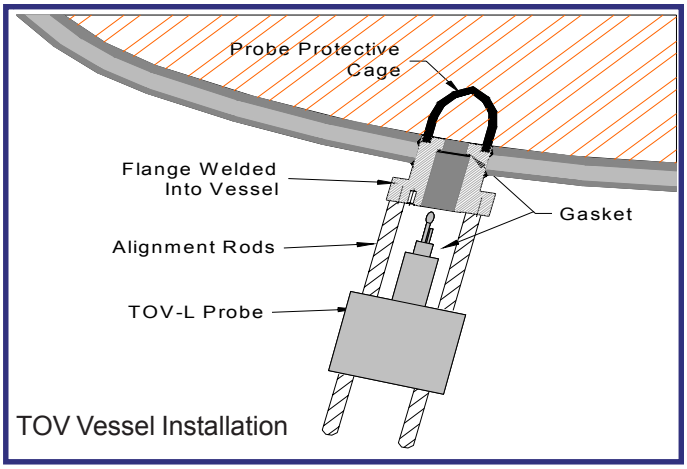
Homogenous Flow:

Fully developed, well mixed flow is an important consideration for any in-line measurement such as viscosity, temperature or pressure. In installations where the Probe will be considerably away from a mixing action (pump, static mixer, etc..), a new location or the addition of a mixer should be considered.

Integral Part of the Pipeline:

Once the Probe is installed, it becomes a part of the pipeline or vessel. It should be heated the same as the process with no outside cooling.

Adaptors are designed for all sizes, from small pilot lines to large vessels. Mansco's years of experience and know how provide the best design and ultimate success of the TOV System.



TOV Vessel Installation

What we need to know about your product and process

Because each TOV System is customized for each process and installation, we need to understand your product(s) and process.

For product information, product family (polyester, nylon, etc.) and target viscosity & temperature range are important considerations when designing and manufacturing a customized TOV .

For process information, data for the polymerization process method (CP, autoclave, etc.) and operating pressure range are important TOV considerations.

For TOV Adaptor design, whether we make the Adaptor or the customer manufactures locally, the pipeline specifications are needed. The core pipe size, schedule and materials of construction are important considerations. And, if the a jacket is present, the jacket specifications are needed.

Finally, to ensure proper location of the TOV Probe installation, we need your hellp by providing a sketch or even pictyures of the process with available locations for Probe installation. This is even more important in vessels where agitators are present. With your help, we can work together to select a location where the Probe can be successfully installed to produce the results you expect.

For more information, please contact:

TOV Viscometer System™

MANSCO PRODUCTS

34 Richard Road
Ivyland, Pennsylvania 18974
United States
Telephone: +215.674.4395
Fax: +215.674.4396
http:\\www.ManscoProducts.com