

tov viscometer system focus

Value Considerations

The TOV Viscometer System (TOV) is the only viscometer with sensitivity to allow precise control that can provide proportional unity gain (one-to-one). Thus, the TOV is the best device to control the final polymerization vessel. For plant managers and process engineers, this translates into value:

IMPROVED PRODUCT QUALITY

The TOV provides the most sensitive and reliable results and, as part of the feedback loop, rheological properties are controlled . . . resulting in improved product quality.

IMPROVES PROCESS EFFICIENCY

Viscosity measurements are direct on a real-time basis. Lab tests are reduced, no delays in process time . . . any way you look at it, the TOV helps improve process efficiency.

REDUCES HUMAN ERROR

The TOV, as part of the control loop, reduces manual or operator control resulting in substantial reductions in human error.

REDUCES SCRAP

Improved product quality combined with improved process efficiency and less human error translates into better product with less scrap, for less money.

SAVES TIME

With direct in-line viscosity on a real-time basis and significant reduction in lab tests, the TOV saves valuable process time. (i.e., no process delays)

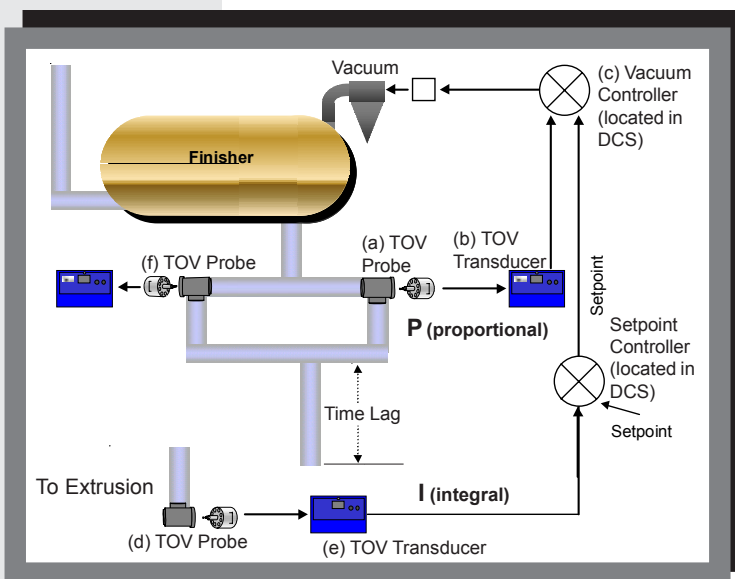
SAVES MONEY

The TOV Viscometer System's effective results are reflected on the bottom line . . . better product for less money.

Control Feedback & the TOV Viscometer System

The TOV Viscometer System (TOV) is a vital link in the control loop so that a 1% change in the vacuum range results in a 1% change in the viscosity reading . . .
. . . a unity gain in the control feedback loop.

The Mansco Products TOV Viscometer System illustrated as part of a PID control loop. Please refer to the diagram for the description, below:



This process illustration is a sample portion of a typical continuous polycondensation process (CP) from the final stages of polymerization to just before extrusion.

P (proportional action):

The first TOV Probe (a) is installed in-line directly after the finisher. The TOV Probe's sensor transmits a signal to the first TOV Transducer (b). The TOV Transducer then transmits the signal to the Vacuum Controller (c). The Vacuum Controller compares the set point with the transmitted signal and produces an error signal for precise vacuum (viscosity) control.

I (integral action):

A second TOV Probe (d) is installed in-line at a location close to extrusion. Although the principal functions of the 2nd TOV Probe are for viscosity control (at the point closest to extrusion) and to monitor

thermal degradation, it also provides the integral action (*I*) in the control feedback loop. As with the *P* Action, the TOV Probe transmits a signal to the second TOV Transducer (e). The second TOV Transducer then transmits the signal to the Vacuum Controller (c). The Vacuum Controller compares the signal for the time duration, or integral of time, to the set point for the *I* Action. This *I* Action acts as a "macro" adjustment for the unity gain (*P* Action) and provides even more process control.

Note: (1) The third TOV Probe (f) & TOV Transducer are installed for in-line reference and as an operating spare, thus assuring optimal process control at all times. (2) The Derivative Action (*D*) of a PID controller is not required and is typically not used in slow moving processes.



The PID Control Feedback Loop

... a closer look

Other Points to Consider

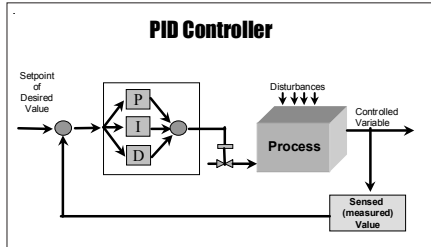
(1) A single TOV Probe installed directly after the finisher is a very effective control device for the final polymerization vessel (the finisher) by allowing unity gain with the vacuum.

(2) For the most effective TOV results, Mansco Products highly recommends a homogeneous flow at the point where viscosity is measured (i.e., eliminate the parabolic flow). A Mansco Products process technician can help provide alternatives and solutions.

(3) The TOV Probe measures viscosity at a low shear rate which provides greater sensitivity in molecular weight change and, thereby, providing the most effective and reliable viscosity reading possible.

(4) The recommended TOV Viscometer System for a typical CP includes 3 TOV Probe and Transducer installations. The 2nd and 3rd TOV Probes are used for viscosity and thermal degradation control, a built-in reference and in-line spare, respectively.

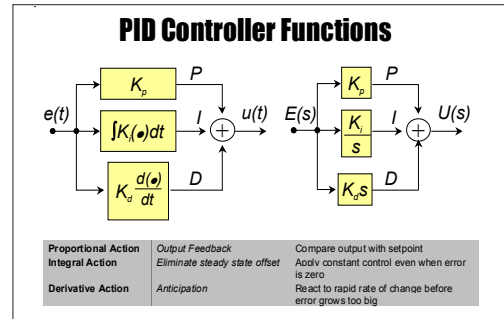
(5) The TOV Viscometer System (TOV) is the only viscometer with sensitivity to allow precise control that can provide proportional unity gain (one-to-one). Thus, the TOV is the best device to control the final polymerization vessel.



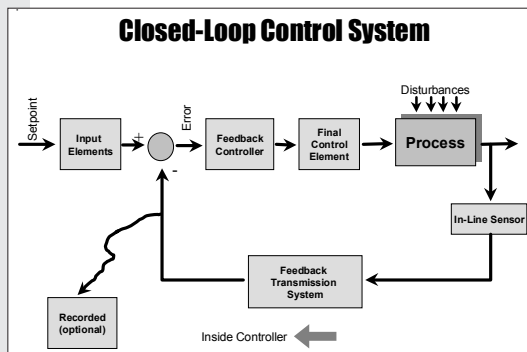
Graphical representation of a typical PID controller.

When properly installed into a control loop for the final polymerization vessel (the finisher), the TOV Viscometer System (TOV) will provide the Proportional Action in a single-mode proportional control and the Integral Action of a double-mode PI control. As a result, the TOV Viscometer System becomes an integral control device in the polymerization process.

The TOV is the most effective and reliable device available for measuring viscosity in an in-line environment. The TOV provides the most sensitivity at low shear rates and operates in extreme environments (up to 350°C, no pressure limit, etc.). But, the benefits do not end there. More important, it can be a vital link in the control loop of a condensation polymer (e.g., polyamide or polyester). The TOV Probe is installed in a location as close to the final polymerization vessel as possible. Then, whatever the vacuum range of the final polymerization vessel, be it 0-5mm or 0-1mm absolute, the sensitivity of the TOV is set so a 1% change in the vacuum range results in a 1% change in the viscosity reading. This procedure will result in a unity gain in the



Graphical representation of the PID controller functions.



Graphical representation of a typical closed loop system.

control feedback loop.

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