

# Density and viscosity systems for oil and petrochemical applications

IP7002

Based around Solartron Mobrey's proven vibrating element transducers, every configuration has been tried and tested. Each one offers significant benefits over other measurement methods.

### **Rugged and reliable**

All Solartron transducers are built for hard work! Unlike other viscosity sensors, they contain no moving parts, require little or no maintenance and infrequent calibration.

### **Accurate , repeatable ...and fast!**

At the heart of the viscosity systems, the 7827 viscosity analyzer provides continuous accurate and repeatable measurements of dynamic viscosity, density and temperature, with a response measured in seconds rather than minutes.

### **Measurements for the real world**

Most viscosity sensors only provide a measure of line dynamic viscosity, but 7827 - in conjunction with a Solartron 795x signal converter/flow computer - provides accurate measurement of:

- ▶ Kinematic viscosity (cSt) at line temperature
- ▶ Base/referred density
- ▶ °API, S.G.
- ▶ Base kinematic viscosity at fixed or variable reference temperatures

Solartron Mobrey's renowned expertise in the on-line measurement of viscosity and density has been harnessed for applications such as:

- ▶ Heavy fuel oil, feedstock and bitumen blending
- ▶ Crude oil viscosity control for pipelines
- ▶ Controlling polymerization
- ▶ Distillation and quench oil applications
- ▶ Deasphalting processes
- ▶ Lube oil production
- ▶ Heavy fuel oil viscosity conditioning for engines
- ▶ Flow meter correction
- ▶ Interface detection

The skids are designed by Solartron and built in partnership with experienced systems constructors to your standards and regulatory conditions.

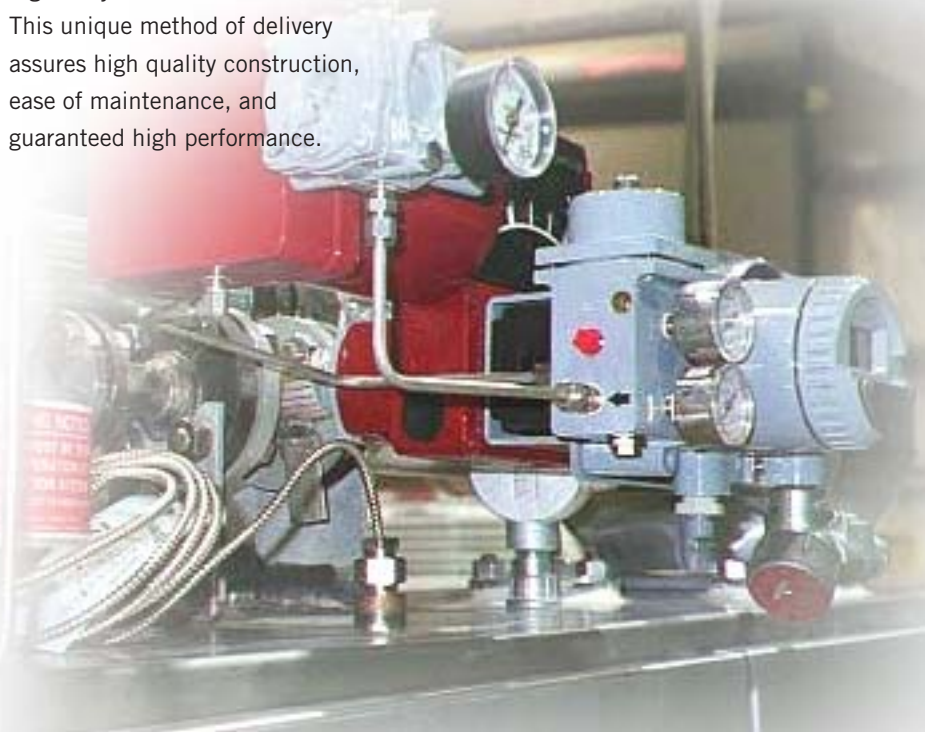
This unique method of delivery assures high quality construction, ease of maintenance, and guaranteed high performance.

### **Closing the loop in process control**

Real-time closed loop processes using viscosity or density as the control parameter are now a realistic and practical solution for a wide range of applications.

Solartron designed skids, customized to meet your specification.

- ▶ Superior product quality
- ▶ Guaranteed performance
- ▶ Rugged construction
- ▶ Minimal maintenance



## Viscosity Systems

The viscosity of a fluid often varies significantly with temperature, making it impractical to use line dynamic viscosity as a consistent control parameter. Virtually all viscosity process standards are expressed in terms of base kinematic viscosity, which takes account of the density of the fluid.

Using viscosity for process control presents several technical challenges:

- ▶ *measuring dynamic viscosity at line conditions accurately enough to provide the precise base viscosity required for process control;*
- ▶ *converting dynamic viscosity to kinematic viscosity;*
- ▶ *deriving base viscosity from line viscosity;*
- ▶ *having a rapid response to changes in fluid composition and temperature*
- ▶ *performing reliably under the arduous conditions usually experienced in the oil and petrochemical industry.*

Solartron's 7827 has been proven to meet all these challenges consistently and reliably, and with virtually no maintenance.



### Base viscosity referral

The simplest method of referral is to bring the fluid to the reference temperature using a heat exchanger on a bypass loop, and measure the viscosity there.

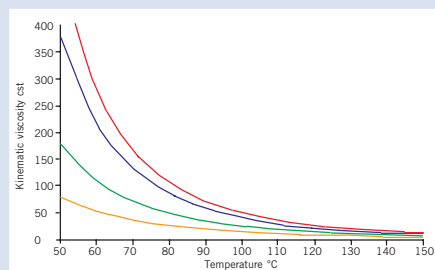
Where this is not practical, Solartron's systems use methods based the ASTM D341 standard, the most accurate available method for relating viscosity and temperature:

$$\log_{10} \log_{10} (n + 0.7) =$$

$$A - B \log_{10} (T + 273)$$

where T is the temperature in °C, n is the kinematic viscosity, and A and B are specific to the fluid.

Previously, no instrumentation was available which could meet the accuracy and speed of response required to utilize the equation for process control. Solartron's methods - proven in the field - have been specifically developed to take



advantage of the unique features of the 7827.

In practice, the application of the equation depends on the variation in composition of the fluid.

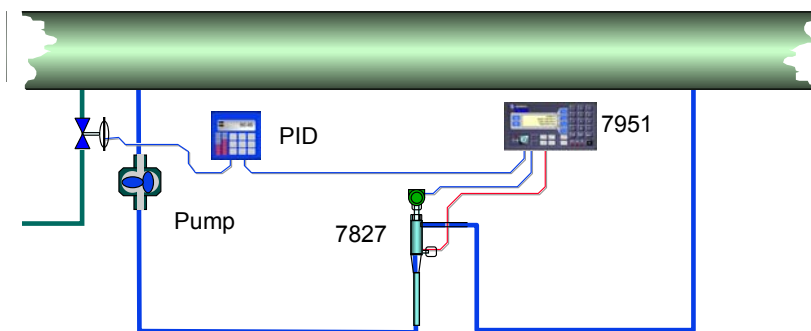
**Equation method:** Where fluid quality is stable, a simple application of the equation (effectively assuming B is constant) is sufficient.

**Multi-curve method:** For more variable fluids (fuel oil blending, for example) a 'map' (A and B values) of the viscosity/temperature relationship for a range of fluids similar to the target fluid is used to derive the base viscosity.

Both the above methods require only one viscosity analyzer, but rely on fluid composition staying within assumed limits.

**Self-calibrating method:** This gives maximum accuracy and reliability, and has the advantage that no assumptions are made about the fluid composition. It uses two independent viscosity analyzers to measure kinematic viscosity at different temperatures; the results are combined to provide a continuous update of A and B.

### Viscosity System 1: Single viscosity analyzer, no heat exchanger



#### Typical applications:

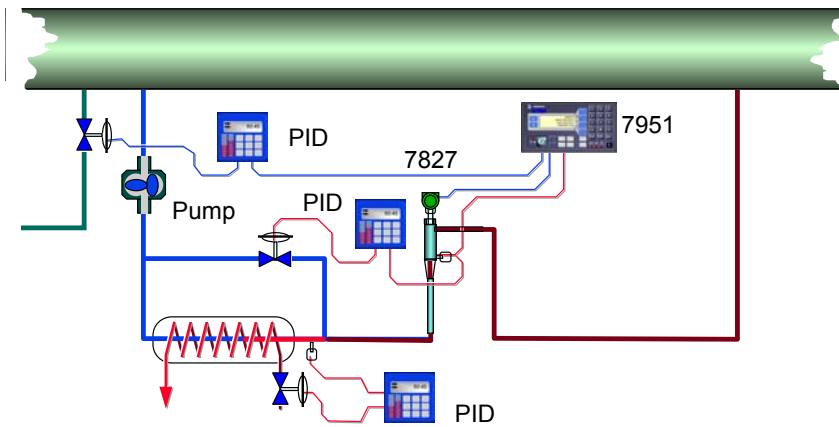
- ▶ *Quench oil control.*
- ▶ *Heavy fuel oil blending*
- ▶ *Bitumen blending*
- ▶ *Multi-product pipelines*

This simple system uses a single 7827 viscosity analyser installed in a constant flowrate bypass or directly into the main pipe line or tank. It can be used for line dynamic or line kinematic viscosity measurement applications, where no referral to base conditions is needed.

Alternatively, referral can be implemented for base kinematic viscosity applications. The equation method is suitable where viscosity varies only moderately with temperature, and product composition is fairly constant. Periodic laboratory testing should be used to validate the value B utilized.

For more variable products, the multi-curve method is used.

## Viscosity System 2: Single viscosity analyzer with heat exchanger, no referral



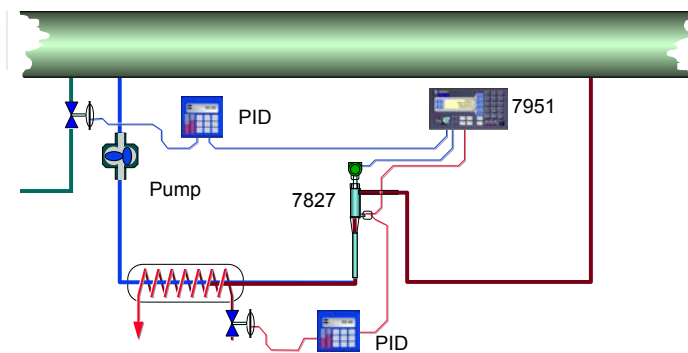
### Typical applications:

- ▶ Direct replacement for process capillary systems
- ▶ Lube oil processing
- ▶ Multi-product pipelines

This system is used where product composition is too variable for simple viscometer referral methods to be dependable. Kinematic viscosity is measured directly at the reference temperature.

The reference temperature at the viscosity analyzer is maintained by controlled mixing of a divided bypass flow, one part of which is heated or cooled by a heat exchanger. This provides a fast and accurate response to changes in fluid temperature, comparable to - and often better than - the best process capillary viscometer and density meter. Temperatures can be maintained to within 1°F at 210°F, and response times are typically less than 60 seconds.

## Viscosity System 3: Single viscosity analyzer with heat exchanger and referral

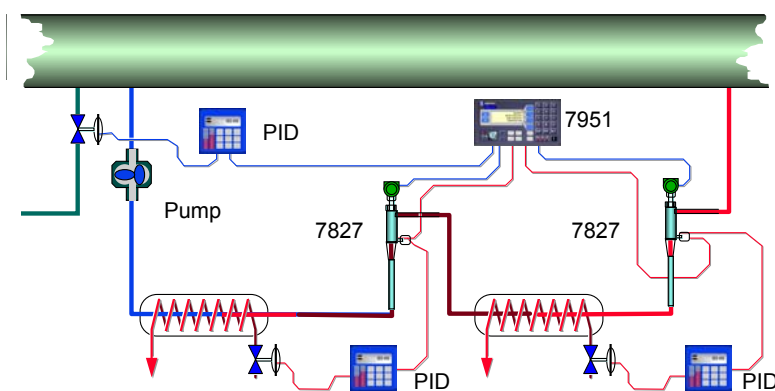


### Typical applications:

- ▶ Bitumens and polymers where the viscosity at line temperature cannot be correlated with the viscosity at reference

This system uses a combination of temperature control and referral to bring the sample temperature within the range of the 7827, and to bring the sample temperature closer to the reference temperature. This reduces base kinematic viscosity inaccuracies in products with a high rate of change of viscosity with temperature. The sample flows through a simple heat exchanger before the fluid viscosity is measured. Temperature control need not be highly sophisticated, since variations are compensated for by multi-curve referral techniques.

## Viscosity System 4: Dual viscosity analyzer, self-calibrating



### Typical applications:

- ▶ Crude oil viscosity control in pipelines with cross boundary metering
- ▶ Where product viscosity and composition vary significantly
- ▶ Where routine laboratory overchecking is impractical

This system is ideal where product composition varies significantly. It uses two independent viscosity analyzers measuring the sample fluid at different temperatures to continuously calculate the A and B values in the ASTM D341 equation.

A direct calculation of base kinematic viscosity using live results from both analyzers gives a rapid response to change. A second, more accurate calculation compensates for the transit time between analyzers.

This method is self-calibrating, and requires no laboratory testing to compensate for composition variations. It is therefore an ideal solution for remote measurement applications.

## Density Systems

### Flowmeter correction

Volumetric flow, measured at process conditions, must be corrected for temperature and pressure effects. Some volumetric flowmeters - such as turbines, positive displacement meters and some ultrasonic meters - also require correction to compensate for meter factor errors caused by changes in the viscosity of the fluid. Most metering installations include a meter correction or analyzer skid containing one or more density transducers to provide density correction to recognised standards. Solartron's metering skids, designed and installed to give optimum performance, may also include a viscosity analyzer.

#### "Achievable Accuracy"

Achievable accuracy is a measure of the product quality that can be realistically obtained from a process system. It is a function of measurement accuracy, stability and system response. High accuracy alone is no guarantee of good product quality if the response time is measured in tens of minutes! Similarly, systems which require constant calibration and maintenance cannot offer good achievable accuracy. With very high accuracy, response times of typically less than one minute, and minimal maintenance, Solartron's systems are uniquely able to provide unsurpassed achievable accuracy.

### Interface detection

In multi-product pipelines the interface between the products must be detected and measured so that diverter valve systems can operate accurately to separate the products and divert them to the appropriate storage tanks.

Density has proved to be an efficient indicator for product identification, and can be implemented using a single density meter.

In some refineries where leaded and unleaded gasoline or different qualities of diesel are to be segregated, two density meters may be used in series in a density difference system.



Based on the proven techniques described in this brochure, Solartron Mobrey will design systems to suit your exact application requirements for viscosity measurement, meter correction or interface detection. Contact us today, and talk to the experts.



Solartron Mobrey is a market leader in the supply of precision measurement solutions for the oil, gas, process, power, and aerospace industries for over 50 years. Part of the Roxboro Group PLC, Solartron Mobrey manufactures a range of transducers and instrumentation for on-line continuous measurement of density and viscosity in liquids and gas which, together with data acquisition products and materials test equipment, have a global reputation for excellence in performance, reliability and support.

Solartron's Quality System is approved to BS EN 9001: 1994, and our Calibration Laboratories are certified by NAMAS.



Certificate  
No FM 1709



Calibration  
No. 0099

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