HALLIKAINEN *Viscometer* *for non-Newtonian fluids*

Analytical Technology & Control Limited

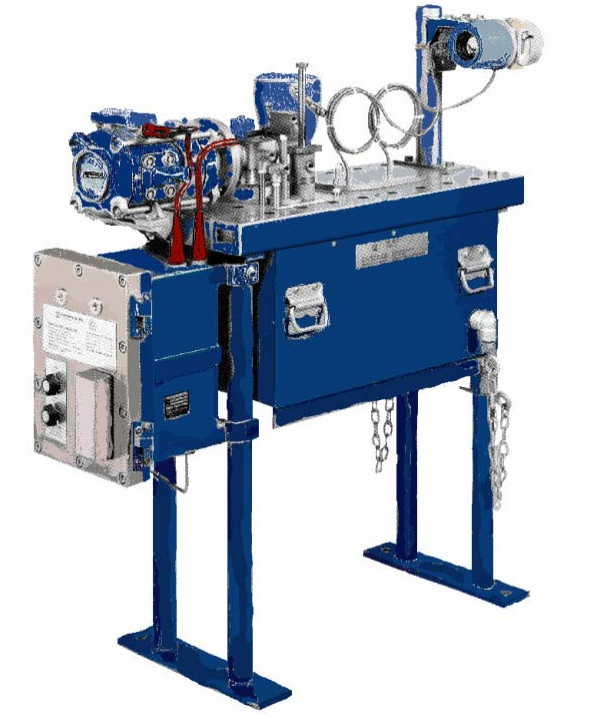
MEASURES THE VISCOSITY OF A HYDROCARBON LIQUID STREAM

The Model 491 large bore Viscometer is a completely automatic process stream analyser for measuring viscosity in absolute units. When used with a density measurement, correlation with ASTM D 445 can be achieved.

TYPICAL APPLICATIONS

The analyser, which utilises a special large bore capillary, makes it suitable for use with highly viscous, **non-Newtonian** samples whose viscosity may be affected by shear rate.

- Lube oil blending
- Fuel oil blending
- Lube oil de-waxing
- Residual fuels
- Distillate fuel product specification
- Visbreaker feed stock



PRINCIPLE OF OPERATION

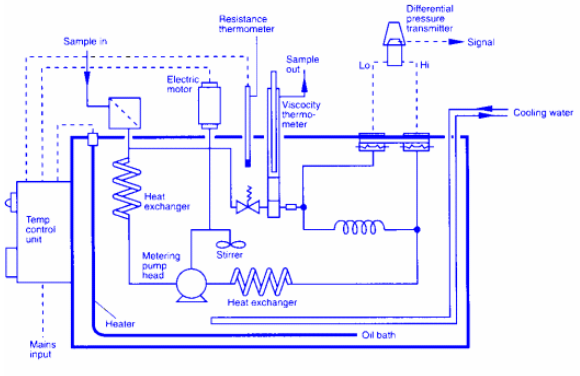
The analyser measures differential pressure across a capillary through which a fluid is passed. The differential pressure is proportional to the absolute viscosity of the fluid as described by the Hagan-Poiseuille equation:

$$\mu = \frac{1.45 \times 10^{5} \times d^{4}P}{QL}$$

where μ = absolute viscosity in centiPoise (cP)
d = capillary bore (mm)
P = differential pressure across capillary (bar)
Q = sample flow (ml/min)
L = capillary length (mm)

As d, Q and L are constants, μ (absolute viscosity) is directly proportional to P (differential pressure measured across capillary).

A precision pump meters the flow of sample. To ensure that the sample metered by the pump is at approximately the same temperature as the sample entering the capillary, two heat exchanges are fitted, one either side of the metering pump. Input pressure is set so that the metering pump suction pressure is always positive.



The sample flows at a constant rate through the capillary, across which a differential pressure transmitter is connected. The transmitter is isolated from the sample by diaphragm seals to prevent obstruction of the impulse lines. The output of this transmitter is then directly proportional to the absolute viscosity of the sample.

The critical components are maintained at a fixed temperature by immersion in an oil bath, the temperature, of which, is controlled by a precision temperature controller, heater and, when necessary, water cooling. The temperature is monitored by the relevant ASTM (IP) thermometer.

ONE OF THE ATAC RANGE OF PROCESS ANALYSERS

SPECIFICATION

Analyser performance

Ranges	Maximum: 0 - 3500cP Minimum: 0 - 10cP
Note:	Offset zeros are possible but not recommended.
Repeatability	± 0.5% FS.
Precision	± 1% FS.
Response time	30 seconds to 3 minutes depending on sample temperature

Specified measurement temperature

Normally 40 - 150°C (100 - 300°F) but 170°C is available (see options).

Output signal

Range	4 - 20 mA fully isolated loop powered.
or	Digital output depending on transmitter selected

Out-of-service alarm contact signalling mains failure (or off) or bath temperature fuse blown.

Sample conditions required at inlet

Pressure	Within range 0.7 - 14 bar g (10 - 200 psig) dependent upon the viscosity of sample.
Temperature	Must be within ±100°C (212°F) of the required measuring temperature.
Flow	60.7 ml/min (0.8 gal/h) when power supply frequency is 50Hz and 72.8 ml/min (0.9 gal/h) at 60Hz.

Sample conditioning

Sample should be clean and filtered prior to being introduced into the analyser. Pressure pulses should be avoided.
The analyser will accept samples having the above inlet conditions. Complete sample systems can be supplied to condition sample as required at the analyser inlet.

Sample disposal

Return to process or a recovery system. Sample recovery systems can be supplied.

Utility requirements

Power supply

Voltage	115V or 230V ±10% single phase
Frequency	50 or 60 Hz
Consumption	2 kVA or 2.8 kVA depending on the specified measurement temperature.

Cooling water

When the sample is at a high temperature or when the measurement temperature is low with respect to ambient, a supply of cool, potable water (9 - 45 l/h) should be provided to carry away the excess heat. The necessary coil is fitted as standard. If potable water is not available, alternative cooling coil materials can be provided.

Oil for temperature bath

22 litres (5 gal) of Shell Thermia B or equivalent. Normal maximum working temperature of bath is 170°C (protected by a thermal fuse). The sample temperature at capillary outlet is measured by a mercury-in-glass thermometer.

Local display

0 - 100% linear scale on the transmitter.

Standard connections

Sample inlet	$^{1}/_{4}$" NPT (female)
Sample outlet	$^{3}/_{8}$" NPT (female)
Cooling water	$^{1}/_{4}$" NPT (female) IN
Cooling water	$^{1}/_{4}$" NPT (female) OUT
Electrical	M25 (power), M20 (alarm) (½" NPT NEC)
Signal out	As transmitter specification, either EExd or EExia with 4-20mA isolated output or digital output.

Explosion protection

Model 491J

The analyser is ATEX certified
Ex II 2G EEx d e IIB T1-T6*
*model dependent
for use in zone 1 areas.
Certificate no.
EPSILON 04SYS1283V1

Model 491H

Explosion proof design for use in NEC Class 1, Group D, Div 1 Area.

Environmental protection

The Viscometer is free-standing, and, provided that it is sheltered from direct sun, rain and strong winds, it will operate satisfactorily outdoors under normal temperature conditions in the range 0-55°C (32 - 130°F).

Dimensions and weight

Width	490 mm
Depth	1075 mm
Height	1270 mm
Weight	230 kg

Floor fixing bolt holes (4 off $^{5}/_{8}$" dia) at 717 mm x 351 mm.

Access dimensions

Length	1680 mm
Depth	1350 mm (inc.open door)
Height	1830 mm

The space below the viscometer must be kept clear for lowering the oil bath.

Options

- Local digital indicator (scaled in engineering units).
- Water cooled gearbox and high temperature stirrer. These items when fitted allow operation of the viscometer at up to 170°C.
- Digital transmitter with integral microprocessor permitting remote diagnostics, configuration and interrogation of transmitter plus loop integrity test using manufacturer's hand-held communicator.
- Measurement of viscosity at line temperature.
- Remote indication of bath temperature.
- Fast loop manifold connection.

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