

## Model 0421 Viscometer

The Model 421 multi-range Viscometer is a completely automatic process stream analyser for measuring the Dynamic Viscosity (cP) of petroleum products in correlation with ASTM D445.

The use of a wide bore measuring tube allows the accurate viscosity measurement of samples such as fuel oil, which exhibit non-Newtonian characteristics when measured using smaller bore capillary tubes.

If the sample density is also available, either by external measurement or stable fixed value, the user may insert this value into a calculation to determine the Kinematic Viscosity (cSt). [cSt = cP/ρ where ρ = density].

### TYPICAL APPLICATIONS

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

The Hagen-Poiseuille equation

$$\mu = 1.45 \times 10^5 \times d^4 P / QL$$

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)

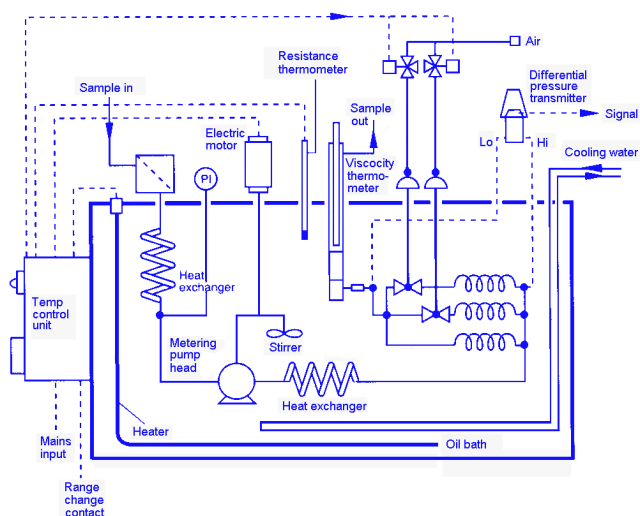
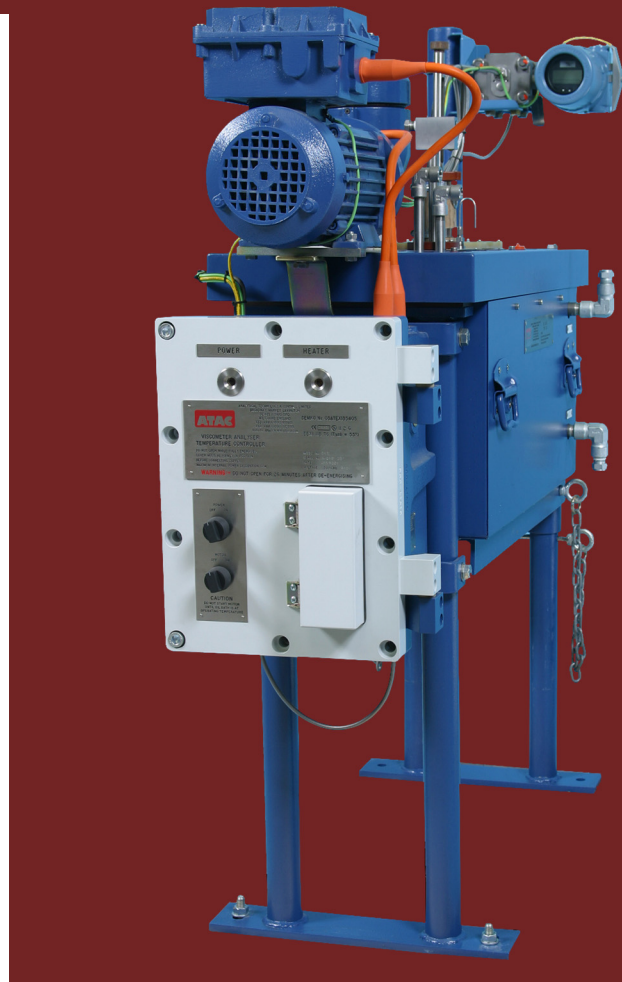


Figure 1: Model 0421 schematic



### PRINCIPLE OF OPERATION

A schematic of the analyser is shown in figure 1.

Viscometers measure differential pressure across a capillary through which the sample fluid is passed.

The differential pressure is proportional to the absolute viscosity of the fluid as described by the Hagen-Poiseuille equation.

As d, Q and L are constants, the absolute viscosity (μ) is directly proportional to the differential pressure measured across capillary (P). The model 421 uses 3 capillaries to provide 3 separate viscosity ranges.

A precision pump meters sample flow and two heat exchangers, fitted either side of the metering pump, ensure the sample metered by the pump is at approximately the same temperature as sample entering the capillary.

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 output of this pressure transmitter is directly proportional to the absolute viscosity of the sample. All critical components are maintained at a fixed temperature by immersion in an oil bath controlled by a precision temperature controller, heater and (when necessary) water cooling. The temperature is monitored by the relevant ASTM (IP) thermometer. The Model 1077 has the added convenience that the capillary is housed in an easily removable holder to enable cleaning or range changing without needing to lower the oil bath.

## Specifications

Configuration	Up to three wide bore capillary	
Ranges	Minimum : 0-10cP - Maximum : 0-3500cP	
Repeatability	± 0.5% FS	
Precision	± 1% FS	
Response time	30 seconds to 3 minutes, depending on sample temperature	
Measurement temp.	Normally 40-150°C (100 -300°F) but 170°C is available (see options)	
Output signal	Range (depending on transmitter selected – see options) : 4-20 mA fully isolated, loop powered or digital output. Out-of-service alarm contact signalling mains failure (or off) or bath temperature fuse blown.	
Local display	0 - 100% linear scale on the transmitter	
Temperature bath capacity	22 litres of oil Use Shell Thermia B or equivalent oil. Normal maximum working temperature of bath is 170°C (protected by thermal fuse). Sample temperature at capillary outlet is measured by spirit-in-glass thermometer.	
Cooling water	When sample is at high temperature relative to measuring temperature or when measurement temperature is low with respect to ambient temperature, a supply of cool, potable water (9 - 45 l/h) should be provided to carry away excess heat. The necessary coil is fitted as standard. If potable water is not available, alternative cooling coil materials can be provided.	
Dimensions	Width 490 mm	Depth 1075 mm
	Height 1270 mm	Weight 230 kg
Sample conditions required at inlet	Pressure: within range 0.7 - 21 bar g (10 - 305 psig) depending on 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 50 Hz and 72.8 ml/min (0.9 gal/h) at 60 Hz	
Power supply	Voltage: 115V or 230V ±10% Frequency 50 or 60 Hz Consumption: single phase 1.5 kVA or 2.0 kVA depending on specified measurement temperature	
Connections	Sample:	1/4" NPT (female) inlet, 3/8" NPT (female) outlet
	Cooling water	1/4" NPT (female) inlet, 1/4" NPT (female) outlet
	Electrical	M25 (power), M20 (alarm)
	Signal out	M20
	Steam tracing	Model 1077 - steam at low pressure (1 bar max) required for samples having pour point above lowest ambient temperature. Connection is 1/4" o.d. compression. (see options)
Explosion Protection	ATEX certified for use in Zone 1 areas  II 2G EEx d e ia IIB T3-T4* (*Dependant on model) Certificate no. ITS09ATEX1654X  II 2G EEx d e ia IIB+H <sub>2</sub> T3-T4* (*Dependant on model) Certificate no. ITS09ATEX1655X	
Options	Local digital display / transmission of controlled bath temperature Bath temperature (standard up to 110°C) up to 170°C Environmental protection to IP65 ATEX IIB + H <sub>2</sub> certification Choice of pressure transmitter manufacturer; Emerson Rosemount / Honeywell / Foxboro / Yokogawa Metric adaptors for end user connection if required Steam tracing for Model 1077 (if required – see connections) Provision for secondary fast loop (for improved response times)	