Flow Assurance Specialist

Process Measurement and Control Systems
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The Micro PVT Analyser

PMAC Systems have exclusive licence to the **Micro PVT** Analyser. The Micro PVT was developed to provide precise and rapid analysis of the physical and thermodynamic properties of fluids. Weighing less than 10 kg and working with a sample of less than 10 mls. The **MicroPVT** can be used in the laboratory or at the well site.

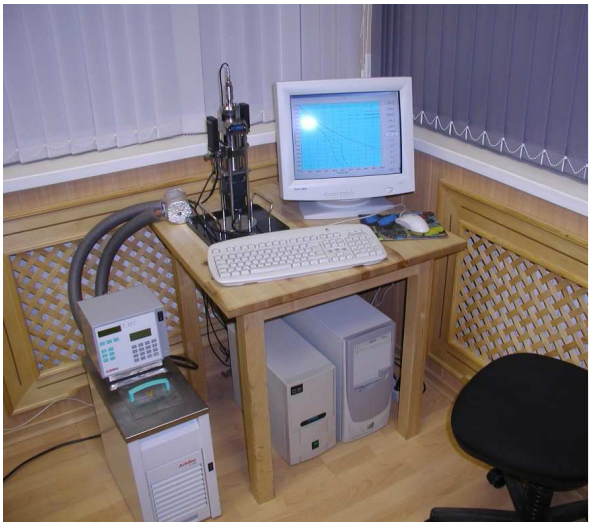
Equipment Description

The MicroPVT Analyser consists of the following basic elements:

High Pressure Pump
High Resolution Volume Gauge
High Resolution Pressure Gauge
Computer based control
Pressure Range 0.1 to 5000 Bar
System Software

The basis statistics of the system are:

Temperature	-30 to 100°C
Sample Volume	0.1 to 10 cc
System Weight	< 10 kg



Applications

The MicroPVT Analyser measures the change in volume of a sample under applied pressure. The volume / pressure relationship is generated on a real time basis and displayed visually on a computer. From the V(P) data one can calculate: pressure function, relative volume (Vp/Vo, where Vp- volume at pressure, and Vo- the volume at initial pressure) specific volume, density (ρ), derivatives (δV/δP) and (δP/δV), Compression ratio b= -1/V*(δV/δP) bulk modulus K=1/b, and strain relaxation times. At the same time the V(p) data allows one to relate experimental data to the coefficients of the equation of state. These measurements can be performed at a range of temperatures to provide the volume / pressure relationship as a function of temperature.

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Applications:

The **MicroPVT** is the only system available, which can cope with such small volumes of sample and will enhance its usefulness at the well site when only small volumes of sample are available.

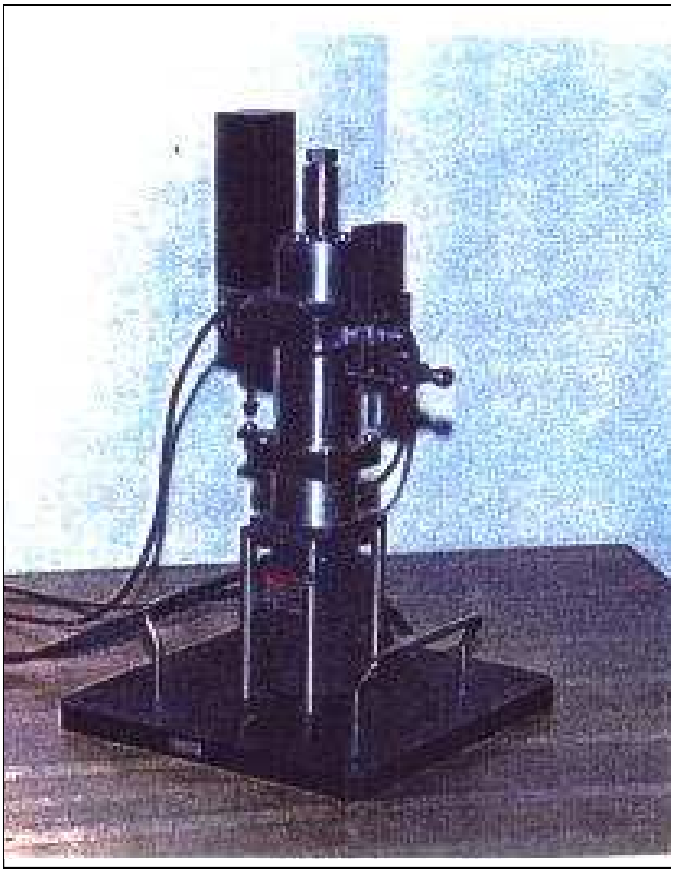
1. The MicroPVT can provide a pressure volume curve within 20 minutes for “quick look” PVT data or can be programmed to build up or reduce pressure over any time frame.

2. Linking the MicroPVT with a capillary coil and BPV provides a high-pressure capillary viscometer capability.

3. The Micro PVT has also a special ore holder attachement, allowing for permeability and porosity measurements in core samples

4. The MicroPVT can be used to measure wax crystallisation temperature and pressure on live fluids.

5. The MicroPVT can be used to investigate Hydrate formation.



Functional Description

The **MicroPVT** is a small-sized, light and safe measuring unit. The **MicroPVT** is designed for a precise and rapid analysis of fluids which are chemically compatible with the high-strength stainless steels which make up the cylinder, piston of the cylinder and piston of the press, as well as the beryllium bronze and hydrocarbon resistant elastomers that form the elements of the cylinder / piston seal.

The accuracy of pressure measurement in the working chamber of the cylinder is obtained by continuous information about the value of axial component of seal material frictional force against the piston.

Removable cylinder, easy access to the piston, and knock-down construction of the seal make it easy to fill the working chamber with, to wash the chamber and to change the seal's elements.

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Detailed Operation

The **MicroPVT** analyser is intended for experimental study of the dependence between fluid volumes and crystallised media and pressure under different rates of loading (compression) and unloading, as well as for analysis of chemical reaction processes and automatic pressurisation in different small volume measuring chambers.

Actual realisation of volume V as a function of pressure P in tabulated form is registered in a real time scale and logged by a computer. This enables the analyst to find an equation of state which better describes the dependence V(P) at temperature (T) and to calculate the corresponding thermodynamic functions and potentials. Program-simulated drive allows the creation of various conditions for pressure and volume change and to perform feedback between the processes of receiving predicted and experimental data including the data in real time scale. In order to extend the information obtained from the **MicroPVT** analyser a data base and software package is required. The AVESTA automatic system of thermophysical data developed by the Ukrainian Thermodynamic Centre (Kiev) can be supplied with the **MicroPVT** analyser.

Based on the V(P) data one can calculate: pressure function, relative volume (Vp/Vo, where Vp - the volume at pressure P, and Vo - the volume at initial pressure), specific volume, density þ, derivatives aV / 0P and 0P / 0V, compression ratio b = -1/V. c3V/0P, bulk modulus K = 1/b, strain relaxation times. At the same time the V(P) data allowed to approximate experimental data obtained by different functions and to define coefficients of the equations is obtained.
The program - simulated drive and specially designed seal enable the instrument to carry out both infinite-slow compression (isothermal) and quick compression close to adiabatic.

The **MicroPVT** can be used for analysis of elastometer properties and friction under pressure change.

The **MicroPVT** can be furnished with remote control system, which will allow control of the unit and processing of experimental data both offshore and onshore, at any site with a telephone link.

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STANDARD MicroPVT SPECIFICATIONS

1.	Working volume of hydrocylinder	780 mm^3
2*.	Range of controlled pressure change in liquid	0-500 MPa (0-5000 barg)
3.	Max. permissible strain of solid compression after liquid crystallisation	490 MPa (4900 barg)
4.	Range of controlled change in hydrocylinder volume	330-789 mm^3
5.	Basic relative error in volume measurement	$\pm$0,1%
6.	Basic relative error in pressure change measurement	$\pm$0,15%
7.	Volume change resolution of drive	4,072. $10^{\cdot 4}$ mm3/step
8.	Working lilts of volume change rate regulation under nominal moment	0 - 6,5 mm3/s
9.	Mean time of liquid compression up to a pressure of 3500 bar at a max. rate	20 s
10.	Weight	9,8 kg
11.	Size	240x240x566 mm

The **MicroPVT** is furnished with a PAK SAMM complex enabling it to take experimental measurements in a real time scale followed by their processing and visual presentation.

The PAK SAMM has been developed under the "virtual construction" concept that allows a user to work in standard conditions of physical and chemical experiment, since the computer's screen is a "virtual unit" panel. Both taken and calculated physical and chemical values are represented by "buttons" and "levers" of the "virtual unit" the manipulation of which allows the operator to change both measured and calculated parameters.

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The PAK SAMM complex is easy to operate.The data generated by the MicroPVT are illustrated in Figs. 1 - 3.

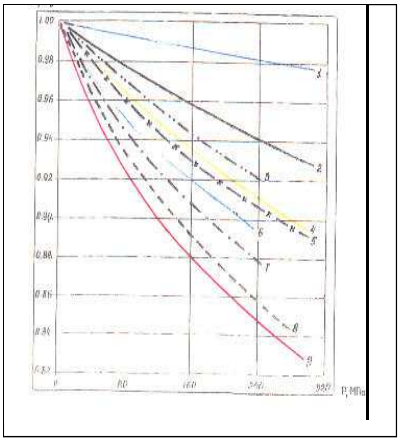

Fig. l. Dependence of a relative volume Vp/Vo (where Vp - the volume at pressure P and Vo - the volume at normal pressure) oil pressure Pb, MPa.

lst curve- liquid metal
2d curve - glycerol
3d curve - ssinovial liquid
4th curve - distilled water
5th curve - Mineral oil
6th curve - diesel fuel
7th curve - alcohol
8th curve - gasoline
9th curve - petroleum ether
The rate of compression is 1,5 MPa/s.
Temperature is 20 oC.

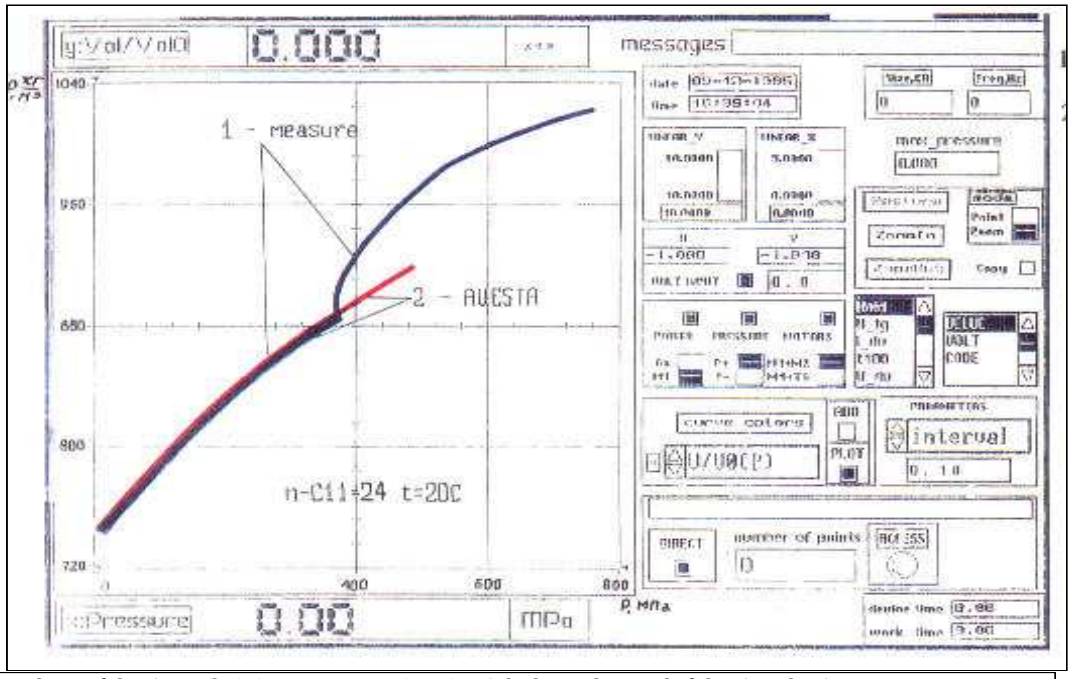

Fig. 2. Dependence of density, p (kg/m) on pressure P (MPa) as it looks on the panel of the virtual unit.

Substance: n - C 11H24 Temperature: 20 °C
1st cra-ye- Data obtained on MicroPVT
2d curve - Data of AVESTA system

Fig.3. Dependence of relative volume Vp/Vo on pressure P (MPa) under loading ( )and unloading ( ).

Substance: n - C 16H34 Temperature: 20 oC 1st curve - Data obtained on MicroPVT, compression rate - 1,5MPa/s.
2d curve - Bridgeman data, isometric measurement

Compression rate at MicroPVT is 500 times higher compared to that forBridgeman measurement. A number of points on the loading curve is over 2000.