TECHNICAL DESCRIPTION

QUALITY IS OUR CONCERN

# MINIVOL LVR

## Fully Automatic Vapor-Liquid Ratio Tester
## ASTM D 5188

GRABNER INSTRUMENTS

# COMPLIANCE MONITORING FOR VAPOR-LIQUID RATIO TEMPERATURE

## MINIVOL LVR

## THE COMPANY THAT SETS THE STANDARDS

*GRABNER INSTRUMENTS stands for "Innovation and Quality".*
*Our strict commitment to ISO 9001 and to new technology permits us to develop instruments with entirely new test-methods.*
*Unrestrained by the traditions of current practices and standards, our R&D department only looks at the practical and theoretical requirements of a specific application to find the best and most efficient design for a new instrument.*
*Several new American and European standards, patents and innovation awards confirm our successful philosophy.*

MINIVOL LVR is a measuring instrument for the automatic determination of the vapor-liquid ratio temperature of nonviscous liquids including hydrocarbons like gasoline, solvents and similar chemical compounds.
The vapor-liquid ratio temperature is determined with high precision for a presettable temperature range of 20 to 80 ºC (68 to 176 ºF). The pressure at which the measurement is performed can be varied between 50 and 200 kPa.

## ONLY 4 mL OF SAMPLE

The instrument performs fully automatically with a sample volume of only 4 mL. The chilled and air saturated sample is drawn into a precision glass syringe which is inserted into the Luer bore on the right hand side of the instrument.

## PELTIER COOLING

MINIVOL LVR does not require an external liquid thermostatic bath. Cooling below ambient temperature is performed with high-power thermoelectric cooling devices (Peltier elements).

## VACUUM PUMP

A standard 2-stage rotary vacuum pump is required for operation. A vapor trap between the tester and the vacuum pump is recommended.

## FULLY AUTOMATIC SAMPLE INJECTION

The measuring chamber with an overall volume of 15 mL is evacuated and heated above the expected temperature of the V/L ratio to be measured.
The injection of the exact amount of sample is performed fully automatically with a precision syringe and a motor driven burette drive, avoiding errors in handling.

## TEST METHOD

The measuring method used in MINIVOL LVR is performed according to the ASTM D 5188 »Evacuated Chamber Method«. In this method, an exact amount of air saturated sample is injected into an evacuated chamber of known volume. After the injection, the temperature of the measuring chamber is regulated until the nominal pressure (in D 5188 p = 101.3 kPa) is observed.
This temperature is reported as the result of the measurement.

## SINGLE POINT T(V/L=20)

Single point measurement at a vapor-liquid ratio of 20 for compliance tests and product specifications are performed with one automatic injection.

## MULTIPLE POINTS T(V/L=100 TO 4)

MINIVOL LVR can do much more than the ASTM D 5188 requires. Multiple point measurements at V/L = 100 down to V/L = 4 can be measured automatically with one single 4 mL sample.

## VARIOUS TEST PRESSURES

For research and development, the vapor-liquid ratio temperature for pressures different than 101.3 kPa is of interest to many labs. In MINIVOL LVR the nominal pressure can be readily adjusted in a range of 50 to 200 kPa.

## AUTOMATIC VERSUS MANUAL METHODS

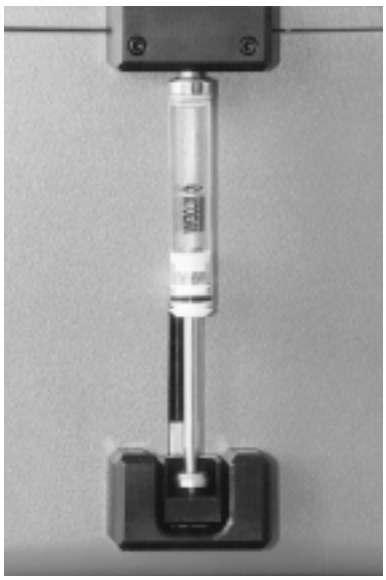
A large ASTM round robin showed in the USA showed that the results of the D 5188 method are equivalent to the former »glycerin method« D 2533.

The advantages of the vacuum method are obvious. The tester is easy to handle, it performs automatically, and the tests can be carried out by lab personnel without specialized training.

**Reproducibility**
The reproducibility of this tester is better than all existing manual methods.
**Use of Glycerin**
The manual method using glycerin cannot be used with oxygenated blends because of the solubility of alcohol in glycerin.
**Use of Mercury**
The use of mercury instead of glycerin does not show generally acceptable results because of the tendency of aromatics to amalgamate in the mercury. Also mercury is not welcome in laboratories.

## SAMPLE SYRINGE AND PRECISION DRIVE

4 mL of chilled and air-saturated sample is drawn bubble free into the syringe. The filled syringe is inserted into the LUER inlet of the tester and RUN is pressed.
At first, the chamber is rinsed with 1 mL of sample to be measured and evacuated. An accurate amount of sample according to the programmed vapor-liquid ratio is then automatically injected into the measuring chamber.



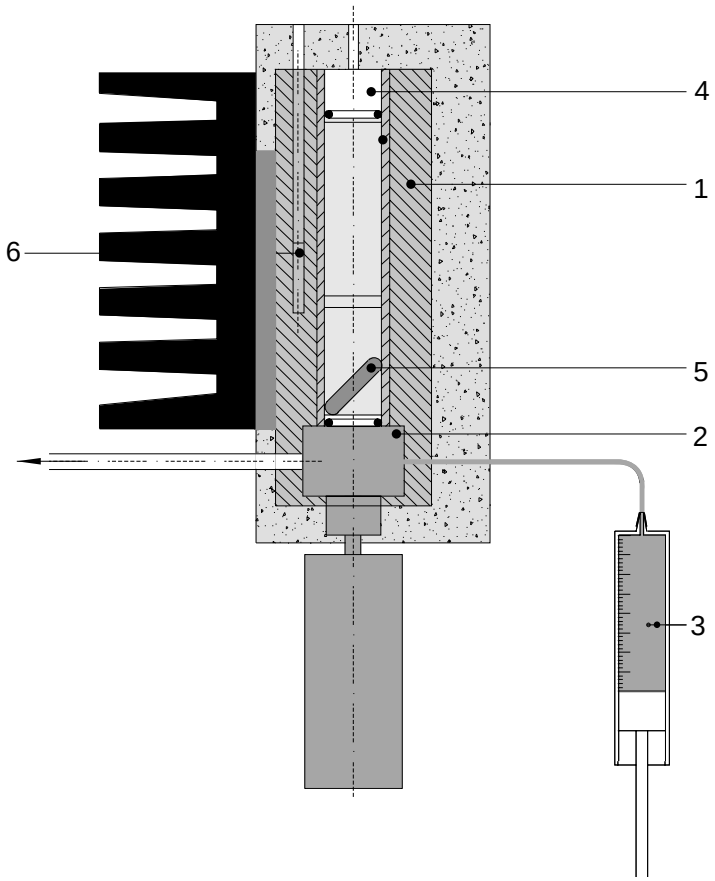
## LIGHTWEIGHT AND PORTABLE

The tester is truly portable and is housed in a small aluminum enclosure. A handle on top of the tester makes carrying easy.

## PRINCIPLE OF OPERATION

The test chamber (1) has a volume of 15 mL. A motor driven ball valve (2) for injection and evacuation is located below the temperature controlled chamber. With a precision syringe with Luer-lock (3), the chilled and air-saturated sample is drawn in, and the syringe is placed into the automatic injection drive.

The pressure in the chamber is monitored with a high precision piezo-resistive pressure transducer (4). A magnetic stirrer (5) is installed inside the chamber to achieve fast equilibrium. Cooling and heating are performed with a thermoelectric module (6). The temperature of the test chamber is measured with a highly stable, platinum RTD.



## SINGLE POINT MEASUREMENT

The measuring chamber is evacuated and heated above the expected temperature for the vapor-liquid ratio.
The sample to be measured is chilled and air saturated prior to the measurement and is filled into a cooled precision syringe of 4 mL, without the presence of air bubbles. The filled syringe is connected onto the Luer-lock on the right hand side of the tester, and the RUN key is pressed to start the automatic measurement.
With the motor driven burette, a small amount of the sample is injected to rinse and fill the whole injection system to the measuring chamber. Afterwards the measuring chamber is evacuated again.
The exact amount of sample for the programmed vapor-liquid ratio is injected automatically, and the ball valve below the measuring chamber is closed.
The temperature regulation is now activated to decrease the chamber temperature until the measuring pressure (in D 5188, p = 101.3 kPa) is observed.
To achieve equilibrium in a short time, a magnetic stirrer is installed inside the measuring chamber, reducing the equilibrium time for one measuring point below only 2 minutes.
The result is displayed and printed, and the temperature is again increased to the starting temperature. The result is calculated according to:

$V/L = (V - v)/v$

- V Volume of the test chamber
- v Volume of the injected sample

## MULTIPLE POINT MEASUREMENTS

For multiple point or curve measurements, the measuring chamber is heated to 80 ºC (176 ºF) and the automatic injection starts with V/L=100, the next points are V/L=80, 60, 40, 30, 25, 20, 15, 10, 5 and 4.
For the consecutive steps, the additional amount of sample is added to achieve the next lower V/L value and the temperature is automatically regulated for each step. With this design, no piston for a variable chamber volume is necessary and a very large range in vapor-liquid ratio can be achieved with only a 4 mL sample volume.

**Vapor-Liquid Ratios down to 0.1**
Vapor-liquid ratios as low as 0.1 can be measured by using a 16 mL sample syringe (special order).

## RINSING OF THE MEASURING CHAMBER

Prior to each measurement, the measuring chamber is automatically rinsed with the new sample and evacuated after the rinsing.
If liquids of very different volatility are measured consecutively, a cleaning cycle between the measurements is required.
Cleaning is performed by flushing the measuring chamber at the high initial temperature Ti three times with air, followed by evacuation.

## SAMPLE HANDLING

Sample handling and proper sample preparation are essential procedures for V/L measurements and require the utmost precaution and the most meticulous care.

According to ASTM, the sample has to be chilled and air saturated prior to the measurement in accordance with the REID Vapor Pressure procedure. Please read carefully the ASTM instructions for LVR measurements.
Wait until the instrument is ready for measurement. Remove the sample container from the refrigerator or ice bath. Fill the chilled and air-dried syringe with an aliquot of sample and insert the syringe in the Luer inlet of the tester. Press RUN to start the test.

## SAMPLE STORAGE

Use only gas tight and chilled containers for storage of the sample to avoid loss of high volatiles.

Excerpt from ASTM D 5188

**1. Scope**

1.1 This test method covers the determination of the temperature at which the vapor formed from a selected volume of volatile petroleum product saturated with air at 0 to 1 ºC (32 to 34 ºF) produces a pressure of one atmosphere in an evacuated chamber of fixed volume. This test method is applicable to samples for which the determined temperature is between 36 and 80 ºC (97 and 176 ºF) and the vapor-liquid ratio is between 8 to 1 and 75 to 1.

1.2 This test method is applicable to both gasoline and gasoline-oxygenate blends.

**4. Summary of Test Method**

4.1 A known volume of chilled, air-saturated sample is introduced into an evacuated, thermostatically controlled test chamber of known volume. The sample volume is calculated to give the desired vapor-liquid ratio for the chamber volume in use. After injection, the chamber temperature is adjusted until with a stable chamber temperature, a stable chamber pressure of 101.3 kPa (14.69 psi) is achieved.

**5. Significance and Use**

5.1 The tendency of a fuel to vaporize in automotive engine fuel systems is indicated by the vapor-liquid ratio of the fuel.

5.2 Automotive fuel specifications generally include $T_{(V/L=20)}$ limits to ensure products of suitable volatility performance. For high ambient temperatures, a fuel with a high value of $T_{(V/L=20)}$, indicating a fuel with a low tendency to vaporize, is generally specified; conversely for low ambient temperatures, a fuel with a low value of $T_{(V/L=20)}$ is specified.

**6. Apparatus**

6.1 Apparatus suitable for use in this test method employ a small volume test chamber incorporating a transducer for pressure measurements and associated equipment for thermostatically controlling the chamber temperature, evacuating the test chamber prior to sample introduction, and cleaning and purging the chamber following the test.[4] Critical elements of the apparatus shall meet the following specifications:

6.1.1 Test chamber, constructed of stainless steel or aluminum, designed to contain between 5 and 50 mL of liquid plus vapor with a tolerance of ±1% on the nominal capacity.

6.1.2 Pressure transducer, minimum operational range from 0 to 177 kPa (0 to 25.6 psi) with minimum resolution of 0.1 kPa (0.01 psi) and minimum accuracy of ±0.8 kPa (±0.12 psi). The pressure measurement system shall include associated electronics and readout devices to display the resulting pressure reading.

6.1.3 Heater, thermostatically controlled heater capable of maintaining the test chamber within 0.1 ºC of the set temperature for a minimum of 3 min.

6.1.4 Platinum resistance thermometer, used to measure the temperature of the test chamber, having a minimum temperature range of 36 ºC to 80 ºC, minimum resolution of 0.1 ºC (0.2 ºF) and minimum accuracy of ±0.1 ºC (±0.2 ºF).

6.2 Vacuum pump, capable of reducing the pressure in the test chamber to less than 0.01 kPa (0.001 psia).

6.3 Syringes, (if required for sample introduction), gas-tight, 1-to 20 mL capacity with minimum accuracy and precision of ±1%.

6.4 Bath, iced water or air, for chilling the samples and syringe (if required) to between 0 and 1 ºC (32 to 34 ºF).

6.5 Mercury Barometer, 0 to 120 kPa (o to 17.4 psi) range.

6.6 McLeod Vacuum Gauge, capable of measuring between 0 to 0.67 kPa (0 to 5 mm Hg).

[4] The following instruments have been found satisfactory for use in this test method as determined by interlaboratory cooperative testing: Grabner, available from Grabner Instruments, Vienna, Austria, and Petrolab, Latham, NY 12110; and Setavap, available from Stanhope-Seta, Chertsey, England, and Core Labs Refinery Systems, Princeton, NY 08540.

**14. Precision and Bias**

14.1 Precision - The precision of this test method for measuring the $T_{(V/L=20)}$ value of gasoline and gasoline-oxygenate blends as determined by the statistical examination of interlaboratory test results is as follows:

14.1.1 Repeatability - The difference between two successive test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method exceed the following value only in one case in twenty:
0.6 ºC (1.1 ºF)

14.1.2 Reproducibility - The difference between two single and independent test results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method exceed the following value only in one case in twenty:
0.9 ºC (1.6 ºF)

## DATA HANDLING AND INTERFACES

### PRINTER INTERFACE

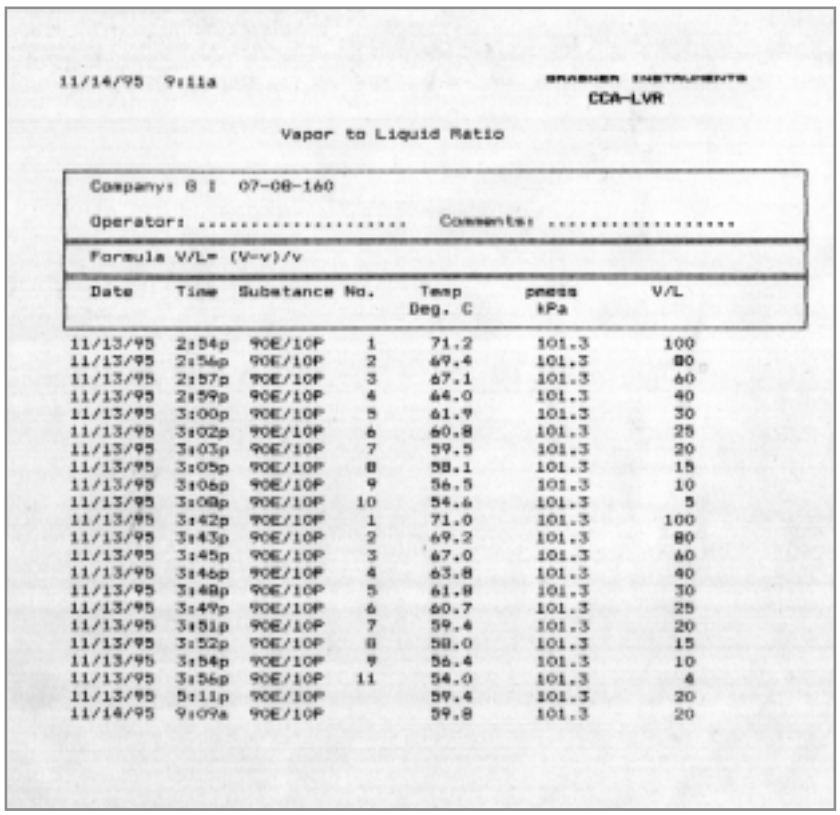
A printer with an RS 232 serial interface can be connected directly for immediate printout of the measured data. A record with all necessary information is printed.

### DATA MEMORY

More than 800 tests can be stored and later recalled from the data memory.

### ALPHANUMERIC DISPLAY

A large backlit LCD with 2 x 40 digits assists the user to program and operate the MINIVOL LVR tester. The test data are displayed together with all necessary information on the LCD.



11/14/95 9:11a

GRABNER INSTRUMENTS
CCA-LVR

Vapor to Liquid Ratio

Company: G I 07-08-160

Operator: ..... Comments: .....

Formula V/L= (V-v)/v

| Date | Time | Substance | No. | Temp Deg. C | press kPa | V/L |
|---|---|---|---|---|---|---|
| 11/13/95 | 2:54p | 90E/10P | 1 | 71.2 | 101.3 | 100 |
| 11/13/95 | 2:56p | 90E/10P | 2 | 69.4 | 101.3 | 80 |
| 11/13/95 | 2:57p | 90E/10P | 3 | 67.1 | 101.3 | 60 |
| 11/13/95 | 2:59p | 90E/10P | 4 | 64.0 | 101.3 | 40 |
| 11/13/95 | 3:00p | 90E/10P | 5 | 61.9 | 101.3 | 30 |
| 11/13/95 | 3:02p | 90E/10P | 6 | 60.8 | 101.3 | 25 |
| 11/13/95 | 3:03p | 90E/10P | 7 | 59.5 | 101.3 | 20 |
| 11/13/95 | 3:05p | 90E/10P | 8 | 58.1 | 101.3 | 15 |
| 11/13/95 | 3:06p | 90E/10P | 9 | 56.5 | 101.3 | 10 |
| 11/13/95 | 3:08p | 90E/10P | 10 | 54.6 | 101.3 | 5 |
| 11/13/95 | 3:42p | 90E/10P | 1 | 71.0 | 101.3 | 100 |
| 11/13/95 | 3:43p | 90E/10P | 2 | 69.2 | 101.3 | 80 |
| 11/13/95 | 3:45p | 90E/10P | 3 | 67.0 | 101.3 | 60 |
| 11/13/95 | 3:46p | 90E/10P | 4 | 63.8 | 101.3 | 40 |
| 11/13/95 | 3:48p | 90E/10P | 5 | 61.8 | 101.3 | 30 |
| 11/13/95 | 3:49p | 90E/10P | 6 | 60.7 | 101.3 | 25 |
| 11/13/95 | 3:51p | 90E/10P | 7 | 59.4 | 101.3 | 20 |
| 11/13/95 | 3:52p | 90E/10P | 8 | 58.0 | 101.3 | 15 |
| 11/13/95 | 3:54p | 90E/10P | 9 | 56.4 | 101.3 | 10 |
| 11/13/95 | 3:56p | 90E/10P | 11 | 54.0 | 101.3 | 4 |
| 11/13/95 | 5:11p | 90E/10P | | 59.4 | 101.3 | 20 |
| 11/14/95 | 9:09a | 90E/10P | | 59.8 | 101.3 | 20 |

## ORDERING INFORMATION

| | |
|---|---|
| CCA300-000-00 | **MINIVOL LVR** automatic vapor-liquid ratio tester |

## ACCESSORIES

| | |
|---|---|
| CCA100-400-00 | Vacuum pump, 2-stage, rotary **(required!)** |
| A1000-100-00 | Matrix printer with serial interface, standard paper size |
| CCA210-800-00 | **MINICAL:** Temperature calibration unit |
| CCA210-810-00 | Quartz thermometer, for calibration/verification, 0.01 °C resolution |

## TECHNICAL DATA

| | |
|---|---|
| Volume of measuring cell: | 15 mL |
| Range of vapor-liquid ratios: | 4 to 100 |
| Temperature range: | 0 to 80 ºC<br>68 to 176 ºF |
| Accuracy of temperature reading: | +/- 0.1 ºC<br>+/- 0.2 ºF |
| Pressure range: | 0 to 2 000 hPa<br>0 to 200.0 kPa<br>0 to 2.000 atm<br>0 to 30.00 psi |
| Communication languages (user selectable): | English, German, French |
| Units of temperature (user selectable): | Celsius or Fahrenheit |
| Units of pressure (user selectable): | hPa, kPa, psi, atm |
| Power requirements: | 100/120/230/240 V AC, 50/60 Hz, 65 W |
| Physical dimensions: | W x H x D = 196 x 315 x 205 mm (7.7” x 12.4” x 8”) |
| Weight: | 9.1 kg (20.1 lbs) |

Manufactured under ISO 9001 guidelines for consistent quality and reliability.

Technical changes may be made without further notice.

GRABNER INSTRUMENTS

QUALITY ISO 9001 CERTIFIED

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