

STANDARD COMPLIANT VAPOR PRESSURE PROCESS ANALYZER



MINIVAP ON-LINE

The RVP profit analyzer

The MINIVAP ON-LINE from GRABNER INSTRUMENTS is a process monitoring analyzer for the determination of vapor pressure of gasoline, life and dead crude oil, LPG and NPG. Its core shares the same triple expansion measurement method, which is used in our laboratory analyzers. Based on the results of extensive ASTM interlaboratory measurements, the MINIVAP outperforms the strictest vapor pressure standards and helps refineries to save millions of dollars per year.

FEATURES

- Highest precision and performance
- US-EPA and CARB approved Grabner method
- Explosion proof Type X or ATEX purging system
- Fully automatic calibration, verification and pressure correction
- Only 10 ml of sample for a complete measurement
- 7 minutes cycle time
- Built-in diagnostic and safety features
- Data transfer via serial interface RS 232
- ASCII code and MODBUS communication protocol
- Optional 4-20 mA analog data output
- Remote control via central controller
- Automatic piston lubrication
- Peltier cooling
- Modular arrangement
- Multiple sample streams
- Maintenance free sample conditioning systems - self cleaning filters
- Optional sample recovery system
- Optional analyzer shelters
- No accessories required for start-up



STANDARDS

Vapor Pressure of Gasoline	ASTM D6378 (Triple Expansion), D5191 (DVPE), D4953 (corr.) and D323 (corr.)
	ASTM D5188 (V/L) without air saturation
	EN 13016-1, IP 394 (ASVP)
	EN 13016-2, IP 409 (AVP)
Vapor Pressure of Crude Oil	ASTM D6377 (VPCR4), D323 (corr.)
Vapor Pressure of LPG	ASTM D6897, D1267 (corr.)

TECHNICAL DETAILS / SPECIFICATIONS

Temperature Range	Internal operation: 5 to 60°C [41 to 140°F] - Measurement temperature 20 to 60°C [68 to 140°F]
Pressure Range	Gasoline, Crude Oil: 0 to 1000 kPa (0 to 145 psi) LPG: 0 to 2000 kPa (0 to 290 psi)
Repeatability	0.3 kPa (0.04psi) @ 37.8°C, 70kPa
Reproducibility	0.7 kPa (0.10psi) @ 37.8°C, 70kPa
Power requirements	100/120/230/240 V AC, 50/60 Hz, 110 W
Maximum physical dimensions	W x H x D = 650 x 1380 x 400 mm (25.6 x 54.4 x 15.8 inches)
Weight	Approx. 50 kgs (110 lbs)
Fast loop sample stream	Minimum flow: 2 L/min, Minimum pressure: Gasoline - 50 kPa (7 psi), LPG - 500 kPa (70 psi), Maximum pressure: 7,000 kPa (1000 psi)
Data Transfer Options	MODBUS RTU (RS 232), 4-20 mA or remote control with central controller

Triple Expansion for direct measurement of physical properties without sample preparation

The manual sample preparation of cooling and air saturation required in former standards made it impossible to develop a standardized on-line equipment for vapor pressure compliance control. Single expansion analyzers who claim to comply with ASTM D5191, D5482 or EN13016 have to perform sample preparation, to standardize the error of the partial pressure of dissolved gas in every sample.

The MINIVAP ON-LINE Triple Expansion Method has a significant advantage: Only the Triple Expansion Method is able to directly measure the amount of gas and butanes in the fuel and to eliminate the need for sample preparation. Best of all: The precision is significantly better than with single expansion analyzers!

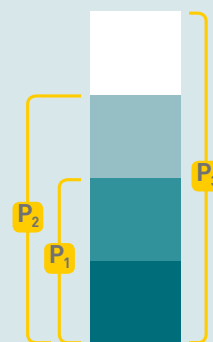
YOUR BENEFIT

Enjoy highest precision with direct vapor pressure testing by Triple Expansion Method, instead of unreliable, adjusted, or unproven correlation vapour pressure estimates.

Triple Expansion Method for accurate VP determination

Based on the assumption that the vapor pressure of liquids remains more or less constant and that all components - like dissolved air - follow the ideal gas equation, an expansion is performed in three steps at constant temperature. Three total pressure values are determined. From these three total pressure values the partial pressure of the dissolved gas (P_{gas}) and the absolute vapor pressure of the liquid (P_{abs}) are calculated.

The Triple Expansion Method makes the MINIVAP ON-LINE an unrivalled tester for the determination of the vapor pressure of different kinds of liquids. The performance of this method is significantly better than ASTM D5191 - Round Robin proven!



Good reasons to decide for a MINIVAP ON-LINE

1. Profit from best precision

In the refinery crude oil is processed to gasoline with different octane rating. Naphta is blended with oxygenates, butane and octane boosters to conform with governmental and environmental regulations, to ensure better performance of the fuels and to reduce production costs. By blending C4-compounds, profit margins can be optimized, while the heat of combustion remains unchanged.

MINIVAP ON-LINE conforms to the strictest ASTM, EN, IP and ISO vapor pressure standards, by using the same method as the laboratory analyzers, which are US EPA reference analyzers for highest precision. And precision of the MINIVAP ONLINE is higher than with other vapor pressure process analyzers.

Repeatability and Reproducibility

MINIVAP ON-LINE is the only vapor pressure process analyzer to perform Triple Expansion and thus rightly reaches highest Round Robin proven precision – online, not just offline. Since there is no operator bias in an on-line tester, the repeatability and reproducibility are significantly better than published in the ASTM standard D6378. A large number of interlaboratory measurements showed the following result:

- Repeatability: 0.3kPa (0.04psi)
- Reproducibility: 0.7kPa (0.10psi)

Best precision gives the MINIVAP ON-LINE an unbeatable advantage over competition and makes the instrument a true profit analyzer. The innovative measuring technique leads to an improved accuracy allowing to blend as close as 0.3 kPa to vapor pressure limits.

Savings at a glance

Industry estimates that for every 0.6 kPa (0.1 psi) better precision, a typical plant can save up to 1 million US\$ per year. Refinery industry experts working a medium sized plant have told GRABNER INSTRUMENTS that exchanging their old ASTM D5482 analyzer for the MINIVAP ON-LINE Vapor Pressure analyzer resulted in savings of more than 600.000 US\$ per quarter, adding up to 2.5 Million US\$ (!) savings per year. With this annual savings, the MINIVAP ON-LINE pays for itself within less than one month. As incredible as this sounds, the results are field proven!



Best precision for best profit

In the following example, normal Butane is blended into Unleaded Gasoline.
A maximum VP of 69 kPa has to be observed.

RVP (Gasoline @ 37.8°C): Before: 62 kPa (9 psi) / After: 69 kPa (10 psi)
Price per Barrel: n-Butane: \$ 65.1 / Gasoline: \$ 81.9

Method/Standard	Reproducibility [kPa]	Blending	Possible profit per 100 000 barrels	Possible profit per YEAR (@100k barrels per day)
Triple Expansion Method	0.7	1.41%	\$ 24 024	8.77 \$M
ASTM D6378-08	1.89	1.14%	\$ 19 320	7.05 \$M
ASTM D5191-07 + EN 13016-1	2.75	0.95%	\$ 16 128	5.89 \$M
ASTM D5482-01 (ABB 4100)	4.14	0.64%	\$ 10 752	3.92 \$M
ASTM D323-06	5.2	0.38%	\$ 6 384	2.33 \$M

2. Fuel quality inspection for batch delivery

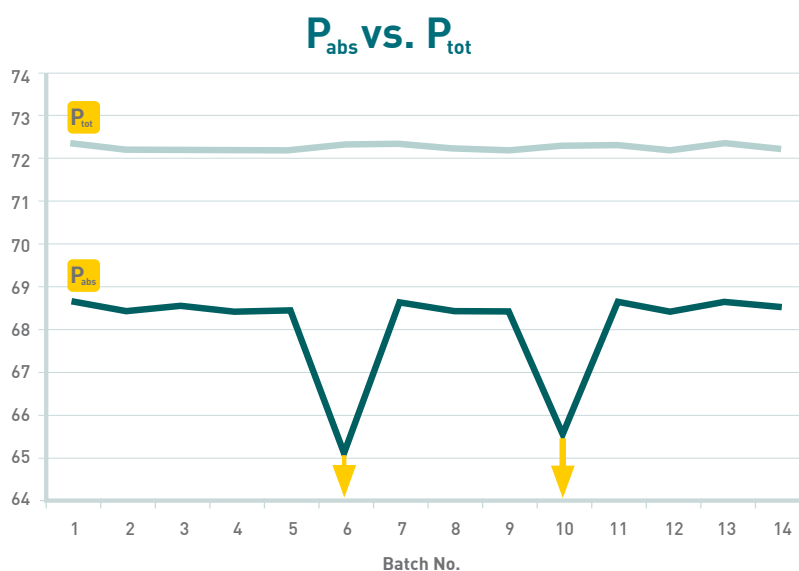
Income quality inspection, which solely relies on the total vapor pressure P_{tot} , as measured by industry standard ASTM D5191, misses one essential information: This method cannot find out how much butanes have already been blended into the lot delivered to their plant.

By measuring the partial pressure of dissolved gases (P_{gas}) in the sample, it is possible to identify "foul" batches - batches of hydrocarbons which have a high amount of butanes already blended into the hydrocarbons. A higher P_{gas} can also indicate a leakage in the transportation system.

The following figure below shows two "foul" batches, delivered with a high amount of dissolved air. While the P_{tot} stays almost constant, the MINIVAP ONLINE is able to determine irregularities in the composition of the hydrocarbons delivered.



P_{abs}	P_{tot}	P_{gas}
68,6	72,3	3,7
68,4	72,2	3,8
68,5	72,2	3,7
68,4	72,2	3,8
68,4	72,2	3,8
65,1	72,3	7,2
68,6	72,3	3,7
68,4	72,2	3,8
68,4	72,2	3,8
65,5	72,3	6,8
68,6	72,3	3,7
68,4	72,2	3,8
68,6	72,3	3,7
68,5	72,2	3,7



3. Testing Crude Oil, TVP and Bubble Point

MINIVAP ON-LINE incorporates the ASTM D6377 method, the new standard for vapor pressure determination of crude oil without sample preparation, which is replacing the 80+ year old method of ASTM D323.

Due to its composition, life crude oil is extremely sensitive to the exposure to barometric pressure at the air saturation procedure. Many crude oils are solid at low temperatures and make an air saturation impossible. With the sample conditioning system of MINIVAP ON-LINE, the pressurized crude oil is directly transferred into the measuring chamber and the vapor pressure is measured against vacuum by a single expansion of a built in piston. The derived precision of this measurement is ASTM Round Robin proven and significantly better than the traditional method of D323, which does not give a precision statement for crude oils at all.



Consequently US EPA acknowledged the broad use of ASTM D6377 in the petroleum industry and confirmed the use of ASTM D6377 as an alternative method for the measurement of the vapor pressure of crude oils, as defined under title 40 CFR. Testing the TVP with the D6377 method is much easier than with the traditional method, which uses the tank stock temperature and the result of a D323 measurement to extrapolate the TVP on the API nomograph.

The MINIVAP ON-LINE also includes a TVP extrapolation method to determine the Bubble Point Pressure of crude oils. From three D6377 measurements at different V/L ratios the TVP of crude oil at a V/L = 0 is extrapolated. This method was demonstrated on a large number of crude oil samples at the US Strategic Petroleum Reserve, and Grabner analyzers have used the TVP extrapolation method successfully around the world.

Crude oil precision at a glance

Method	ASTM D6377-08 (Pressurized containers)	ASTM D323 (Data from D6377 ILS)	Other single expansion method using correlation formulas
Repeatability Reproducibility (V/L = 4 @ 37.8°C)	r = 2.48 kPa R = 4.26 kPa	r = not available R = 9 kPa	Not applicable No Round Robin proven data



FEATURES CRUDE OIL

- Stainless steel housing for crude oil application to accommodate sample conditioning system
- Easy access to SCS without any further tools
- 2 crude oil sample streams possible
- Heated and temperature controlled sample conditioning system (avoids wax appearance)
- Bypass flow
- Calibration flask
- Sample point
- Sample recovery system (optional)

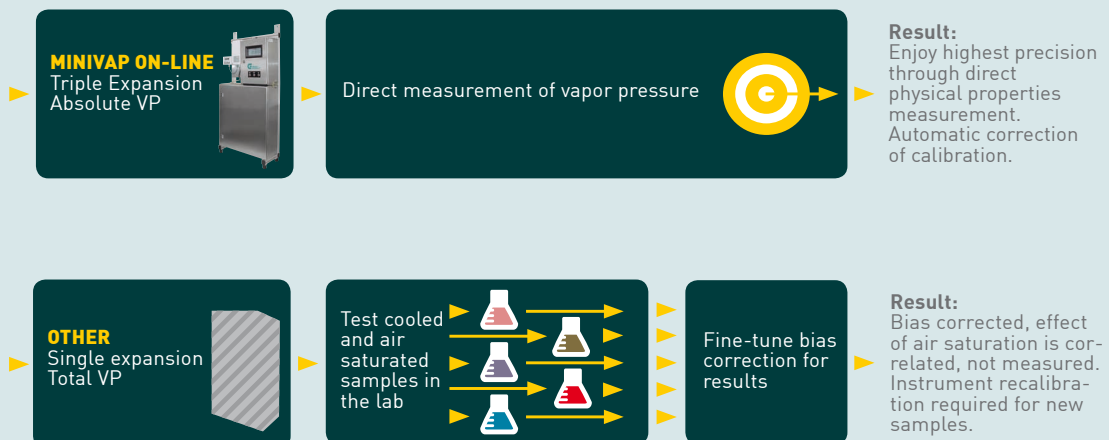
4. Automatic calibration schedule

The MINIVAP ON-LINE is automatically calibrated with a Calibration Reference Fluid in programmable intervals. The pressure reading is corrected according to the nominal vapor pressure of the standard liquid and is valid for subsequent measurements. The offset from the last calibration is always displayed together with the measured vapor pressure of the sample. Calibration corrections are performed fully automatically.

Calibration is a drawback with Single Expansion analyzers: They cannot measure the p_{gas}, to correct the effect of air saturation. Air saturation depends on sample composition and environmental temperature, it is different from sample to sample. To correct the effect of air saturation in online analysis, a number of samples has to be tested in the laboratory and a bias correction model has to be developed. It is not guaranteed that the bias correction model is still valid if stream composition changes.



Calibration



5. Process results = Lab results

During the last 25 years, GRABNER INSTRUMENTS MINIVAP lab vapor pressure testers were installed in almost every refinery all over the world. Because the MINIVAP ON-LINE analyzer is using exactly the same measuring principle, there is no need to validate measurement results against laboratory tests: Results are just as precise and reliable as results are with the best standard compliant vapor pressure laboratory instrument – the MINIVAP lab analyzer.



6. Fast and easy maintenance

MINIVAP ON-LINE incorporates an automatic piston lubrication and extensive self-diagnostics, thus virtually no operator work is required. For best performance in ex-areas, a nitrogen feed line is recommended.



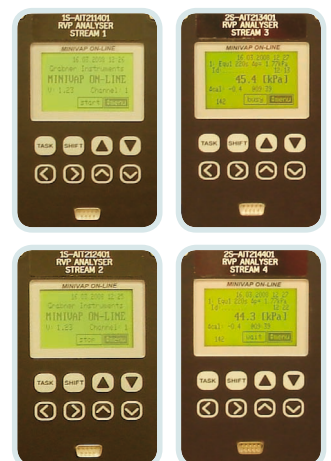
For fast and easy service of the MINIVAP ON-LINE our customers recommend to purchase the additional measurement cell along with the analyzer. The measurement cell is mounted with quick fittings and can be exchanged in 1 minute! No down times are experienced in process!

Advantages of an additional measuring cell

- Easy access to measuring unit
- No tools required to replace measuring cell
- Only 5 quick connectors to detach the cell
- 1 minute exchange time!
- No down time in process
- Cell can be mounted on any MINIVAP ON-LINE analyzer without additional calibration
- Easy attachment to a service unit for error diagnosis and recalibration

7. Data transfer - full networking capabilities

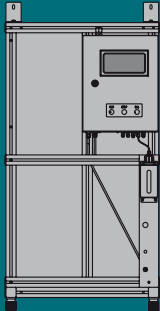
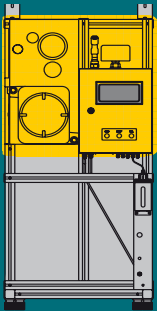
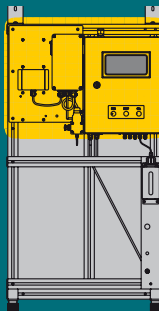
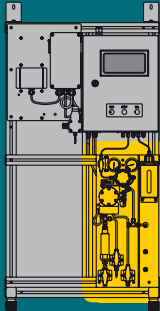
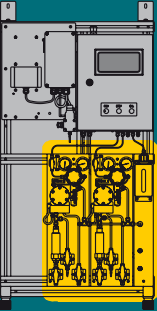
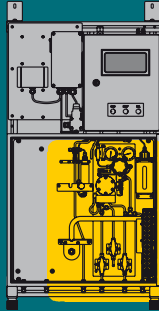
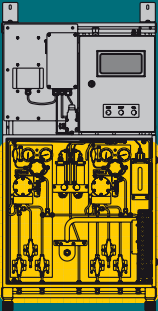
Data can be transferred automatically to a monitoring system via preinstalled MODBUS RTU to be displayed on a screen. Alternatively, 4-20 mA data transfer is possible via modem or central controller unit. With this information readily accessible, corrections (e.g. for the blending system) can be initiated immediately, if a fixed limit is exceeded – for multiple MINIVAP ON-LINE analyzers in one central command place!



MODULAR DESIGN

MINIVAP ON-LINE can be configured according to your needs:

- US or EU version
- Explosion proof or basic type
- 1 or 2 sample streams
- Gasoline, LPG or Crude Oil functionality

BASIC (non ex)	US EX BEBCO	EU EX Gönheimer	
	 US EX px purge control unit: NEMA Class 1, Div 1, BCD, T6, Type X	 EU EX purge control F850S: EN 60079:BVS 06 ATEX E 088; EN954-1 Cat. 3	
GASOLINE & LPG		CRUDE OIL	
Single Stream	Dual Stream	Single Stream	Dual Stream
			

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