



Nanoparticle
Management

RAWGASDILUTER**MD19-E3**



Nanoparticle management

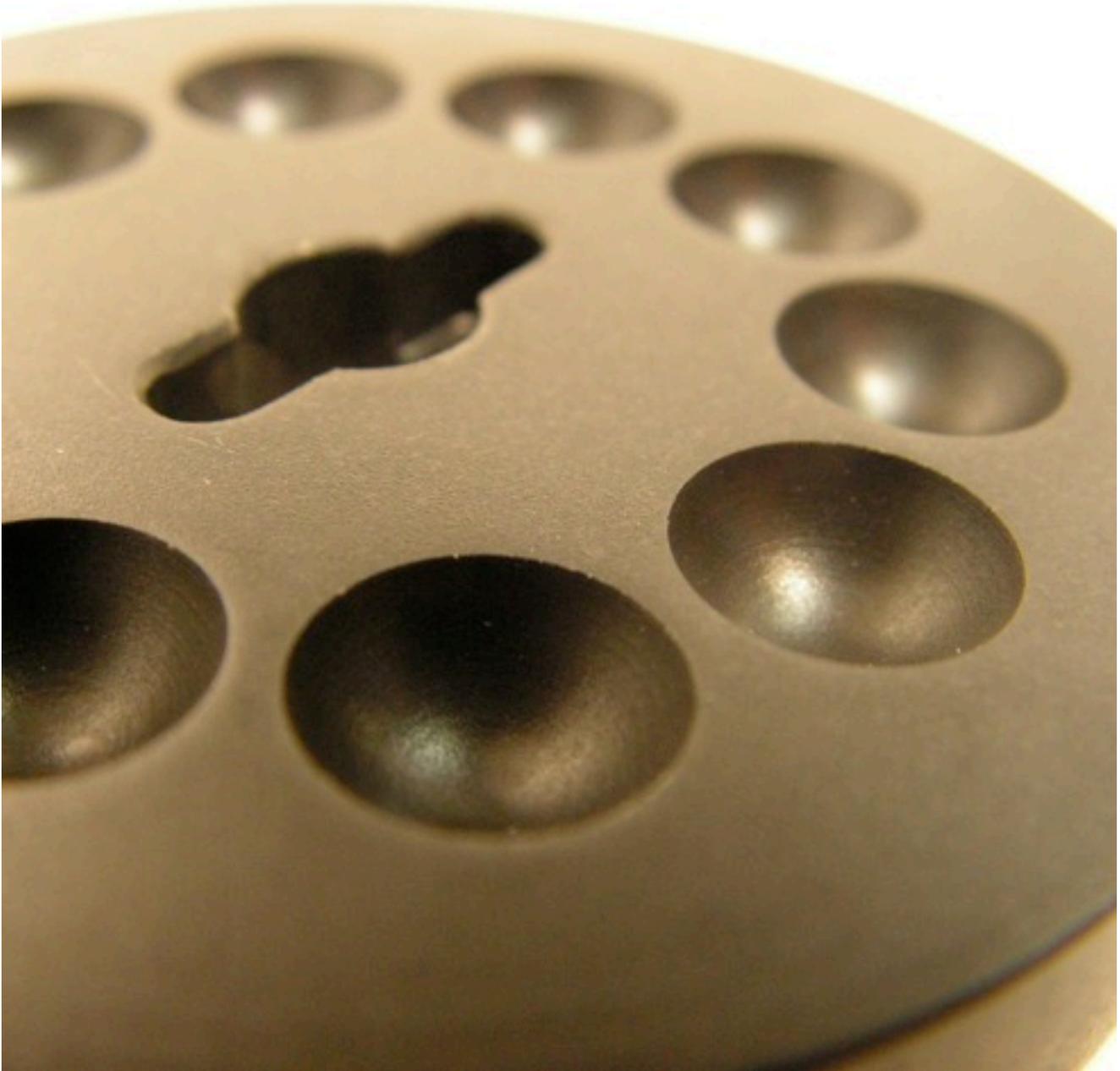
Goals | Values | Visions

Matter Engineering is a world leading provider in the field of nanoparticle measurement. Primarily specializing in workable and realistic analysis of nanoparticles and various particle generator devices we are able to offer measuring devices as well as full range service of ultimate perfection.

Although we are – founded in 2001 – we unify an over 50 year experience in design of instruments and nanoparticle research.

Close cooperation with leading institutions – such as ETH Zurich – advance our high demand on excellence.

From coal-fired power plant up to automotive industry: For all matters of efficient measurement and generation of nanoparticles, Matter Engineering is your partner.



DATASHEET MD19-3E



Accurate dilution of aerosols requires precise and stable mass flow control, specially if large dilution ratios and ranges are requested. The rotation dilution method avoids several problems of the conventional dilution technique and opens new ways for application in aerosol and gas

measurements, particularly in processes where programable dilution ratios in a large range are required.

MD19-3E is a source/stack version for direct sampling on stacks or exhaust pipes. The undiluted gas parts, the dilution unit, and the dilution air may be heated up to selectable temperatures of 150 °C. This avoids condensation of raw gas components sampled from

stacks and exhaust pipes. Sampling and dilution at different temperatures allows one to distinguish between solid particles and volatile droplets which can be formed

BENEFITS OF A ROTATING DISK THERMODILUTER

Usually instruments which determine nanoparticle number concentrations have specific measuring ranges, wherein measurements are possible or best accuracy of the determined values is reached. With the rotating disk diluter it is possible to adapt particle number concentrations to the measuring range of the applied particle sensor.

Particles in the nanometer range tend to coagulate which means smaller primary particles meet together and build larger secondary particles. This leads to smaller particle numbers and a displacement of the particle size distributions. In the diluter the particle concentrations are reduced as close to their emission source as possible before being transported to the measuring sensor and the coagulation effects are reduced significantly.

Depending on fuel and combustion parameters like air humidity, temperatures and residual times, combustion generated aerosols mostly do not only contain CO₂ and solid particles but also water vapor and other volatile components which may condense out if the temperatures drop to ambient conditions, resulting in liquid particles which may damage or pollute the measuring sensors. In the MD19-3E diluter head these components are at first evaporated and then diluted. At low concentrations, they remain dissolved in the surrounding gas and will therefore not affect solid particle measurements anymore.

Since the exhaust raw gas pressure can go up to 300 mbar (at 200°C) it is now possible not only to measure downstream the particle filter but also upstream the filter which eases considerably the test bench installation).

The fully remote system allows a much better flexibility, no need to start and stop manually the pump anymore. the complete system is now computer remote controlled.

The plug-in operation with the thermo-diluter ASET15-1 is ensured, both with the old MD19-2E and the new MD19-3E. The diluter can be assembled from its stand alone version into the ASET15-1 to build a complete compliant VPR (ECE-R83 or Euro 5b/6).

ROTATING DISK DILUTER

The new MD19-3E is a re-engineered diluter. It keeps all advantages which a rotary diluter system brings with, the dilution ratio ranging from 1:15 up to 1:3000. The mobile dilution head method allows to dilute the nearest possible to the aerosol source. This flexibility in the probe intake saves costly add-ons to avoid particle coagulation. New tubing material from the dilution head to the pump reduces the particle losses,

TOTAL COST OF OWNERSHIP

New solutions were searched meeting the following conditions: The durability of a disk and block combination should not depend on extremely narrow tolerances in the different production steps nor surface qualities and coating parameters. The unique used disk material has a high heat conduction leading to small temperature gradients, and a low thermal expansion coefficient. The coated disks slide smoothly on the highly polished and treated steel block. Furthermore the disk and block were improved by some new additional components. More than 1000 operation hours are achieved if disk and block surface are regularly cleaned as required in the manual.

In addition the peristaltic pump has been changed to a rotating pump for better durability. The maintenance will be dramatically reduced due to the replacement of the pump, no more need to change the peristaltic pump tube, the new coated rotating disk which increase the lifetime of the dilution head can be easily replaced with our «*fast lock system*».

A smaller cyclone will allow to save the massive MDx casing. The new cyclone is much smaller and does not need an extra pump. The lightweight cyclone contributes also to the reduction of the general size of the diluter head. The weight reduction of the global system will allow improved handling, flexibility and ultimately save installation and maintenance costs.

Mechanical improvements has also been made such as the «*fast lock system*» and the new bearing system which will reduce dramatically maintenance downtime. Various new features on the software such as heating and rotation speed error indicators help to avoid operator errors and contribute to reducing the total downtime of the system



LOW DOWNTIME

Smart calibration

A variation of Murphy's law states that critical components of measuring equipment will invariably drop out of service exactly at the beginning or very little into the most important measurement campaign. If downtime as such and in planned intervals is expensive, the ability to avoid Murphy-induced downtime is priceless.

Up to now a diluter with block/disc failure had to be returned to Matter Engineering in Switzerland, or at least an authorized dealer, for repair and calibration. With MD19-3E this will be necessary only in very exceptional cases, since the new mechanical design offers several on-site solutions:

Purchase pre-calibrated extra block/disks together to quick swapping with the original if replacement is needed.

Purchase un-calibrated extra discs at any time; accuracy of the diluter remains stable at a new value within +/- 8% of the original calibration.

In this case we recommend annual re-calibration, For PMP application we offer a complete PMP calibration including all 45



NEW DILUTION HEAD

The newly designed diluter head is fulfilling our lifetime expectation of 1000 hours. It not only available on the new MD19-3E but also as an exchange sub-unit for existing MD19-2E. The routine repair of the block/disk has never been easier with our new «fast lock system».



INTERNAL PUMP

The new internal membrane pump has a longer lifetime than the former peristaltic pump. Therefore, no particular intervention by the customer is needed to keep the pump going. No more action is needed except standard maintenance to operate the diluter throughout a longer measurement campaign.



QUICK BAYONET TUBING CONNECTORS

A quick and fast bayonet connection as been used to quicken assemble and disassemble of the tubing.



**OPTION:
CYCLONE PCF2.5**

In case of high dust concentration in the exhaust our cyclone PCF2.5 is highly recommended between sampling tube and exhaust probe to precipitate particles larger than 2.5-10 µm. For long time sampling (more than a

few hours), it is recommended to clean the sampling tube by periodically blowing compressed air back into the tube. This can be done by using two valves, one valve to protect the exhaust probe while the second valve is opened to the compressed air supply.

DILUTER GENERAL FEATURES

Rotation disk system.

1000 hours lifetime of consumables

Pressure-resistant for exhaust pressure up to 500 mbar above ambient

Temperature-tolerant for exhaust temperatures up to 200°C.

Smaller & simpler cyclone without dedicated pump.

Easy access to the cyclone's cadgment tank.

Durable block/disk material also available for upgrade of MD19-2E units

Improved geometry and material for the MD19-3E Block/Disk

Low-maintenance raw gas pump

Optimized general design of diluter head

improved aerosol tubing

Option to feed raw gas back into source - outlet at diluter head

Full conformity with European CE standard

Diluted gas max flow up to 5 lN, up to 16.5 lN with the ASET15-1

Stand-alone operation or with a secondary thermo diluter (ASET15-1)

Raw gas probe inlet at the mobile diluter head

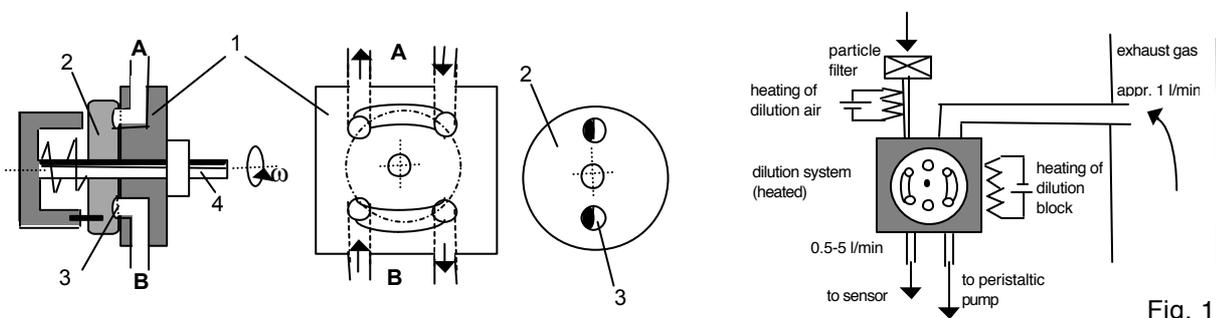
Mechanics
More durable construction of bearings and axle coupling
Fully remote controlled (in association with the CU-1)
Easier and quicker block/disk assembly
Redesigned block and dilution air heating system
Fast lock system
Software / remote (in association with the CU-1)
Visual display (remote)
Records all parameters and error report
Monitors dilution factor (nominal and actual value)

WORKING PRINCIPLE

Fig. 1 illustrates the principle of the dilution method. There are two separate gas channels: The raw gas channel and the diluted measurement channel, yet small volumes are transported from the raw gas channel to the

measurement channel by cavities in a rotating disk. The ratio of dilution of raw gas is a linear function of the cavity volume, the number of cavities on the disk, the frequency of rotation, and the flow in the diluted gas

channel. This method accomplishes dilution of gas and/or aerosols in a range of over 2 decades with high precision and stability. Gas flows are controlled and regulated.



- | | |
|--------------------------|------------------------------|
| A raw gas channel | B measurement channel |
| 1 body | 2 rotating disk |
| 3 disk cavity | 4 axis of rotation |

Fig. 1

TECHNICAL SPECIFICATIONS

GAS SPECIFICATIONS

Nominal dilution ranges	1:15 ... 1:300 (10 cavities on disk, Fd = 0.6 ... 1.5 l/min) 1:150 ... 1:3000 (8 cavities on disk, Fd = 0.6 ... 1.5 l/min)
Input gas flow Fu	2 l/min
Admissible output gas flow Fd	0.6 ... 5 l/min
Accuracy	± 10 % within range specified in Fig. 3 using the calibration factors for the dilution ratios from the calibration protocol supplied with the diluter The dilution unit may also operate correctly at lower Fd and ratio adjustments but without guarantee for compliance with the specifications
Resolution	Output number concentration < 0.5 part./cm ³ at dilution setting 0 % (if dilution air is taken from internal filter and ambient particle concentration does not exceed < 1E4 part./cm ³)
particle size range	10 ... 1000 nm
temperature	0 ... 200 °C gas temperature and vapor pressure of raw gas must be within a range where no condensation occurs at the temperature chosen
differential pressure	+300 mbar between measurement channel and ambient air
Heating	Adjustable temperature of dilution block and dilution air on rotating switch between OFF / 80 / 120 / 150 °C

MECHANICAL SPECIFICATIONS

Construction	1/2-19" plug-in unit (3HU/42TE) in laboratory case with handle
Dimensions	258 x 148 x 312 mm (WxHxD)
Weight	8 kg
Analog In/Out, Error output	25 pol. Sub-D-Connector (female) on rear side
Supply	mains connector with switch and fuse on rear side
to dilution unit:	Triple gas connector to input and output of measurement channel and to raw gas.
to sensor:	Swagelok for tube with outer diam. 6 mm on front or rear side

ELECTRICAL SPECIFICATIONS

Dilution adjustment	10 turn potentiometer with scale 0...100 % on front panel Analog input 0...10 V DC 5...100 % or 0,5 ...10 V DC correspond to 1:300 ... 1:15 for 10 cav. disk 1:3000 ... 1:150 for 8 cav. disk
Analog/digital interface	on 25 pole D-sub female connector
Analog in-/outputs:	0-10V, Records all parameters and error report
Power supply	90 ... 260 V, 50/60 Hz, max. 140 VA



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