



Dr. Födisch
Umweltmesstechnik AG

Dr. Födisch Umweltmesstechnik AG
Zwenkauer Strasse 159
04420 Markranstädt
Germany

Phone: +49 34205 755-0
Fax: +49 34205 755-40
E-mail: sales@foedisch.de
Internet: www.foedisch.de

GMD 13

New gravimetric measuring system with evaluation on location



Measurement of dust content can be necessary at industrial facilities for a number of reasons. At larger plants (e.g. power-generating, waste incineration and cement plants, for instance) there is the necessity of continuously monitoring waste gases for emissions content. At installations with a lower emissions potential, it is nonetheless necessary to check the concentrations of specific pollutants by means of individual measurements made at regular intervals. Measurements of dust content can also be performed in a similar manner on filter systems and separators, for the purposes of acceptance inspections and/or performance trials.



Various measuring methods (e.g. optical or tribo-electric) can be used for continuous measurement of dust concentration. All the measuring instruments used for this have in common that they need to be calibrated under specific plant conditions after installation and, generally, at intervals of three years subsequently. This calibration operation is performed by means of gravimetric control measurements, which are also used for the above mentioned individual measurements.

For this purpose, a particle-laden sample of gas is taken under defined conditions from the waste gas flow and fed through a filter sleeve or a plane filter. The unladen weight of the filter is determined after its elaborate pre-conditioning. Conditioning is then repeated, and the weight of the laden filter then measured. This is normally done in an analytical laboratory.

Every individual sampling operation on location normally takes 30 min. Not less than 15 samples taken on three days are necessary for control measurement for calibration purposes, during which the half-hourly averages of the continuously operating measuring instrument are recorded simultaneously.

The necessary procedure is standardised under DIN EN 13284-1 and VDI 2066, Part 1, *inter alia*, in order to assure the obtainment of representative results. Immediate statement of the dust content at the plant is not possible during the measurements, however. The actual dust content can be stated only once the filters have been weighed under defined conditions in the analytical laboratory. This, under certain circumstances, can take several days. This time lag is unsatisfactory in some cases, particularly in the context of acceptance and/or control measurements abroad. Parallel evaluation in the immediate vicinity has remained impossible up to today, despite the fact that measurements of dust contents of this type have been performed since as long ago as the 19th century.

Current state of the art

The technological state of the art is characterised by the standard procedures and instruments from a range of suppliers and now in use for decades. It is necessary to differentiate between sampling systems, equipment for pre- and after-treatment of the samples, and the actual weighing systems.

This standard reference-measurement procedure is described in detail in DIN EN 13284-1 and VDI 2066, Part 1. The principle of gravimetric measurement is shown in Figure 1. Before measurement is started, the filter holder or the plane filter from the measuring system is submitted to pre-treatment and then weighed. Under DIN EN 13284-1, the temperature in the drying cabinet for the filters and for any other items to be weighed should be 180 °C, and cooling in the desiccator should extend for not less than eight hours.

Since the difference between the weights measured before and after lading of the filters is used to determine dust content, DIN EN 13284-1 requires that after-treatment be extremely similar. Drying after removal of the dust should take place for more than one hour at 160 °C. The cooling time in the desiccator down to the temperature of the room in which weighing is performed should be eight hours. Other temperatures may be selected, depending on the properties of the particulate and, in particular, its thermal stability.

Extractive sampling for the capture of particles must be conducted isokinetically. This means that the taking of the volumetric side-stream must be accomplished at approximately the same velocity as that of the main

flow of waste gas, in order to preclude segregation phenomena during sampling. A nozzle diameter appropriate to the suction rates to be established must be used for this purpose. DIN EN 13284-1 requires the use of nozzles with a diameter of not less than 8 mm. Knowledge of flow conditions in the measuring cross-section is also required.

Measurement using a pitot or Prandtl tube with a pressure-gauge connected must be performed if the waste gas velocity at the measuring point is not known. Total pressure and static pressure are read by the hook-shaped probe of the Prandtl tube, which faces into the waste-gas flow, and local velocity calculated from the differential pressure and gas density. Measurement is performed using a differential-pressure gauge. DIN EN 13284-1 requires that this measurement be made continuously, or at intervals of not longer than five minutes, during sampling.

The value for the dry volume of gas for measurement suctioned off is available on the spot at the end of the measurement. Weight difference is determined following after-treatment of the filter in the laboratory. Dust concentration in mg/m³ (dry, standard temperature and pressure) is calculated using this and the volume of measuring gas suctioned off.

The gravimetric dust measuring systems available on the market achieve, in combination with the laboratory equipment used, measuring accuracies ranging from approx. 0.1 to 1 mg/m³.

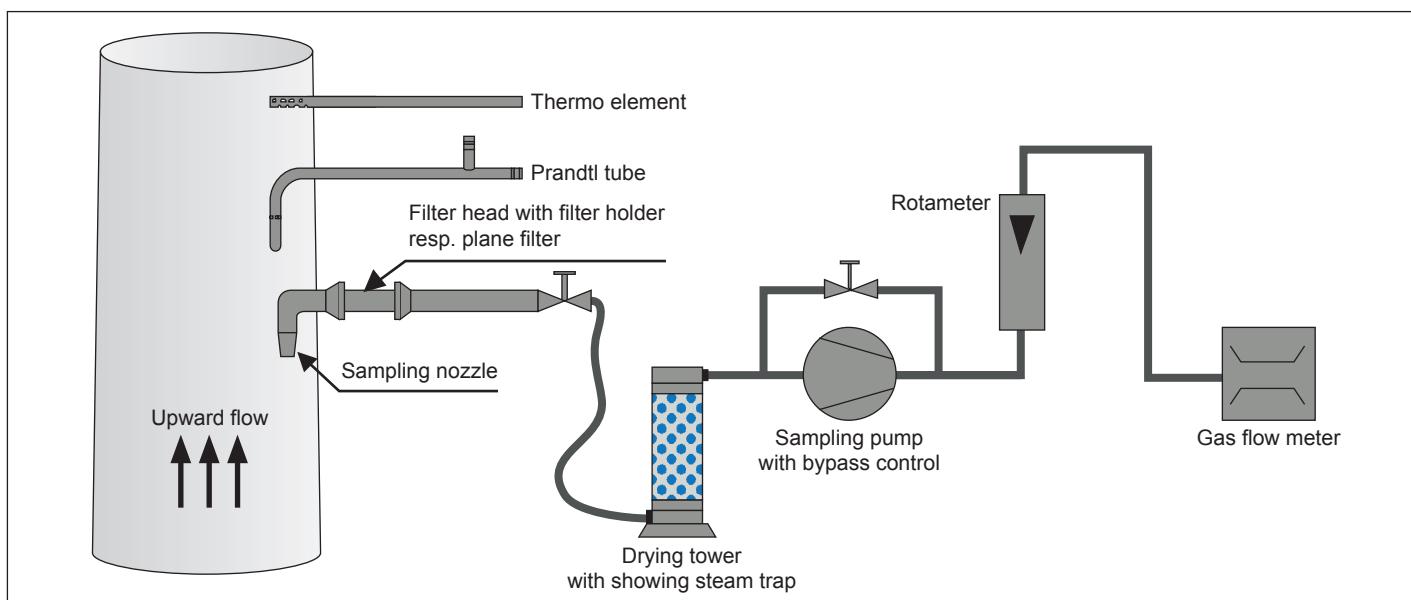


Fig. 1: Gravimetric measurement according to DIN EN 13284-1

The gravimetric measuring system GMD 13

The GMD 13 of Dr. Födisch Umweltmesstechnik AG is a compact and high-grade automated system for isokinetic gravimetric dust measurement in exhaust ducts and stacks in dependence on DIN EN 13284-1.

The system is a further development of the established GMD series, which has been successfully marketed by Dr. Födisch Umweltmesstechnik AG for the purpose of gravimetric control measurements for a number of years now.

The device's integrated hot-weighing system makes it the world's first measuring system to enable the user to state information on the dust concentration measured gravimetrically only a short time after measurement. Additional laboratory equipment for gravimetric measurement is then no longer necessary; transport and the necessary time are therefore also eliminated. The simple and reliable structure of the system, in combination with the project-orientated software package, also minimises error sources during measurement.

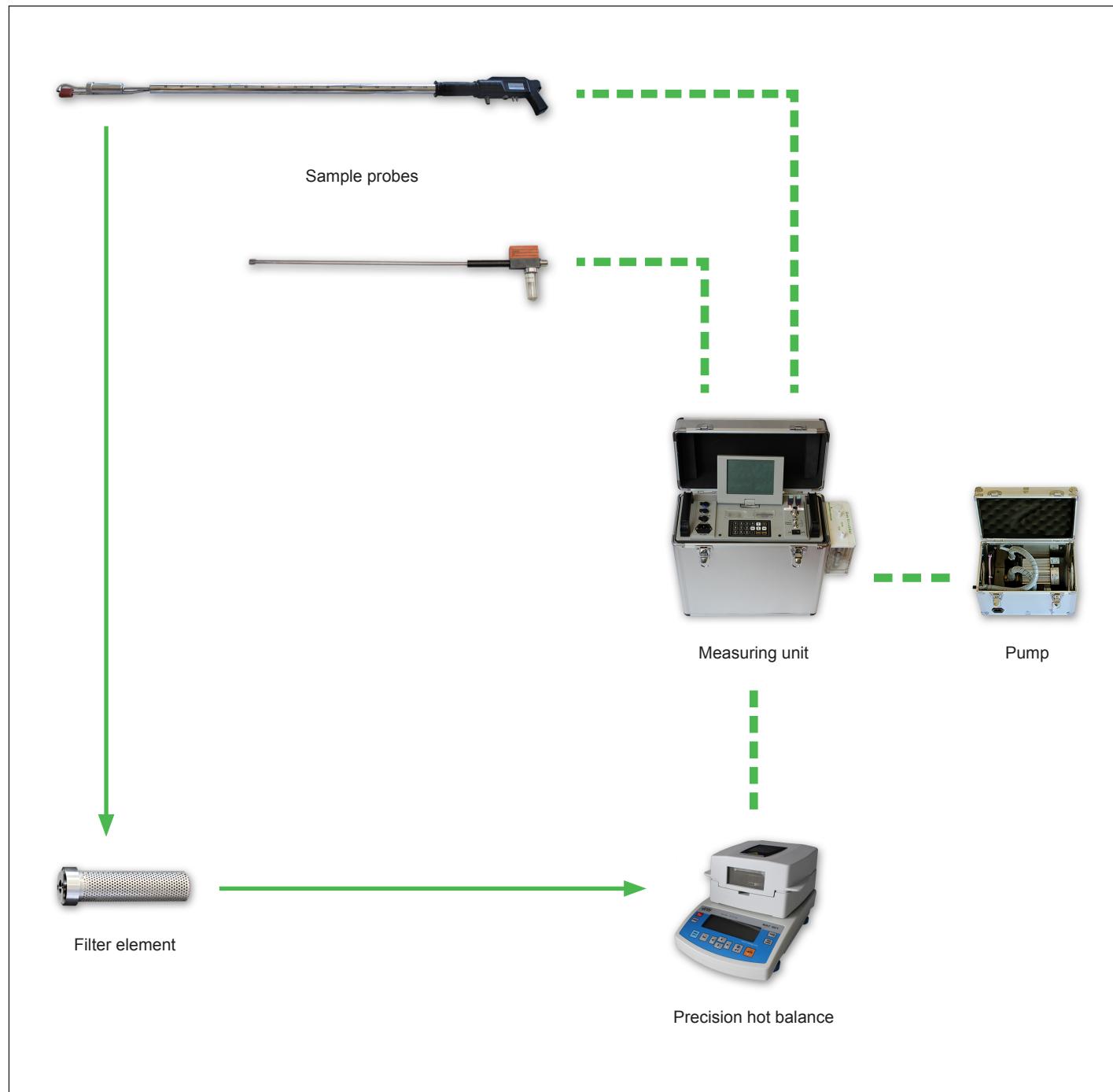


Fig. 2: The gravimetric measuring system GMD 13

Measuring installation at dust sampling

By means of the GMD 13 the measuring gas velocity, the measuring gas pressure and the sampled measuring gas volume are registered. Besides, the measuring gas humidity can be measured by a separate sample probe. Consequently, all relevant parameters for determination of dust content are registered by the system on standard conditions and the measuring gas sampling is regulated fully automatic isokinetic.

The equipment's control system features two additional mA measuring inputs (0 - 20 mA). These can be used

during sampling to record the measured data supplied by any automatic dust-measuring systems installed, thus eliminating the need for a separate recorder. In the case of plants on which no continuous measuring system is installed, it is also possible to operate a directly indicating dust-measuring instrument or a dust sensor in parallel (e.g. the PFM 13 C of Dr. Födisch Umweltmesstechnik AG). This instrument is actively supplied at 24 V by the GMD 13. By parallel operation operational system modifications can be automatically registered and analysed.

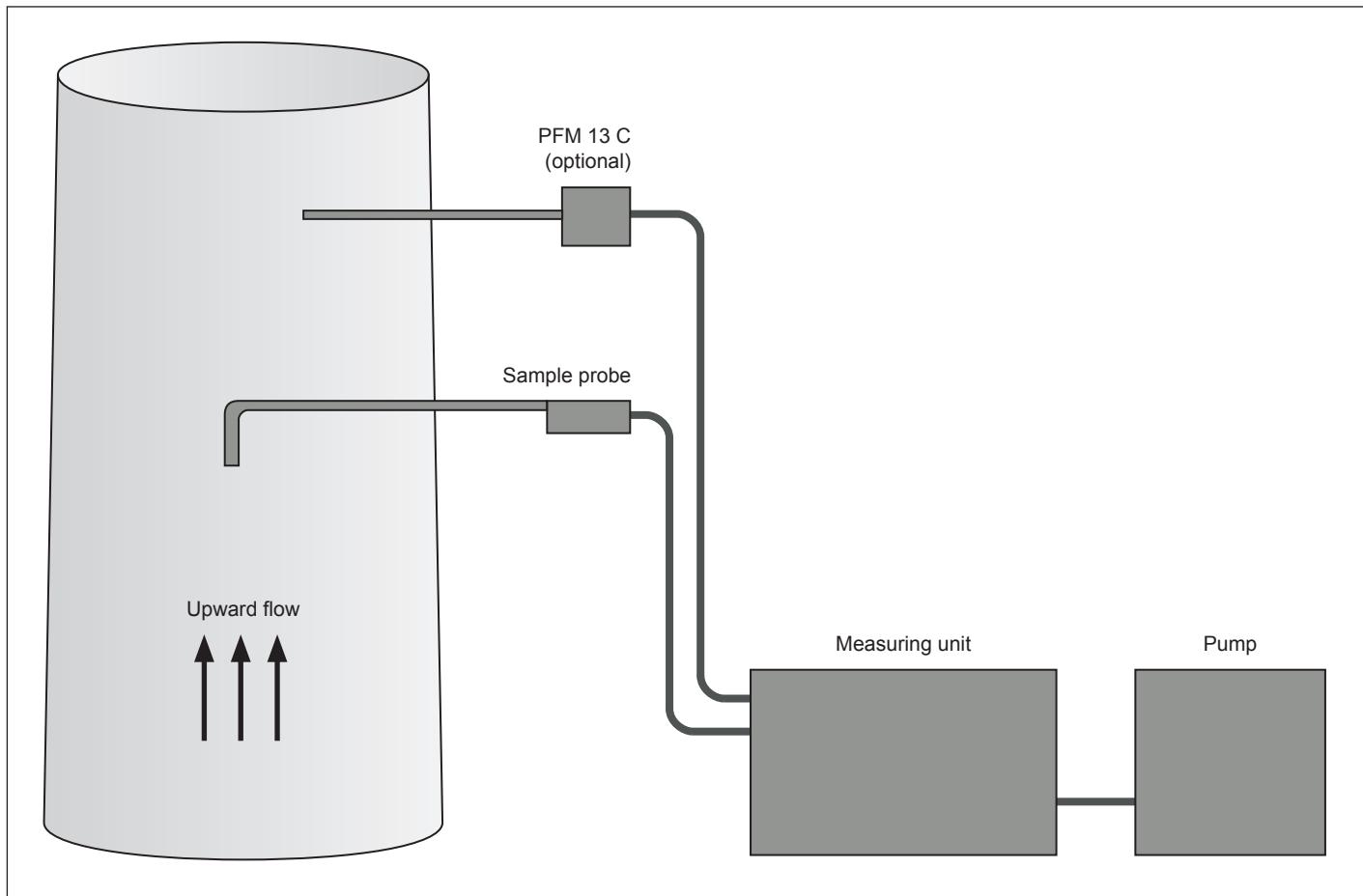


Fig. 3: Measuring installation at dust sampling (optionally with PFM 13 C)

Hot weighting on location

The new gravimetric measuring system GMD 13 permits easy and safe handling of the complete system on location.

The precision hot balance is kept in its carrying case for transportation.

The essential advancement of the GMD 13 is the patented method of hot weighting of the filter integrated in the measuring system. Thereby the extensive conditioning before and after the dust sampling does not apply and there is the possibility to determine the measured dust content promptly still on location.

Conditioning is now superfluous, because the filter is heated so intensively during weighing that its entire water content is expelled. The filter can be heated to up to 160° C during the weighing operation using the precision hot balance.

The used filters consist of pressed fibre glass and require extremely careful handling. To assure this, the used filter is protected by a robust filter holder which is



Fig. 4: Precision hot balance with carrying case

weighed together with the filter during hot weighing. The weighting of the complete filter element is admissible according to DIN EN 13284-1.



Filter holder

Filter

Filter holder head

Fig. 5: Filter element

Value accuracy

Before weighing, the precision hot balance is tared and connected directly to the control system of GMD 13 on the measuring unit. Weighing using the precision hot balance is performed prior to and after gravimetric measurement in a clean, draft-free and vibration-free room (e.g. office, workshop, hotel room).

The control system guides the user through the weighing process, and receives the measured data. No settings on the precision hot balance are necessary. Weighing is performed semi-automatically at an accuracy of less than 1.0 mg. Completion of weighing is signalled by means of an audible tone.

By multiple weighting of the same filter element the weighing accuracy can be improved to 0.4 mg with

passable expenditure of time. Already after approx. 3 to 5 weightings a steady average value results, so that precise measuring results can be achieved.

Figure 6 shows typical measuring values of a multiple weighting at two measuring days with 11 weighting in each case. Already after the 5th repetition weighting the weighing difference of the determined average values lies under 0.25 mg. Even larger variations, for example by the large deviation of a single weighting (see marking), affect the average value non-significant.

The time requirement for the first weighing operation varies between 5 and 30 minutes, and the time necessary for further weighing operations between 3 and 15 minutes per operation.

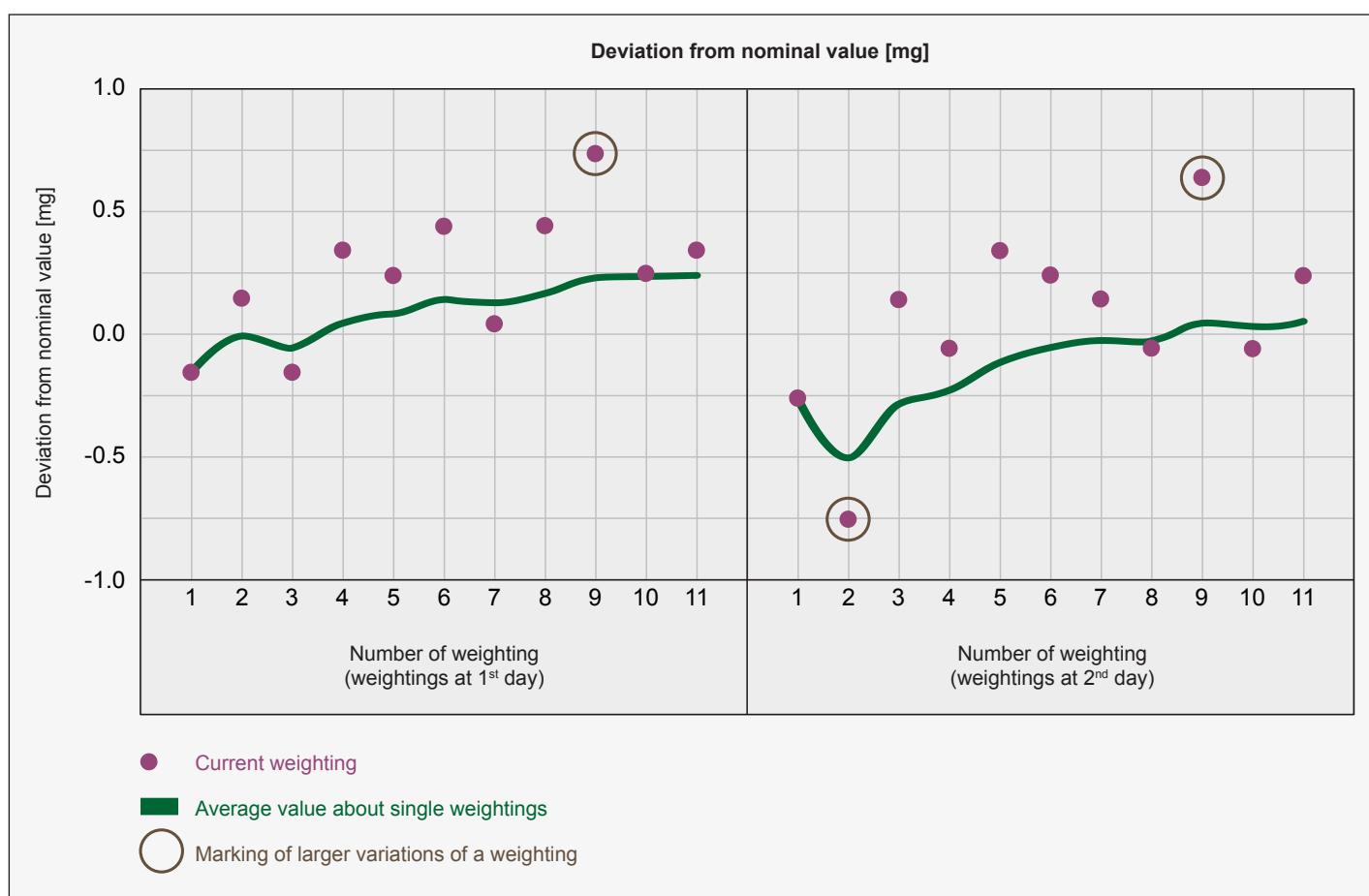


Fig. 6: Improvement in weighing accuracy via multiple weighing of one filter element

The software, which has been revised compared to previous models, acts project-based. By different filters all measurements and settings of a measuring point are summarised in a project and evaluated together. Besides, the results of a weighting according to DIN EN 13284-1, can be input into the measuring unit and used for evaluation.

At dust sampling, the pressure drop across the filter and, optionally, the signals on the mA inputs during measurement, can be shown in graphic form on the measuring unit's display.

The device's measured data can be outputted on location, or written to a CompactFlash memory card, to permit their further use on a PC.

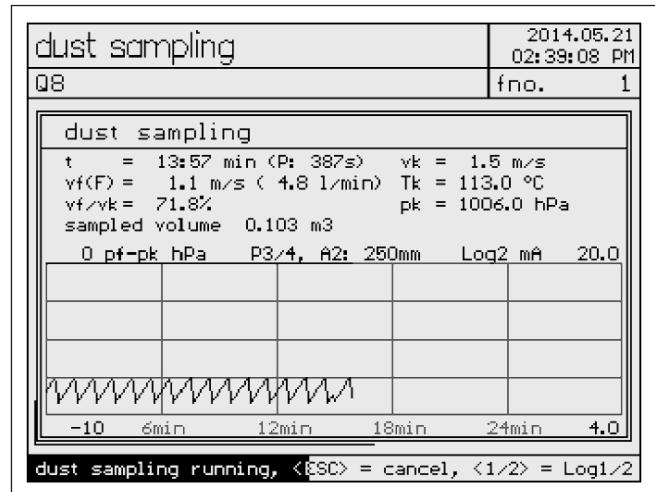


Fig. 7: Display of measuring unit of GMD 13 at dust sampling

Measuring procedure and results

The procedure for gravimetric measurement using the GMD 13 is as follows:

1. Creation of a new project and planned filters/ measurements using the instrument's software; preparation of the required filter holders with the filters
2. Placement of the precision hot balance in a dry, draft-free, vibration-free place
3. Weighing of the filter holders and filters using the precision hot balance
4. Installation of the measuring system at the dust sampling point
5. Measurement of absolute moisture content in the waste gas at the dust sampling point using the moisture probe and/or adoption of a known measured value and entry of gas parameters (O_2 , CO_2)
6. Measurement of waste gas velocity using the dust probe and installation of the sampling nozzle
→ The GMD 13 supports selection of a suitable sampling nozzle.
7. Entry of the boundary parameters for measurement (measuring time, cross-section, flange depth, measuring points)
8. Insertion of the filter element into the filter mounting of the dust sampling probe
9. Start of measurement / dust sampling
→ Any change of measuring points is acoustically signalised and visually displayed, depending on specification.
10. Repetition of measurements using other filter elements (as described in steps 8 and 9)
11. Weighing of the filter elements using the precision hot balance (same balance, same weighing place)
12. Computation of the results of the dust sampling by the GMD 13
→ The results are outputted on the display, by means of a printer, or by means of read-out of the CompactFlash memory card on a PC.

Figure 8 shows a comparison of the dust concentrations determined by means of hot weighing using the GMD 13 and by means of weighing in accordance with DIN EN 13284-1 (32 measurements at the dust duct).

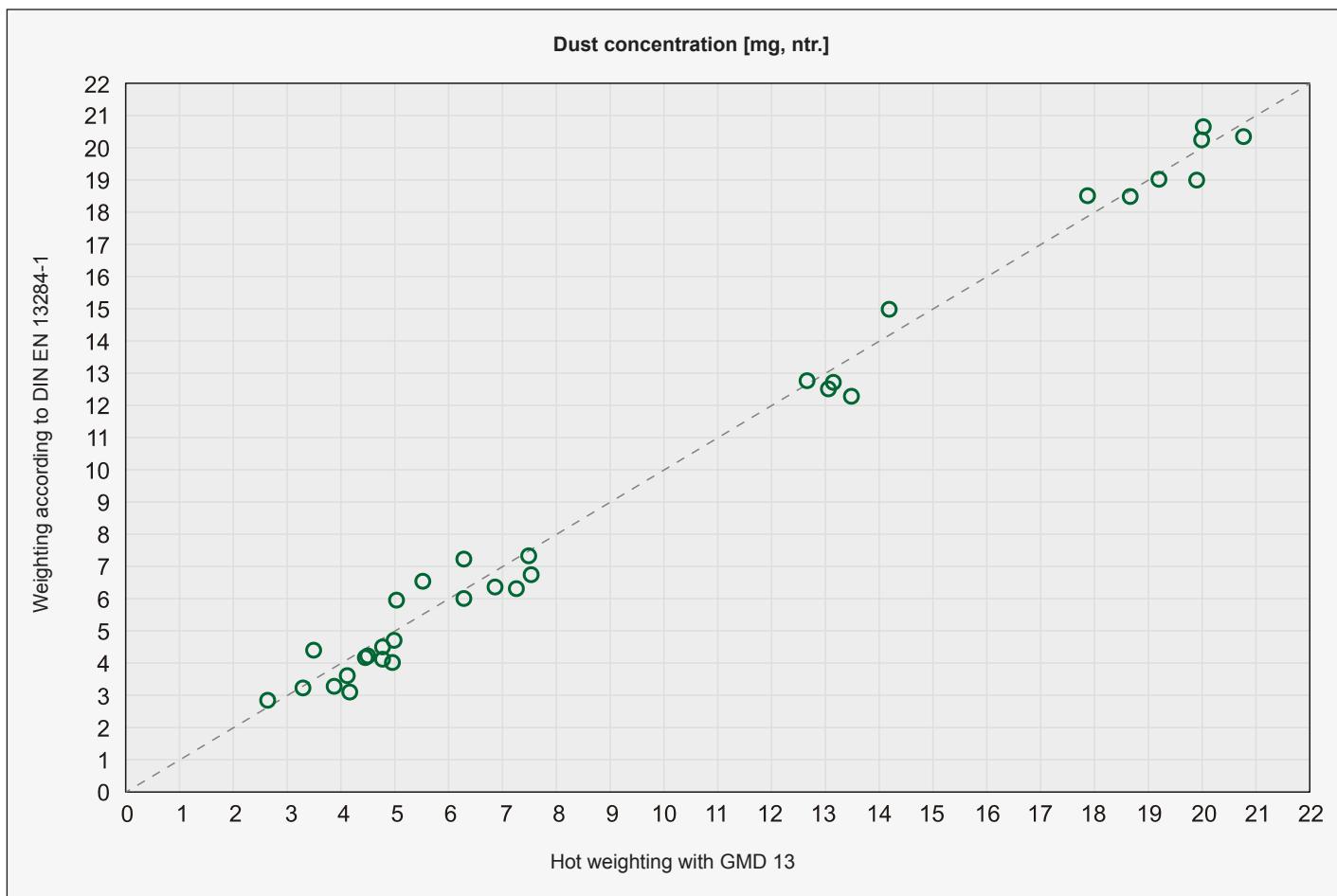


Fig. 8: Dust concentration, comparison of weighing procedures of GMD 13 and according to DIN EN 13284-1

Conclusion

The GMD 13 of Dr. Födisch Umweltmesstechnik AG is a compact and highly automated system for isokinetic gravimetric measurement of dust content in waste gas ducts and stacks. All relevant variables are registered under standardised conditions for determination of dust content and measuring gas sampling is isokinetically regulated fully automatically. The system's simple and reliable structure, in conjunction with the project-based software used, assure accurate measuring results.

The device is the first measuring system in the world featuring integrated hot weighing and the capability for evaluation on location with no additional laboratory equipment. It also permits operation in parallel with a directly indicating dust-measuring instrument and/or a dust sensor, so that system changes caused by operating conditions can be automatically registered and evaluated.

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