Application Note Filter Kit

Determining Particulate Matter
Filter Weighing Solutions

Outstanding repeatability and fast stabilization times make METTLER TOLEDO Balances the ideal solution for determining particulate matter. A specially developed Filter Kit ensures simple handling.

Weighing a 70 mm filter with an Excellence XP2U Ultra Micro Balance from METTLER TOLEDO

METTLER TOLEDO

Introduction

The following example of filter weighing with a METTLER TOLEDO XP2U Ultra Micro Balance demonstrates the reliable measurement of particulate matter with fast stabilization times.

The majority of countries regulate the maximum permissible emission and imission levels of suspended solids with a particle size < 10 µm (PM10) and of alveolar particles with a size < 2.5 µm (PM2.5) which are capable of reaching the pulmonary alveolus [1, 2].
The gravimetric determination of the conditioned filter residue serves as a reference method for the measurement of the particulate matter [3-11].

Excellence XP2U Ultra Micro Balance with Filter Kit and AntiStatic Kit

Meeting regulations
Guidelines and regulations define the procedures to ensure reproducible filtering of emissions and imissions and specify which filters should be used. They also determine the weighing system to be used for the measurement.

As a general rule, a resolution of 1 µg or 0.1 µg with corresponding repeatability is specified. METTLER TOLEDO's Filter Weighing Solutions fulfill these requirements.

The following example for filter weighing with an XP2U Ultra Micro Balance demonstrates fast stabilization times and reliable particulate matter measurement in accordance with existing guidelines.

Literature
(1) Summary of worldwide diesel emission standards, http://www.dieselnet.com; 23.10.2008
(2) WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide – Global update 2005 – Summary of risk assessment, http://whqlibdoc.who.int; 23.10.2008
(3) Title 40, CFR – Protection of Environment, http://ecfr.gpoaccess.gov; 23.10.2008
(4) DIRECTIVE 2004/26/EC of the European Parliament and of the Council; 21 April 2004
(5) DIRECTIVE 2005/55/EC of the European Parliament and of the Council; 28 September 2005
(6) COMMISSION DIRECTIVE 2005/78/EC
(7) DIN EN 12341, 1999-03; Air quality - Determination of the PM10 fraction of suspended particulate matter
(8) REGULATION (EC) No. 715/2007 of the European Parliament and of the Council
(9) Swiss Clean Air Act,16 December 1985 (LRV), http://www.admin.ch; 23.10.2008
(10) Title 42, US Federal Code USC – The public health and welfare; 3 January 2006
(11) Perfect weighing for pollution monitoring; Mettler-Toledo AG, 11795856, 09/2006

Equipment

- XP2U Ultra Micro Balance, METTLER TOLEDO (ME-11122430)
- Filter Kit for filters with Ø 47mm and Ø 70mm, METTLER TOLEDO (ME-11122136)
- U-Electrode small, METTLER TOLEDO (ME-11140161)
- Power supply unit for AntiStatic Kit for XP Balances, METTLER TOLEDO (ME-111140161)
- T60A20 filters consisting of borosilicate glass, coated with TFE, (PALL™)

Filter weighing method

Default balance settings

- Application: statistics, automatic weight transfer: on
- Limit: 0.05 g
- Delay time: 0 sec.
- SmartSens: door; ErgoSens-1 (AUX): AntiStatic Kit (for closed door: 0 sec. on); Plausibility Check: 15 %

1. Reset to zero ->0<-
2. Define the "Max n" quantity of repeated individual measurements (e.g. 10 for 10 filters).
3. Open the doors with SmartSens and pass the acclimatized filter through the U-Electrode to neutralize any electrostatic charge. (AntiStatic Kit automatically switches on when the door is opened).
4. Carefully place the filter onto the weighing pan and close the draft shield door.

5. Manually confirm the weighing result. In the case of further measurements, the value is transferred automatically and the most recently calculated mean value and standard deviation (sd) can be viewed on the balance display.
6. Remove the filter from the weighing chamber and close the draft shield.
7. Repeat points 3-6 for each filter.
8. The filter(s) can now be used in accordance with the specified filtering regulations.
9. The weight of the filter residue is determined by residual weighing. Points 3-6 are repeated again for each filter.

   Note 1: In the case of repeated measurements, the range of the two mean weights is used for the calculation.

   Note 2: Appropriate electrostatic grounding must be in place for all operating steps (e.g. by means of antistatic wristband, conductive tweezers).

Results

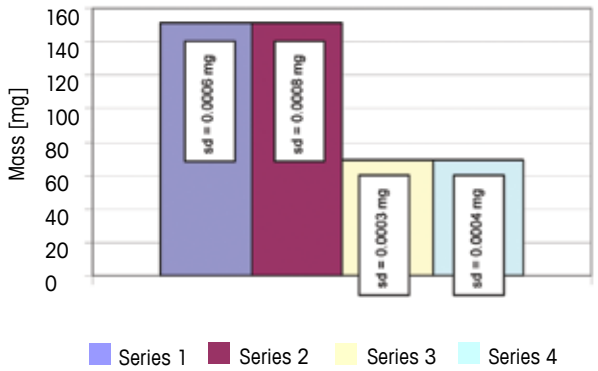
In order to determine the reliability and speed of the XP2U Ultra Micro Balance, series of repeatability tests were performed using two different sizes of TFE-connected borosilicate glass filters (T60A20). The repeatability is defined by the standard deviation of the measurement series.

The typical repeatability levels and stabilization times for series of ten consecutive measurements have been determined.
The study compares repeatability levels of weighing results with various balance settings at the time of the weighing value release.

	Series 1	Series 2	Series 3	Series 4
Filter	T60A20	T60A20	T60A20	T60A20
Filter size	Ø 70 mm	Ø 70 mm	Ø 47 mm	Ø 47 mm
Mode	Checkweighing	Checkweighing	Checkweighing	Checkweighing
Environment	Unstable	Unstable	Standard	Standard
Release	Reliable and fast	Fast	Reliable and fast	Fast
AutoZero	On	Off	On	On
Manual zero value consideration	Yes	Yes	No (no influence)	Yes
Stabilization time with filter [sec.]	35.4	21.3	21.2	14
Mean weight value [mg]	151.2291	151.2312	69.3443	69.3469
Standard deviation of the individual measurements of the filter weight [µg]	0.6	0.8	0.3	0.4

Table 1: Typical results of a repeated filter measurement with various weighing parameters.
The stabilization time is defined as the period of time between the filter being placed onto the balance and a stable weighing value being achieved.

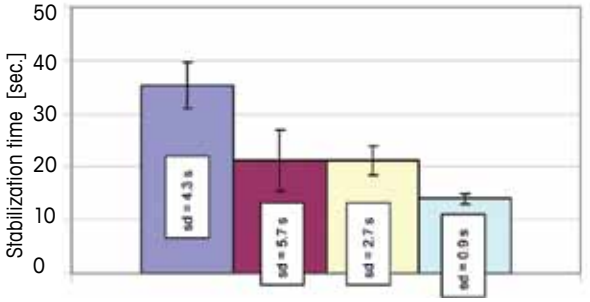
Mean mass using T60A20 filters



Test series with various balance settings

Figure 1: Gravimetrically determined mean mass of the individual measurement results from T60A20 filters with diameters of 47 mm and 70 mm. Balance settings for test series in accordance with the data specified in Table 1.

Mean stabilization times using T60A20 filters



Test series with various balance settings

Figure 2: Mean stabilization times of T60A20 filters in the gravimetric determination of particulate matter.

Conclusion

When determining the weight of T60A20 filters with Ø 47 mm, the best repeatability of 0.3 µg (sd) is achieved on average within 21 seconds. For T60A20 filters with Ø 70 mm, a repeatability of below 0.6 µg is achieved on average within 35 seconds.
By changing the weighing parameters and release criteria, faster stabilization times can be achieved. This can however, depending on environmental influences, result in poorer repeatability levels.

With weighing parameters that have been optimized to produce fast stabilization times, a repeatability of 0.8 µg is achieved after an average of 21 seconds with a filter Ø of 70 mm. In the case of T60A20 filters with Ø 47 mm, a repeatability of 0.4 µg is achieved on average within 14 seconds.
These findings show that the optimization of stabilization times is dependent on the requirements specified in the regulations and guidelines.

www.mt.com/filter
For further information

Mettler-Toledo AG
Laboratory & Weighing Technologies
8606 Greifensee, Switzerland
Tel. +41 44 944 22 11
Fax +41 44 944 31 70

GWP®
Good Weighing Practice™

The internationally recognized GWP® guidelines reduce weighing risks and help to:
- identify the correct balance for the weighing task
- reduce costs by optimizing testing procedures
- ensure compliance with regulations