Automatic weighing system (AWS) with RFID technology for gravimetric evaluation of dust-loaded filters with a diameter of 47 mm

Type AWS-1R
The automatic weighing system AWS-1R registers and documents the amount of particulate matter in outdoor air in compliance with the EN 12341:2014 (PM\(_{10}\) and PM\(_{2.5}\)) standards. The particulate matter is collected on filter media with a filter diameter of 47 mm inserted in filter trays with RFID technology mounted in volume samplers in combination with sampling systems.

- Very exact, automatic weight determination system for filters with a diameter of 47 mm inserted in filter trays with RFID technic.
- Automatic registration and documentation of particulate matter concentration
- Tremendous reduction of measurement deficiencies
- Great reduction of stress and strain for personnel
- Air-tight housing to isolate the weighing system from the outside world. This is to keep the system from being contaminated by airborne particles and to maintain the specified climatic conditions (temperature and humidity).
- When the AWS is set up in an appropriately conditioned atmosphere (e.g. 20 °C and 50 % relative humidity) one may, of course, operate the system without the integrated climate control feature.
- The filters are inserted in filter trays equipped with an RFID transponder and a data storage. Filters and filter trays will not be separated during the entire collecting and weighing process. The system can recognize the encoding and identify the filter trays and the filters contact-free.

Options:
- Integrated temperature and humidity regulation
- Wind protection device with a soft-closing mechanism for the weighing cell unit
- Ionization blower for Teflon filters
- Two more filter magazines for the conditioning chamber are available
- Microbalance: Mettler-Toledo weighing cell WXS26S/15 or Sartorius weighing cell WZA-26-NC (other microbalances can be used on request)
Introduction of the automatic weighing system

Several European Union directives require that the particulate matter present in outside air be measured. In most cases reference units (low-volume samplers) are used for this purpose. A vacuum pump is used to draw particulate-laden air into the device, the particulates are sorted by size in separation stages (impactors) and the dust particles thus recovered are deposited on a filter. In the past, the amount of dust thus collected was ascertained by manual weighing at an outside laboratory. Where non-continuous registration and ongoing monitoring of the dust concentration are required, the usual technique is to employ filter changers that automatically remove individual filters after a defined exposure period and place them in a magazine. The collector unit is then fitted with a fresh filter. In this way dust can be collected for subsequent evaluation over a relatively lengthy period of time.

The type AWS-1R automatic weight determination system was developed to register and document the amount of particulate matter in outdoor air. Automatic weighing of filters eliminates the need to weigh the filters manually. This simplifies the staff’s work considerably. Errors in determining and recording the measured values, resulting from human subjectivity, are virtually excluded. Both the clean filters and the dust-laden filters have to be weighed several times to arrive at a mean value. This results in a very large number of weighing operations, representing considerable strain for personnel due to the concentrated but monotonous nature of this work.

The filters are stored - both prior to the collection cycle and then for a certain period of time after exposure - at a specified temperature and defined relative humidity level. This makes it necessary for the automatic weighing system to be capable of maintaining these defined atmospheric conditions.

The particulate concentration, expressed in micrograms per cubic meter (µg/m³), is calculated on the basis of the difference in the weights of the laden and clean filters, taking account of the total volume of air processed during the collection period. A prerequisite for running the entire process automatically is marking the individual filters so that they can be identified. To achieve this, the filters are laid in filter trays during the entire particle collection and weighing process. These two components are not separated until the weighing process is complete.

The patented filter trays are fitted with RFID transponders. This makes it possible to read filter code previously applied without touching the object. This also makes it possible for a reading unit to read out process data previously placed in storage.

The high capacity of the weighing system (750 filters) and the very short processing period ensure a continuous, non-interrupted operating sequence. Here new filter trays containing loaded filters are continuously supplied. The tray and filter are then separated automatically at the end of the process.

Filter trays and particle filter holders

Specially patented filter trays are used in the AWS-1R to transport and store the 47 mm sampling filters. The filter trays are made of potential-balancing polyoxymethylene (POM). They are self-centering, which simplifies inserting the filter and exact positioning in the filter magazine. Each tray, as previously mentioned, is equipped with an RFID transponder so that the system can recognize the encoding and identify the filter trays and the filters inserted. In addition, the filter trays are equipped with internal data storage. Each tray is also provided with an alphanumeric code, readable from the out-side and etched by laser marking.

Microbalance

The scale used here is a microbalance, readable to 0.001 mg. Other microbalances can be used on request. The balance was modified mechanically for this operation so that the filter conveyor fork can lay the filter to be weighed on the balance and then remove it again. The modifications to the balance have no influence on the technical data guaranteed by the manufacturer of the balance. (Additional technical information may be found in the manufacturer’s specification sheet.)
Filter disc magazines
The two filter magazines serve to accept the filters to be weighed. Each of the magazines consists of a magazine tower and a turntable fitted with a polymer slide-type bearing permitting rotation. Each tower is made up of 25 filter discs and each disc can accept 15 filter trays. The magazines' overall capacity is thus 750 filters. The handling system automatically inserts the filter trays into the magazines and removes them, as well. If necessary, the magazine towers can be lifted individually from the turntables. The turntables for the magazines are driven by brushless servomotors and feature precision angular gearing that ensures exact positioning of the magazines relative to the transport arm. The magazine discs are made of fiberglass reinforced epoxy resin (FR4). Similar discs are used in manufacturing printed circuit boards. The upper surfaces of the magazine discs are gold-plated. The filter trays are always placed at the gold-plated positions intended for the filters, this being in the interest of preventing static build-up. At the same time the gold plating is used to equalize the electrical potential for all 10 or 20 magazine discs.

Filter identification
As already mentioned a prerequisite for running the entire process automatically is marking the individual filters so that they can be identified. During the collection process thus the data storage built in the filter trays is already provided with the relevant data. In the filter conveyor fork of the AWS-1R there is an antenna integrated for the noncontact reading of the data storage. The following measured values are stored at the beginning of the weighing and conditioning process in conjunction with identifying the filter exposure conditions:
- Temperature
- Relative humidity
- Number of the magazine disc
- Filter position on the magazine disc
- Filter code for identification purposes
- Date and time of day

Equipment to control the temperature and humidity of the air inside the weighing system
The automatic weighing system will have to maintain defined atmospheric conditions by controlling the temperature and humidity. Any ingress of foreign, airborne particles will have to be prevented. The system is thus closed with a protective hood. The temperature is maintained with a climate control unit for heating and cooling. The AWS is also fitted with an evaporator as air cooler unit offering great operational reliability. It is able to maintain the specified relative humidity exactly. The system is very quiet and economical and features superior regulation properties. Included among the safety features are an overheating sensor, overflow sensor and protection against dry running.

Filter conveyor unit
The device is fitted with a filter conveyor fork that can be moved both radially and vertically. It moves radially to access these positions: filter identification, filter balance, disc magazine and calibration weights. Moving along its vertical axis, the filter conveyor fork removes the filters from the disc magazine and lays them down at the appropriate stations. The filter is returned to the disc magazine once the identification and weighing cycle has been completed. The disc magazine may be changed out after all the filters on hand are weighed.

Intermediate check of the balance using the calibration weights
The system is programmed to conduct an intermediate check of the balance, using the calibration weights integrated in the balance. As an option, calibration supported by the system can be realized with the help of external weights provided with a calibration certificate. In this case the weights are placed in the reference magazine. The uncertainty of the weights is in accordance with class E2 (OIML).
The magazine in a specimen sampling system is fitted with 16 filter cassettes containing filters; one of these filters is a so-called “blank filter” (reference filter). It is used to determine the passive accumulation of dust in the specimen sampling system’s changing unit. Once the magazine discs in the automatic weight determination system have been fitted with filters taken from the cassettes in the specimen sampling system, the reference filter will be weighed before the start of each weighing cycling to determine the potential need for corrective measures. In addition, the automatic weight determination system provides space for eight additional reference filters. These may be made from one of several different materials (e.g. fiberglass filter, quartz fiber filter cellulose nitrate filter or Teflon filter). These are kept in the reference filter tower, making it possible to detect – by weighing these filters – any accumulation of dust in the weighing chamber itself.

Reference magazine configuration menu

In addition, the automatic weight determination system provides space for eight additional reference filters. These may be made from one of several different materials (e.g. fiberglass filter, quartz fiber filter cellulose nitrate filter or Teflon filter). These are kept in the reference filter tower, making it possible to detect – by weighing these filters – any accumulation of dust in the weighing chamber itself.

Evaluation and documentation

The supplied evaluation software can be used to post-process the data stored in databases or in an Excel spreadsheet. Custom modifications can be provided as extra-cost options. In addition to the data mentioned above, the weights of the non-laden and laden filters will be stored after the weighing process is completed.

Information on the filter materials

The following filter materials can be weighed with the AWS-1R:
- Glass fiber filter
- Quartz fiber filter
- Cellulose nitrate filter
- Teflon filter (without encoding)

The materials used for the reference filters are identical to those in the filters used to collect fine dust. These filters are changed out together with the filter disc magazine.
Dimensions

Dimensions in mm
### Technical Data Automatic Weighing System  Type AWS -1R

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of magazine towers:</td>
<td>2</td>
</tr>
<tr>
<td>Number of magazine towers for conditioning chamber:</td>
<td>2</td>
</tr>
<tr>
<td>Number of magazine discs holding filters / magazine tower:</td>
<td>25</td>
</tr>
<tr>
<td>Number of filters / magazine disc:</td>
<td>15</td>
</tr>
<tr>
<td>Total number of filters / 2 magazine towers:</td>
<td>750</td>
</tr>
<tr>
<td>Potential equalization:</td>
<td>By means of cone contacts between the gold plated magazine discs</td>
</tr>
<tr>
<td>Drive system of the disc magazine:</td>
<td>Brushless DC motor (maintenance-free)</td>
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<tr>
<td>Positioning of the disc magazine:</td>
<td>By means of incremental encoder</td>
</tr>
</tbody>
</table>

#### Filter
- **Filter material:**
  - Glass fiber filter
  - Quartz fiber filter
  - Cellulose nitrate filter
  - Teflon filter (without coding)
- **Filter diameter:** 47 mm
- **Coding of the filters:** By use of RFID transponders in the filter trays
- **Reader station:** Non-contact identification of the filters by means of RFID technology

#### Microbalance (optional)
- **Manufacturer:** Mettler-Toledo Microbalance cell WXs26S/15 or Sartorius Microbalance cell Type WZA-26-NC (other microbalances can be used on request)
- **Reading precision (resolution):** 0.001 mg
- **Maximum load:** 20/22 g
- **Location of microbalance:** Platform with a large mass (approx. 200 kg), decoupled from the main mounting rack
- **Calibration weights for the weighing system:** Integrated in the balance

#### Data output
- **Data output:** RS-232
- **Data export (CSV data file):** Weight of unloaded filter (average)
- **(other data formats on customer request):**
  - Weight of loaded filter (average)
  - Difference of weight of unloaded and loaded filter (average)
  - Temperature, humidity rel., barometric pressure
  - Filter number
  - Sampling number
  - Date / time
  - Amount of weighings per filter

#### Power
- **Power supply:** 230 V ± 10%, 50 Hz
- **Power consumption:** 250 VA

#### Dimensions and weight of mounting rack
- **Length:** 1620 mm
- **Width:** 900 mm
- **Height of operation:** 860 mm
- **Height with protective hood:** 2325 mm
- **Overall weight (including granite block for balance):** Approx. 600 kg

#### Conditioning of climate (optional)
- **Temperature regulation:** climate control unit (heating and cooling) with water (external compressor)
- **Humidifier unit:** Evaporator as air cooler unit
- **Permissible operating and environmental conditions:** 15 … 32 °C, 30 … 60 % rel. humidity
- **Power consumption:** Approx. 2000 VA
- **Power consumption of compressor:** approx. 1500 VA

Comde-Derenda GmbH reserves the right to discontinue or change specifications, design or materials without notice consistent with sound engineering principles and quality practices.

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Comde-Derenda GmbH was originally founded as an engineering office in Berlin, in the year 1972. The company’s activities at that time included the development, production and sales of measurement and control systems and gas analysis systems.

Over the course of time the engineering office focused on the development and production of devices and systems for the collection of particulates in the ambient air, used in the field of environmental protection.

COMDE GmbH was founded in the year 1992. The company in particular concentrated on the development and production of equipment to measure and monitor pressure, gas density in high voltage circuit breakers (containing SF6 gas) and pressure at high temperatures. Moreover, the company developed and produced several white canes designed to increase the mobility of those who are visually impaired.

Our own building was erected in Stahnsdorf near Berlin, in 2007. All the activities of the three existing fields of operation gas density and pressure monitoring, environmental monitoring systems, and white canes are concentrated here.

The engineering office and COMDE GmbH were merged to form Comde-Derenda GmbH in the year 2012. Comde-Derenda GmbH has been certified as per the DIN EN ISO 9001:2008 standards for quality assurance.

Comde-Derenda GmbH can supply far more than the products found in its product overview. A wide range of custom-engineered equipment can also be manufactured.

If you are interested in a product or accessory item and you do not see it in our line, then please be sure to ask.