hund
WETZLAR

Dust Sampling and measuring Instrument

RESPICON TM

Technical Description and Instruction Manual

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Note

Operating manuals RESPICON -TM and Datalogger DSS8

During measurement, the Datalogger DSS8 should be located in the leather-bag (article-no. 902.0081.0) and should be operated in the same workplace-atmosphere together with RESPICON -TM.
Non-observance can lead to diminished results. This is very important for measurements in ducts as it is described in the Test-Report or Approval No. GF, Nr. 72302702, issued by DMT (Deutsche Montan Technologie), Essen, dated 17.7.2002; page 62, chapter 8.5,
(Interpretation der Ergebnisse).

Summary

1. Unpacking and Parts Idendification

Carefully unpack the RESPICON TM and accessories from the carrying case. Use the table and illustrations below to make certain that there are no missing components. Contact Hund immediately if anything is missing or damaged.

Pos.	Description	Article-no.	pcs.
1.	**Gravimetric dust collection system RESPICON**		
1.1	RESPICON Personal Particle Sampler,	001.0085.001	1
	including assembling cylinder and disk		
1.2	Stage Flow Checker	001.0085.002	1
1.3	Total Flow Checker	001.0085.005	1
1.4	Data Analysis Spreadsheet	N.N.	1
2.	**Gravimetric/photometric Personal Particle sampler and measuring instrument RESPICON TM**		
2.1	RESPICON TM Personal Particle sampler and -measuring instrument, inclusive assembling cylinder and disc	001.0087.001	1
2.2	Stage Flow Checker	001.0087.002	1
2.3	Total Flow Checker	001.0085.005	1
2.4	3 (8) - channel Datalogger DSS 8, inclusive connecting cable to RESPICON TM and RS232C cable Transfer- and Dataprocessing software	001.0086.000	1
2.5	Power- and charging unit to Datalogger DSS 8	001.0086.003	1
2.6	5-channel BNC-Terminal, to connect five different sensors to RESPICON TM additionally	001.0086.002	1
2.7	Leather bag for Datalogger DSS 8	902.0081.0	1
3.	**Consumables**		
3.1	Fibreglass filters, 37 mm dia, without organic binders (1 piece = 50 filters), **recommended quantity: 2 pcs. à 50 filters**	001.0001.014	1
3.2	Fibreglass filters, 37 mm dia, without organic binders, (1 piece = 50 filters), **but inclusive a concentric cut-out, recommended quantity: 4 pieces à 50 filters**	001.0085.007	1

Pos.	Description	Art.-no.	pcs.
3.3	Filter cartridge to incoroporate 37 mm filters,	001.0001.017	1
	recommended quantity: 12 pcs.		
3.4	Pipe cleaners (1 piece = 50 cleaners)	902.0062.0	1
3.5	Soap lotion, approx. 230 ml in polyethylene bottle, for glass-tube soap-film, flowmeter	902.0064.0	1

4. Accessories

4.1	Chest harness belt for RESPICON and RESPICON TM	902.0060.0	1
4.2	Chest harness Adaptor to fix the RESPICON or RESPICON TM to it´s belt clip	902.0061.0	1
4.3	Silicone sample tube, D5x1,5; 2 m	556.0042.0	1
4.4	Tweezers for filterhandling	902.0063.0	1
4.5	Transport case for all RESPICON models, accessories, consumables and Miscellaneous	902.0059.0	1
4.6	Rotameter kit, contains two tubes: 38-380 ml/min. and 400 -4000 ml/min., with basement	001.0085.006	1
4.7	Personal probe sampling pump, SKC product, model 224-PCXR8, flow-range 1000 - 5000 ml/min., including 230 V AC/DC power and charging unit, Microprocessor controlled, intrinsically safe approval UL Notice: **not included** 5-1000 ml/min. flow range, needs adjustable low flow holder. Ask for further informations.	646.0012.0	1
4.8	Transfer- and data evaluation software for RESPICON TM/Datalogger DSS 8, german version (3 discs)	001.0086.006	1
4.9	Transfer- and data evaluation software for RESPICON TM/Datalogger DSS 8, english version (3 discs)	001.0086.007	1
4.10	8-channel BNC-terminal to DSS 8 for pure Datalogger mode	001.0086.001	1
4.11	Inlet head, 2,5 µm cut	001.0085.004	1

Pos.	Description	Art.-no.	pcs.
	Primare flow calibrations systems		
4.12	Glass-tube soap-film ((bubble) flow meter, 0-4000 ml/min.,	001.0085.003	1
	accuracy +/- 1 %, complete with basement. Soap lotion		
	see item 3.5		
4.13	Mechanical stop watch for glass-tube flowmeters	902.0058.0	1
4.14	Electronic flowmeter, completely dry, 10-10000 ml/min., 230 V AC, power and charging unit, transport case, printer port parallel, accuracy +/- 1 %, model DryCal DC 1	649.0007.0	1
	Other calibrations systems on request		

5. Spareparts

5.1	Accu replace kit for Datalogger DSS 8	665.2010.0	1
5.2	O-ring kit, complete for replace, fits RESPICON and RESPICON TM	001.0085.010	1
5.3	Orifice exchangeable, code red, stage 1	011.8504.0	1
5.4	Orifice exchangeable, code yellow, stage 2	011.8505.0	1
5.5	Orifice exchangeable, code green, stage 3	011.8506.0	1
5.6	Filter stage1 for RESPICON	011.8500.0	1
5.7	Filterstage 2 for RESPICON	011.8501.0	1
5.8	Filterstage 3 for RESPICON	011.8502.0	1
5.9	Filterstage 1 for RESPICON TM	011.8700.0	1
5.10	Filterstage 2 for RESPICON TM	011.8701.0	1
5.11	Filterstage 3 for RESPICON TM	011.8702.0	1
5.12	Light trap adapter for stage 1 of RESPICONTM	011.8703.0	1
5.13	Stage Flow checker Inlet for RESPICON/-RESPICON TM	500.0484.0	1
5.14	O-ring for stage flow checker	594.0030.0	1

2. Introduction

The measuring principle of the RESPICON TM is a combination of inertial classification and concentration enrichment using a virtual impactor, filter sampling and aerosol photometry. It is a compact and easy to use instrument. Using only one sampling head, RESPICON TM collects and monitors three size ranges according to the new European Standard EN 481- Size fraction definitions for measurement of airborne particles - workplace atmospheres -

RESPICON TM measures simultaneously five health related size fractions.Three of these are measured directly. They are sampled simultaneously and monitored on - line.

The three size fractions are:

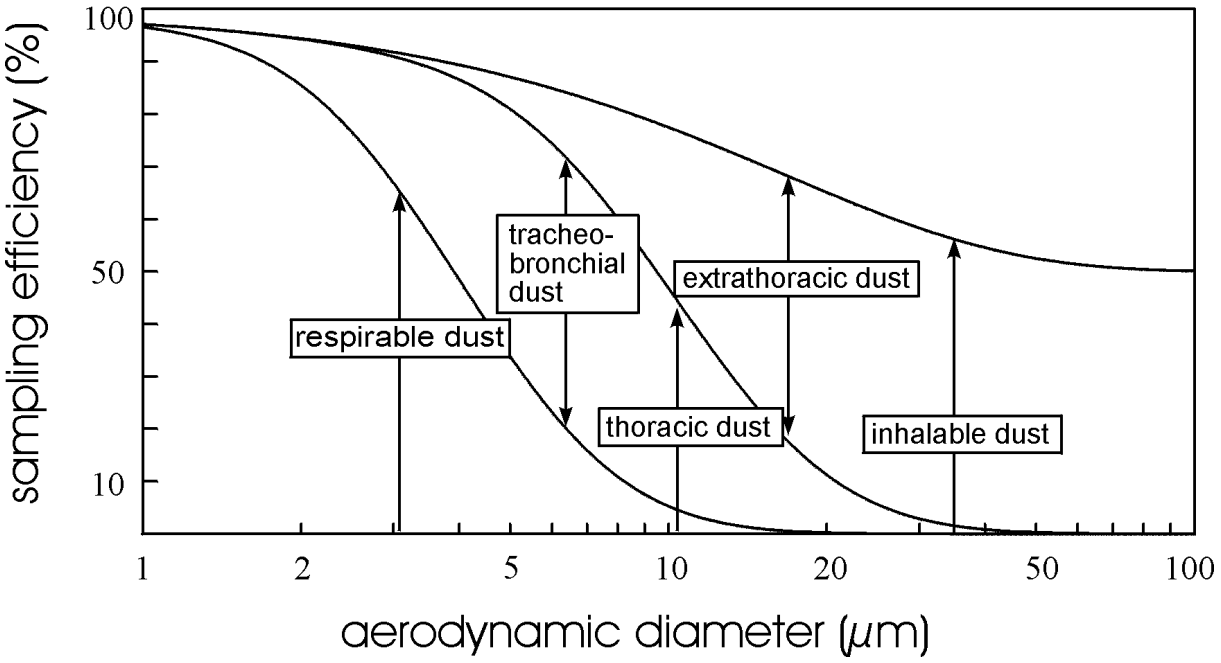
- inhalable: representing the aerosol fraction that enters the nose and/ore mouth during breathing (50% cut-point at 100µm).
- thoracic: representing the subfraction of inhalable aerosol that penetrates into the respiration tract below the (50% cut-point at 10µm).
- respirable: representing the subfraction of inhalable aerosol that penetrates to the alveloar region of the lung. (50% cut-point at 4µm.)

Two additional fractions are derived from the above.

- extrathoracic fraction
- tracheobronchial fraction

RESPICON TM was developed in cooperation with the Fraunhofer -Institute of Toxicology and Aerosol Research, Hannover, Germany. It has been specially densigned for use at workplaces and may be used to characterize dust content and thus get a better medical evaluation of any possible hazards present in time with the convention for the collection and monitoring of health related dust fractions according to international standards.

Definitions of size fractions of the airborne dust for health oriented dust sampling.



There exist several standards defining health oriented dust measurements at work places: the German MAK list (list of maximum work place concentrations), the ISO-standard 7708-1996 (International Standardization Organization), and the European standard EN 481 (Definition of size fractions for the measurement of airborne dust at work places). Different dust fractions which are determined by the particle size dependent probability of inspiration, penetration and deposition of particles in the human respiratory system, are defined in these standards. The figure above shows the definition curves of three (respectively five) relevant size fractions according to the European standard EN 481. These curves are also adopted by the German MAK Commission.

The curve for the inhalable fraction represents the average probability of particles to enter the respiratory system via the nose or the mouth as a function of the aerodynamic particle diameter. Thus, the total area below this curves is the inspired fraction of the total suspended particulate mass. The thoracic fraction covers all inspired particles that pass the larynx and penetrate into the conducting airways (trachea, bifurcations) and the bronchial region of the lung. All particles entering the non ciliated region of the lung belong to the so called alveolar fraction. Two additonal fractions can be defined: The extrathoracic and the tracheo-bronchial fraction obtained by substracting the inhalable and the thoracic, respectivly the thoracic and the alveolar fraction. Particles belonging to this fraction will pass the larinx but will not enter the alveolar region of the lung.

The above classification of the airborne dust accounts for the different potential health effects related to particles of different sizes.

The RESPICON TM measures all five dust fractions simultaneously. The **alveolar**, the **thoracic** and the **inhalable** fraction are sampled on filters, and the respective concentrations are determined. From these data, the concentrations of the **extrathoracic** and the **tracheobronchial** fraction are calculated. Thus, the RESPICON TM samples the airborne dust in accordance with both, the MAK list prescribing the measurement of alveolar and inhalable dust, as well as the EN standard encountering also the thoracic fraction.

The instrument can be used for stationary and for personal dust monitoring.

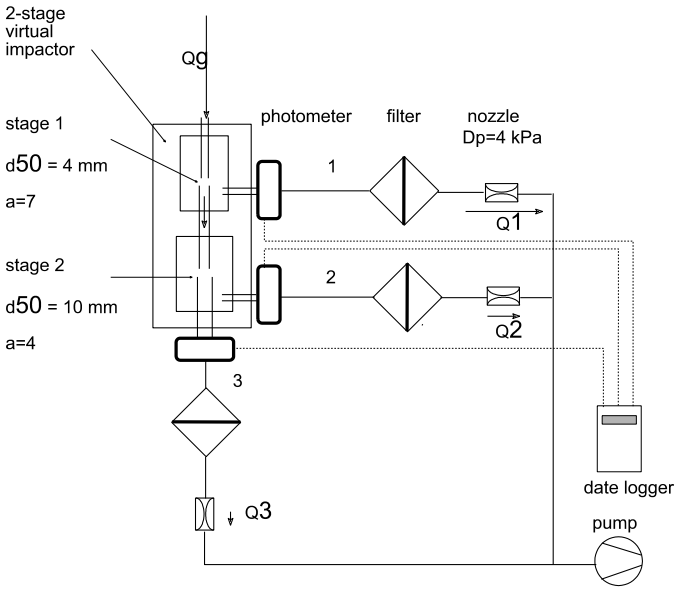
2.1 Principles of Measurement

The RESPICON TM consists of a two stage, virtual impactor which, together with filters, are in a symmetrical-rotation, concentric configuration. The airborne dust is drawn in through a ring gap and into the RESPICON TM via a 3 stage flow divider. Coarse particles pass straigth through to the lower collector while other particles are aerodynamically separated. Particles of smaller diameter follow flow paths and are distributed into channels according to their flow characteristics. The first virtual impactor stage separates out the respirable fraction with a separation diameter of 4 µm. The second stage addresses the thoracic fraction with a separation diameter of 10 µm. Both these fractions are separated out through the re-directed air streams and the concentrically arranged filters. The coarse particles with an aerodynamic particle diameter larger than 10 µm are to be found on the last filter.

The aerosol fractions passing the 3 stages are measured by scattered light photometers continuously and simultaneously. Photometer 1 measures the respirable fraction. Photometer 2 and 3 measures the coarse dust fractions enriched by the factors 7 and 28. This enrichement increases the sensitivity of the photometers concerning coarse dust.

The sampling instrument is a two stage virtual impactor as shown in lower figure. The three sampling filters and the impactor are assembled in a concentric unit with cylindrical symmetry. The aerosol enters the instrument via an annular slit. Inside the instrument the total flow (flow rate of 3.11 l/min) is divided into three individual streams with flow rates Q_1=2.66, Q_2=0.33, and Q_3=0.11 l/min. In each of the two stages of the virtual impactor the air flow is split up into one stream with a large and one stream with a small flow rate. The flow separation takes place occurs in the

region of a virtual stagnation flow between two opposing nozzles. The major flow is deflected by 90°. The minor flow enters the lower nozzle. Suspended dust particles are classified with respect to their aerodynamic size. All particles with an aerodynamic diameter larger than a critical value, determined by the nozzle diameter and the flow velocity, do not follow the streamlines of the major flow and go straight into the nozzle of the minor flow. Thus, the major flow contains no suspended coarse particles. The small particles with low inertia follow the stream lines. The mass flux of these particles is



3. Operating the instrument

The dust sampling and measuring instrument, RESPICON TM, consists of a mantle unit with a tube fitting to connect the sampler with the suction pump; an inlet head; three units to support the filter cassettes and the impactor nozzles (1); and a assembling cylinder and a disk (2) helping to assemble and disassemble the instrument. The flow rates can be measured using the flow checker (3) in together with the corresponding adapter (4) (default parts).

3.1 Preparation for sampling

First disassemble the instrument. Open the lock by slightly pressing on the inlet head and turning it counter clock wise. Place the instrument on top of the assembling cylinder.

The pin on the underside of the body unit must be put into the corresponding groove of the assembling cylinder.

Put the disk on the sampling instrument. Press steadily on the disk. The filter supports will come loose and the mantle can be pushed down

Label the filters (glass fibre filters with central hole: part number 001.0085.007, glass fibre filters without central hole: part number 001.0001.014) before loading the instrument. Determine the weight of the plain filters and store weights and filter ID numbers using the data evaluation form on page 22.

Proceed following the figures and the instructions below:

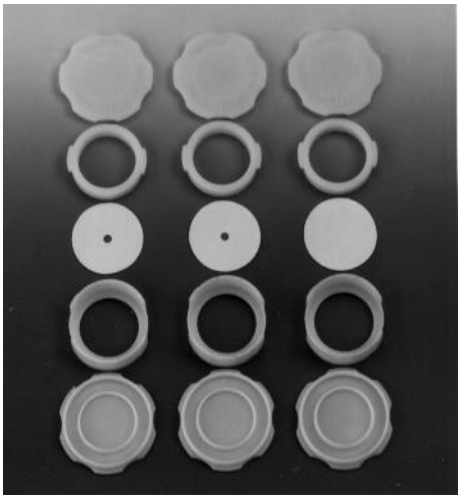
Top lid of the transport case

Top ring of the filter cassette

Filter with hole, without hole

Bottom ring of the filter cassette

Bottom lid of the transport case



Insert the filter in the cassettes (part number: 001.0001.017). Then put the filter cassettes containing the filters with hole into the supports #1 and #2, respectively, and put the filter cassette containing the filter without hole into the support #3.
See page 13.

The filters must be carefully centered in relation to the filter-cassettes and filter - supports no. 1 and no. 2. For that reason first insert the filter-cassettes into the filter-supports. Than insert (center) the filter to the filter-cassettes and lock each filter-cassette with the top ring (coverlid) of the filtercassette.
Make sure that the O-rings of the filter supports fit properly in the respective grooves.
<u>Important notice</u>! During the storage of the RESPICON TM the three filter supports should be taken out in order to protect the O-rings.

Each of the filter support units is labeled by one or several carved rings on the upper section of its mantle.

Support #1: one ring

Support #2: two rings

Support #3: three rings

Filter support unit 1-3, filter cassettes, filters and light trap adapter on top.

Before starting the sampling procedure assemble the filter supports loaded with cassettes and filters as follows: put support #2 on top of support #3, and support #1 on top of support #2. The ring labels of the supports must be at the top.
After assembling, close the filter supports with light trap adapter,
articelnr.: 01
1.8703.0).

Now put the mantle of the instrument over the assembling cylinder.

Stack up the filter supports loaded with cassettes and filters on the assembling cylinder. Make sure that they are in the right order, i.e. #3 at the bottom, #1 at the top.
The pin on the underside of the body unit must be put into the corresponding groove of the assembling cylinder.

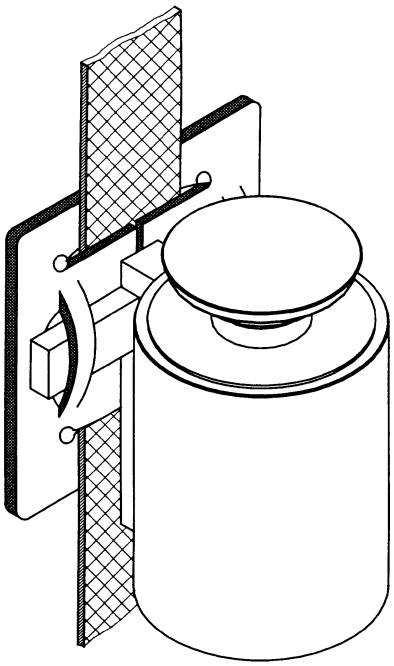
Now lift the mantle so that it loosely covers the supports.

Make sure that the O-rings are clean when introducing the filter supports into the mantle. Remove the instrument from the assembling cylinder

Now press the filter stages into their final position in the mantle as follows:
Place the inlet head on top of filter support #1 so that the position of the bolt in the inlet head matches that of the groove of the mantle.
Make sure that filterstage #3 is in end position and th
at there is no gap.

Use the flat hand to press down the inlet head and turn it clock-wise into the bayonete lock.

3.2 Taking samples



For personal sampling connect the instrument to the carrying belt by first fixing the adapter at the belt and then inserting the instrument into the adapter (as shown in the drawing). For taking stationary samples mount on top of a tripod.

Now use the silicon tube to connect the suction pump with the sampling instrument. Set the pump flow rate to 3.1 l/min. The internal flows are adjusted automatically by three capilary nozzles inserted in the instrument mantle. The pressure drop of each nozzle is 4kPa. When you do not use one of the pumps recommended in the Appendix make sure that the pump is able to maintain a flow rate of at least 3.1 l/min at a pressure drop of 4.4 kPa. The pressure drop of the (first) sampling filter is approximately 400 Pa

The pressure drop may increase during sampling due to the dust deposit. The suction pump has to compensate for this.

3.3 Unloading the instrument

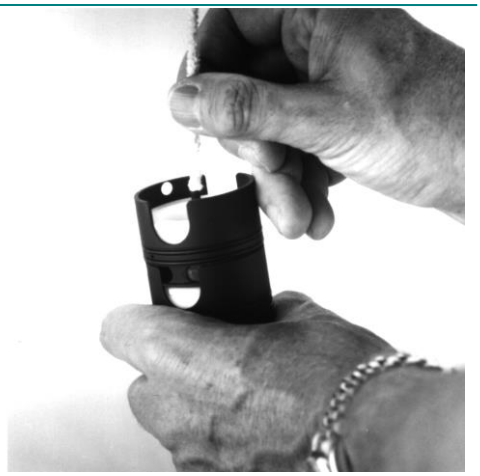
Open the sampling instrument by pressing on the inlet head and turning it counter clock-wise. Now put the instrument on the assembling cylinder.

Put the flat disk on the sampling instrument. Press steadily on the disk. The filter supports will come loose and the mantle can be pushed down.

Now remove the filter cassettes and put them into the transport containers.

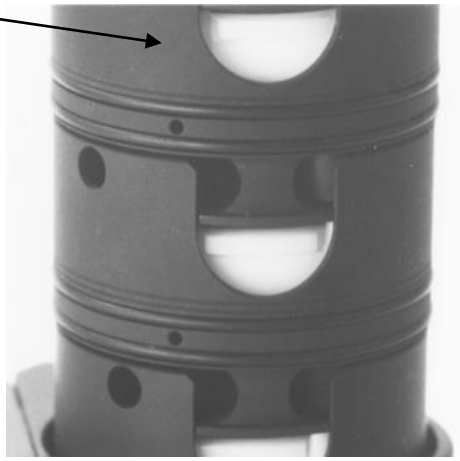
Attention: Label the cassettes containing the filters with the central hole in order not to mix up the cassettes #1 and #2.

3.4 Cleaning the instrument



Remove any deposits in the impactor nozzles using the pipe cleaner (default part). Clean the inlet head with dry pressurized air or rinse it in a water stream. In this case dry the inlet head thoroughly. Eventually use dry pressurized air. Similar procedure is recommended to clean each filter support fine flow capillaries.

Cleaning the lenses: Blow out any dust particles with compressed air. Then clean the lenses using a Q-tip. Don´t use any kind of agressive liquids or materials.



Attention: Don´t scratch or damage the black coatings of all internal pieces. Failures can have influence regarding the photometer measurement.

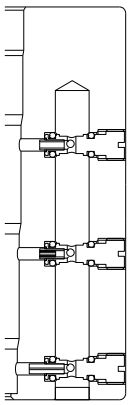
Colour-Code of exchangeable oriffices of RESPICON TM

Top side RESPICON TM

red

yellow

green



Basement of RESPICON TM

3.5 Measuring the internal flow rates

You will find a flow checker in your instruments kit (part#: 001.0085.002).

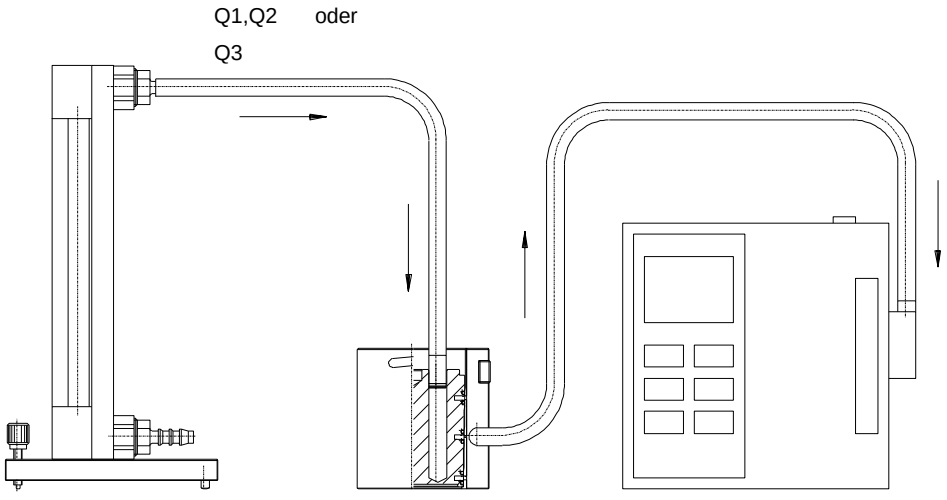
In order to measure the internal flow rates insert the flow checker instead of the filters into the mantle.

Press it completely into the mantle. Eventually use the inlet head or the tube adapter.

Turn on the pump adjusted to 3.1 l/min so that air is drawn through the flow checker. Now measure the internal flow rates Q_1,Q_2, and Q_3 following the instructions below:

To measure the internal flow Q_1, plug the fitting into the corresponding opening of the flow checker (labeled Q_1). Now connect the flow checker with the outlet of the rotameter #1 (measuring range 0-4000 ml/min) using the flexible tube.

The flow rate Q1 can be read directly.
Follow the same procedure to measure the internal flow rates Q_2 and Q_3. However, use rotameter #2 (measuring range 0-380 ml/min) instead of rotameter #1.



Rotameter

RESPICON TM with flow check adapter for Q1, Q2 and Q3

constant volume sampling pump

The total flow rate, Q_G, can also be measured directly. Remove the fitting from the flow checker and put the tube adapter (part #: 001.0085.005) on the flow checker. Make sure that there are no leaks.

Connect the tube adapter with the outlet of the rotameter #1 and read the total flow rate Q_G.

These measurements can also be done with the instrument loaded with filters. Simply remove the flow checker and insert the filters and filter supports following the instruction of section 2.1. However, close the instrument with the tube adapter instead of the inlet head.

Note the following: the rotameters are calibrated under STP-condition (standard temperature and pressure conditions; see also calibration sheets of the rotameters). Deviations from STP-condition can be corrected for by measuring temperature and pressure or by measuring the flows using a bubble flow meter (part# see Appendix).

The difference between the measured flow rates from the intended values should be no more than shown at page 27. If this is not the case, check the internal nozzle for impurities using the flow checker. If necessary, unscrew the orifices, clean the nozzles by blowing oil and particle free pressurized air through them. If there is no improvement ship the instrument for factory check-up to your local supplier or directly to Hund, Wetzlar. Fluctuation of the total flow rate by ±5% caused by the control circuit of the suction pump can be tolerated. These fluctuation do not affect the ratios of the internal flows.

4. Data Analysis

Important Information!

The mass loadings of the three filters are not completely independent from each other. This is due to the way the virtual impactor works. When m_1 is the mass loading of the first filter, the second and third filter shoud at least have loadings corresponding to:
$m_2 = 0.124\ m_1$
$m_3 = 0.04\ m_1 + 0.33\ (m_2 - 0.124\ m_1)$
You should use these values in the evaluation spread sheet when m_1 can be safely determined but the mass loadings of filter 2 and filter 3 are below the detection limit. Never use zero for m_2 and m_3 when m_1 is not zero.

The mass concentration of the aerosol size fractions can be calculated from the aerosol masses, m_1, m_2, m_3 (in mg), deposited on the filters, the sampling time, t_s (in min), and the volume flow rates, Q_1, Q_2, Q_3 (in l/min), according to the following algorithm:

Concentration of the alveolar fraction:

c_R	=	$m_1 * 1000 / (Q_1 * t_s)$	in	mg/m^3

Concentration of the thoracic fraction:

c_{Th}	=	$(m_1 + m_2) * 1000 / ([Q_1 + Q_2] * t_s)$	in	mg/m^3

c_i	=	$(m_1 + m_2 + m_3) * 1000 / ([Q_1 + Q_2 + Q_3] * t_s)$	in	mg/m^3

Concentration of the extra-thoracic fraction:

c_{exth}	=	$(c_i - c_{Th}) * 1.5$	in	mg/m^3

Concentration of the inhalable fraction:

c_I	=	$(c_{Th} + c_{exth})$	in	mg/m^3

Concentration of the tracheobronchial fraction:

c_{tb}	=	$(c_{Th} - c_R)$	in	mg/m^3

The concentration of the inhalable fraction, c_I, is obtained by adding the concentration of the thoracic fraction, c_{Th}, and the extrathoracic fraction, c_{exth}.

RESPICON TM Data Evaluation Form

Organization/company::	Sampling location:
Date:	Operator:
Label of filter set:	Working area:

Start:	End:
Sample time t_S in min.:	Rem..:

Filter label|stage # - #	mass plain (mg)	mass with deposit (mg)	mass deposit (mg)	cumulative mass (mg)	sampling volume (l)
			m_1=	m_1=	V_1=2,66 t_S =
			m_2=	m_1+m_2=	V_2=3,00 t_S =
			m_3=	$m_1+m_2+m_3$=	V_3=3,11 t_S =

Dust fraction	Concentration (mg/m^3)
$c_R = m_1 * 10^3/V_1$	
$c_{Th} = (m_1+m_2) * 10^3/V_2$	
$c_i=(m_1+m_2+m_3)* 10^3/V_3$	
$c_{exth} = (c_i-c_{Th}) * 1.5$	
$c_I = c_{Th}+c_{exth}$	
$c_{tb} = c_{Th}-c_R$	

5. Calibration of the flow rates using the bubble flow meter

5.1 General remarks

A bubble flow meter is a primary method for the measurement of volume flow rates. Within the measuring range of the tube the measuring error is smaller than 1 %. The air can either be sucked or pushed through the tube. For the Respicon the air is sucked through the measuring tube. Bubbles are generated by squeezing the ball filled with a soap solution. The bubbles are entrained by the air flow. Using a stop-watch one measures the time that the bubbles need to pass the two most distant labels on the tube wall. By repeating the measurments a small error margin can be achieved. The volume flow rate, Q, for the actual pressure and temperature conditions is calculated from:

$$Q=V/t.$$

V is the tube volume between the two measuring labels, and t is the corresponding travelling time of the bubbles.

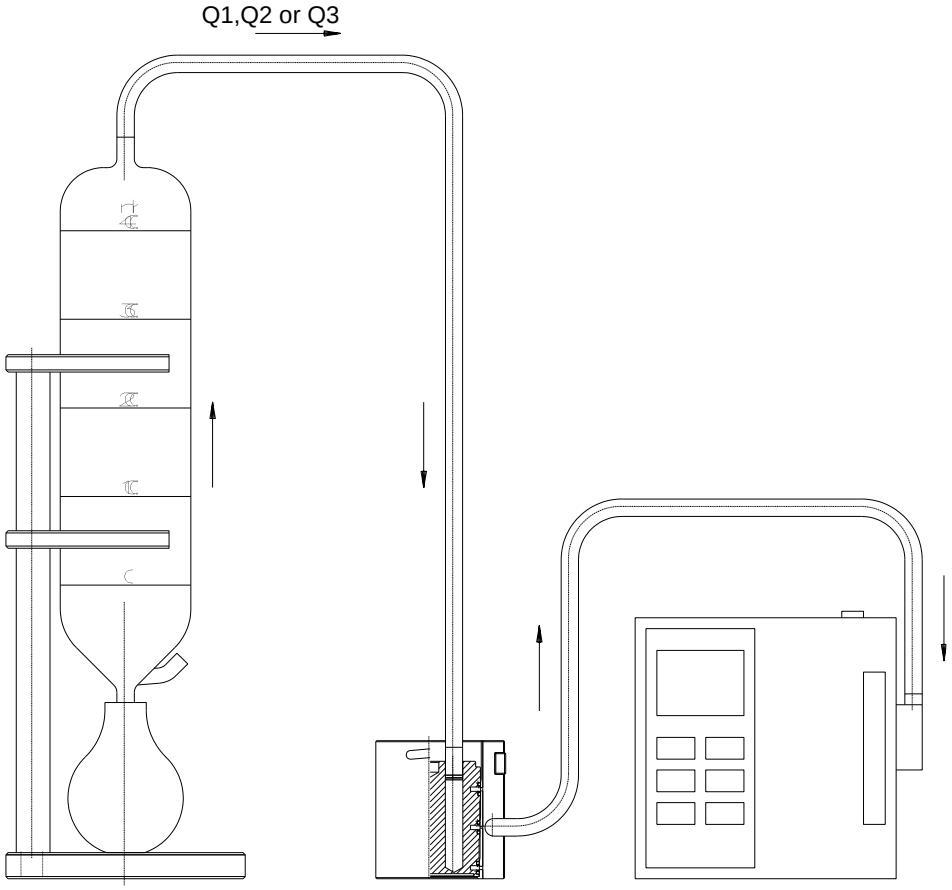
For field measurements, the temperature and the pressure values should deviate no more than 15°C, respectively, 10 mbar, from those for the calibration. Otherwise, the internal and the external flow meters should be recalibrated.

Limit values for the dust concentration are generally defined in terms of miligrams per unit volume of air not corrected for temperature, pressure and relative humidity. Since the bubble flow meter measures the volume flow rate for the prevailing atmospheric condition it provides a calibration standard in accordance with the existing guidelines for dust sampling.

5.2 Checking the total flow rate, Q_G.

(should be done before each dust measurement)

Fig1: Set-up.



1) Connect the bubble flow meter, the RESPICON TM and the pump according to Fig.1. Use the flexible tubes (inner diameter 5 mm, length 70 cm).
2) Turn on the pump and generate several bubbles to wetten the inner surface of the measuring tube.
3) Measure the time, t_G, for a bubble to pass two labels defining a certain volume, V_G, of the tube and calculate the total volume flow, Q_G:

$$Q_G=V_G/t_G$$

Compare the measured and the intended flow rate. Eventually, readjust the flow rate setting of the pump (see corresponding instruction manual) and repeat the measurement.

The tolerable flow rate margins are given in the table below:

							Min. l/min	Max. l/min
Q_G	-	intended	=	3,111	l/min	± 2%	3,0478	3,1722
Q_1	-	intended	=	2,666	l/min	± 3%	2,5536	2,7664
Q_2	-	intended	=	0,333	l/min	± 8%	0,3036	0,3564
Q_3	-	intended	=	0,111	l/min	± 12%	0,0968	0,1232

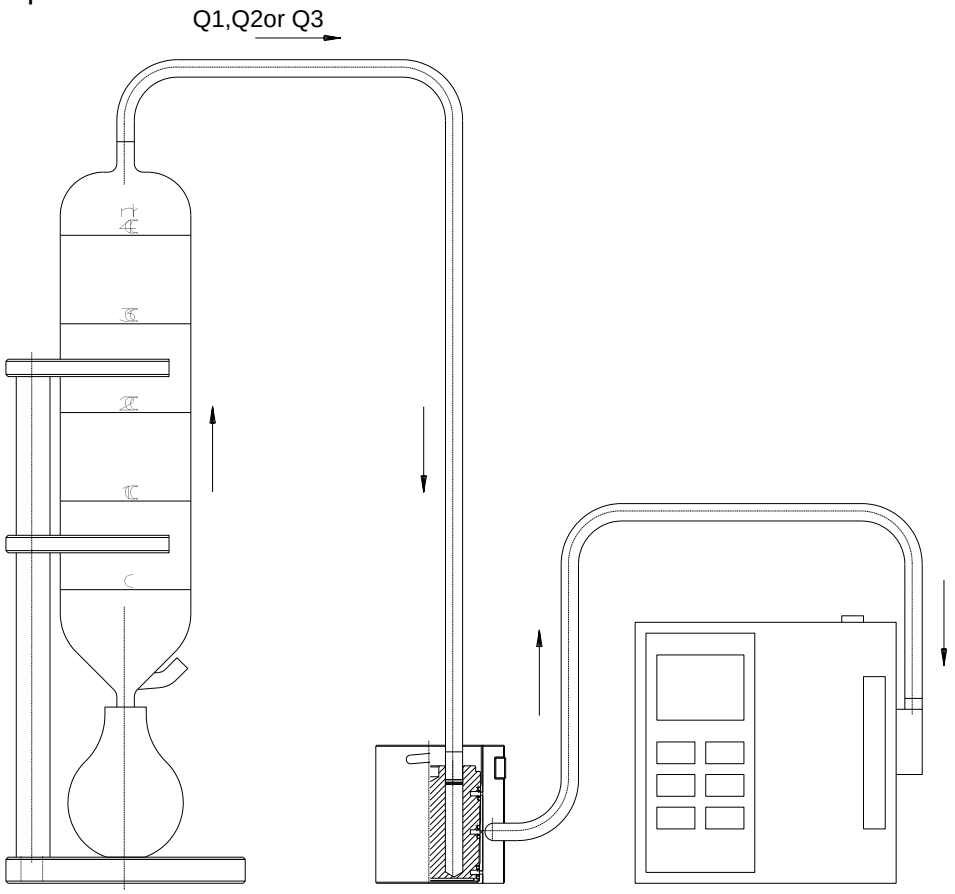
The flow rate check is completed when the measured values are inside the margins. Since all other flow rate values depend on Q_G ($Q_G = Q_1 + Q_2 + Q_3$) make sure that the Q_G meets the intended flow rate as closely as possible.

In order to achieve a high accuracy in your flow rate measurements use a large measuring volume (for example 400 ml) for Q_G and Q_1 and a smaller one (100 ml) for Q_2 and Q_3.

5.3 Measuring the flow rates, Q_1,Q_2, Q_3.

(should be done after 10 dust measurements)

Fig.2: Set-up.



bubble flow meter

RESPICON TM with flow check adapter to measure Q1, Q2 and Q3

constant volume sampling pump. Keep flow setting constant!

Remove the filter and impactor stages from the RESPICON TM and insert the flow checking element. Make sure that the flow checker is completely inside the mantle connect pump, flow checker and bubble flow meter according to fig.1. Do not change the flow rate setting of the pump. To measure the flow rate Q1 connect the bubble flow meter with the outlet of the flow checker labeled Q1. Use the fitting. Measure the flow rate according to section 5.1. Repeat this procedure for Q_2 and Q_3.

5.4 Possible reasons for incorrect flow rates.

When the flow rates of the RESPICON TM deviate from their intended values, please first check all o-ring sealings of the flow checker for damage and replace them if necessary. Also check the capillaries (controling Q_1, Q_2, and Q_3) for dust deposit. The unscrewed orifices and nozzles can be cleaned by blowing dry and oil free compressed air through them, or weep off dirt by using a weak brush. Under no circumstances use a needle to clean the nozzles ore unscrewed orifices. This may lead to irreversible damage. Repeat the flow rate check after the cleaning procedure. Make sure that the pump is operating correctly.

If you don't achieve a proper matching of the measured flow rates with the intended values, please ship the RESPICON TM or a general check-up to your local dealer or directly to Hund, Wetzlar.

From time to time the total flow rate should be checked using the flow checker (according to Fig. 2) as well as using the complete instrument (according to Fig 1). Both methods should give the same results. Deviations are generally due to damaged O-ring sealings. Please, replace the sealings of the respective components for which the lower flow rate value was obtained. The sealings of the inlet head should be checked frequently since they suffer the biggest abrasion.

6. Maintenance

Overview

The RESPICON TM is a very low maintenance instrument. Maintenance consists almost entirely of cleaning the instrument and checking flow rates.

maintenance Schedule

The maintenance schedule for the RESPICON Tm is largely determined by useage patterns. If the instrument is used in very dusty, dirty conditions, it will obviously require more frequently cleaning than if used in relativly clean conditions. The table below summarizes the recommended procedures and frequency.

Recommended Maintenance before Each Use

Item	Frequency
Check O-Rings	Before each use
Clean impactor nozzels	Before each use
Perform total flow check	Before each use

Recommended Maintenance: Every Fifth Use

Perform stage flow check	Every fifth use (more often for dirty conditions)

Recommended Maintenance: Non-Routine

Clean orifices	Quaterly, or if unable to obtain correct flow on each stage
Clean filter stages, body unit	As needed
Clean inlet head	As needed
Replace O-rings	Only if damaged
Replace orifices	Only if damaged

Check O-rings

The RESPICON TM contains 13 O-rings; each one of them is important for Maintaining good seals and correct flowrates within the instrument. The user should become familiar with the location of each O-ring and should routinely inspect them prior to assembly of the instrument. The following list details the size and location of each O-ring. It also identifies those O-rings which need special attention, due to their importance or special conditions.

List of O-rings

Location	Diameter	Special Concerns
Pertimeter of inlet head	42mm	Subject to frequent twisting; may distort or tear
Underside of inlet head; underside of 1 st and 2nd filter stage (x3)	32mm	May become dislodged
Top of each filter stage (x3)	32mm	N/A
Perimeter of each filter stage (x6)	42mm	N/A

Note: Do not use or grease or other lubricant on the O-rings, as this may cause the flow orifices to plug.

7. Troubleshooting

The table below list the symtoms, possible causes and recommended solutions for common problems encounterd with the RESPICON TM

Symptom	Possible Cause	Corrective Action
When using totale flow checker or stage fow checker, flow rates are incorrect.	Leak	Check connection for leaks.Make sure tubing is correct size and tightly fitting. Check O-rings. Make sure all O-rings are properly installed; not twisted or torn. Tighten adapter (turn clockwise)
	Dirty impactor nozzle.	Clean virtual impactor orifices and capillaries using pipe cleaner or compressed air
	Dirty orifice(s).	Unscrew and remove orifice(s). Clean with compressed air or mild soap solution. Blow dry with clean compressed air. DO NOT INSERT OBJECT INTO ORIFICE! Reinstall.
	Pump setting is incorrect.	Using the total flow checker, set the pump flow rate to 3.11 Lpm. Once total flow is incorrect, verify individual flows.

Incorrect flow rate, continued.	Pump not able to maintain proper flow rate.	Verify operating parameters on pump; make sure pump is rated for this application. Make sure batteries are fully charged (or operate with AC adapter).
	Flow checking components are connected incorrectly.	Verify that rotameter, RESPICON TM flow checker and sampling pump are connected in correct manner.
	Wrong filters installed (filters may have too high pressure drop)	Use only HUND approved filters in RESPICON TM, ask for filters recommended
There is no measurable deposit on the first filter stage (respirable fraction) or negativ mass weighted	Improper scale used for weighing filter.	Use scale with microgram resolution (scale with milligram resolution may not be adequate to measure small amounts of particles).
	Samle period was too short; insufficient particles deposited upon filter.	Sample for longer period of time (preferable 8 hour minimum).
	Air contains very low concentrations of aerosol.	No solution.

8. Technical Data

8.1 Components of RESPICON TM

2-stage virtuel cascade impactor (base unit)
Data logger
Software
Filter cassettes
Consumables, filters, accessoires

8.2 Sampling system

system:	dust sampling system for 3 dust fractions
measured dust fractions:	- inhalable fraction - thoracic fraction - alveolar fraction
calculated fractions:	- tracheo bronchial fraction - extra thoracic fraction
mode of operation:	- personal sampling - stationary sampling
mechanism of the size classification:	two-stage virtual impactor
filters:	- glass fiber filter - membrane filter with pore sizes > 2 µm - see recommended filterlist
height:	82 mm
width:	60 mm
weight:	approx. 230 g
thread for tripod:	WHITWORTH W ¼'' on filter cassette support No. 3

8.3 Sampling pump requirements

operation time:	min 8 hours battery power
flow rate:	3.5 l/min, adjustable
pressure drop:	4.5 kPa

flow rate feed back control

battery power for at least 8 h sampling duration

automatic switch off after preset sampling time

8.4 Aerosol photometry

Three photometric dustsensors

Measuring range:	0- 200mg/ m^3 for DEHS particles1µm (Diethylhexasebacate)
Lower dedection limit:	0,1 mg/m^3 for DEHS particles
Resolution:	ca. 50µg/ m^3 for DEHS particles
IR laser:	780 nm, 5mW
Receiver:	Siliziumphotodiode
Signal output voltage:	0-4 V each stage

SMD Technik

Data proccessing, averaging, storing of the three output signals via portable Datalogger

8.5 Portable Datalogger

8 measuring channels:	three to be used by RESPICON - TM ; 5 or up to 8 channels free for other sensors
measuring ranges:	+/- 1V , +/- 5V, +/-10 V , each channel Option. 0-20mA
Resolution:	0,01% each channel
Display:	LED-display
Internal memory:	512 KB for data storage
Extensive software package:	for data transfer, storaging and pre-processing onto the datalogger, data processing via notebook or personal computer

On-line monitoring via datalogger to PC or notebook

Interface:	RS 232	
Powersupply for power and charging unit:	230 V/ 50/60 Hz,	
Rechargeable accu-bloc, operation time via accu approx. 12 hours.		
Accessoires:	Set cables, software	
Dimensions:	Width:	100mm
	Height:	131,5mm
	Depth:	55mm
Weight:	approx.:	575g
Protection code:	IP 54 for RESPICON TM together with Datalogger DSS8	

We herewith confirm that RESPICON TM inclusive Datalogger DSS8 is manufactured by us complied with CE standard.

9. Warranty

The warranty period for HUND dust measuring instruments shall be 12 months from passing of risk.

Parts proven as defective shall be repaired (HUND has three attempts) or replaced by HUND at his discretion and at its own expense. HUND shall not be liable for consequential, indirect or incidental damages, including without limitation loss of profit and production.

The Buyer shall notify HUND in writing immediately on occurrence of a defect informing HUND in detail of the nature and the probable cause of the defect.

Parts subjected to wear and tear, improper use and external factors are excluded.

The warranty period for goods not produced by HUND (goods of trade) will be the period provided by the original manufacturer of these goods.

10. Copyright

This manual was written with carefulness. Hund GmbH excludes any liability for possible errors in the manual and malfunctions caused by these errors.

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