Simas (LTA) Oil Mist Filter AC 3002

Verification Report

Oil mist from tooling machine exhaust air

Date	**25. May 2010**
Project Manager	**Marianne Kyed Ørbæk**
Task no	**110-22627**

0. Table of contents

1. Abbreviations and definitions

The abbreviations and definitions used in the verification report are summarized below.

Word	DANETV
Analytical laboratory	Independent analytical laboratory used to analyze reference samples.
Application	The use of a product specified with respect to matrix, target, effect and limitations.
CEN	European Committee for Standardization
DS	Danish Standard.
Effect	The way the target is affected.
ELPI	Electrical Low Pressure Impactor is an instrument to measure airborne particle size distribution and concentration in real-time.
ELV	Emission Limit Value.
EN	European standard.
ETV	Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and adequate quality assurance.
Evaluation	Evaluation of test data for a technology product for performance and data quality.
Experts	Independent persons qualified on a technology in verification or on verification as a process.
GC	Gas chromatography.
ISO	International Standardization Organization.
Matrix	The type of material that the product is intended for.
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis.
Performance claim	The effects foreseen by the vendor on the target (s) in the matrix of intended use.
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance of an environmental technology product.
QA	Quality assurance
RSD	Relative standard deviation in %.

SRM	Standard Reference Method is the approved method prescribed in a standard.
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis.
Target	The property that is affected by the product.
Test/testing	Determination of the performance of a product for parameters defined for the application.
TOC	Total organic carbon.
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance.
VTC	Verification and Test Centre.

2. Introduction

Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and quality assurance.

2.1. Name of product

The product is Simas (LTA) Oil Mist Filter AC 3002, manufactured by LTA Lufttechnik GmbH in Germany

2.2. Name and contact of vendor

Simas Filters A/S
Rugvænget 10
8500 Grenaa
Denmark
Phone +45 8758 1020
Contact Peter Rebsdorf,
E-mail pre@simas.dk
Cell phone +45 (21) 60 43 49

2.3. Name of centre/verification responsible

Test centre:
FORCE Technology
Park Allé 345
DK - 2605 Brøndby
Denmark.

Verification responsible:
Ole Schleicher
E-mail osc@force.dk
Phone +45 4326 7540
Cell phone +45 2269 7540

2.4. Verification documentation

The documentation of the verification process is described in four main documents in the order indicated below following the template of DANETV FORCE Technology verification centre quality manual /1/. The verification protocol and test plan result in a test and verification report, respectively. The verification report is the final completing document.

1. Verification Protocol
2. Test plan
3. Test Report
4. Verification Report

The verification process is summarized in the verification statement.

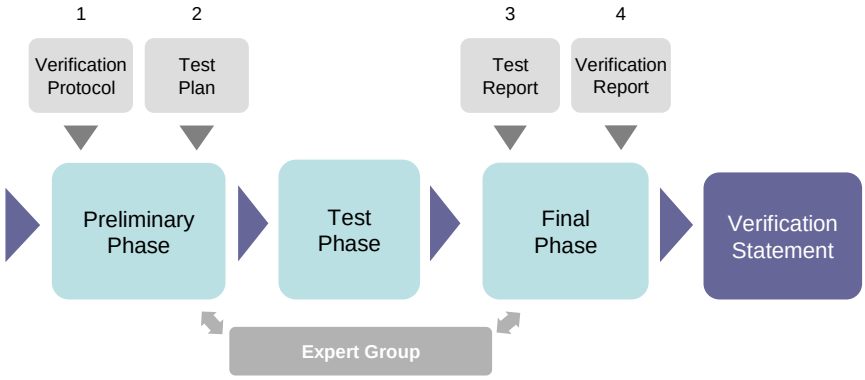
2.4.1. Verification document status

This Simas Filters Verification Report is a result of Simas Filters Verification Protocol, September 2009 /3/ and is referring to Simas Filters Test Report (Appendix 3).

2.5. Verification process

Verification and tests will be conducted in two separate steps, as required by DANETV. The steps in the verification are shown in Figure 1.

Figure 1. Verification steps.



References for the verification process are the Quality Management Plan for DANETV /1/.

2.6. Verification process and test organization

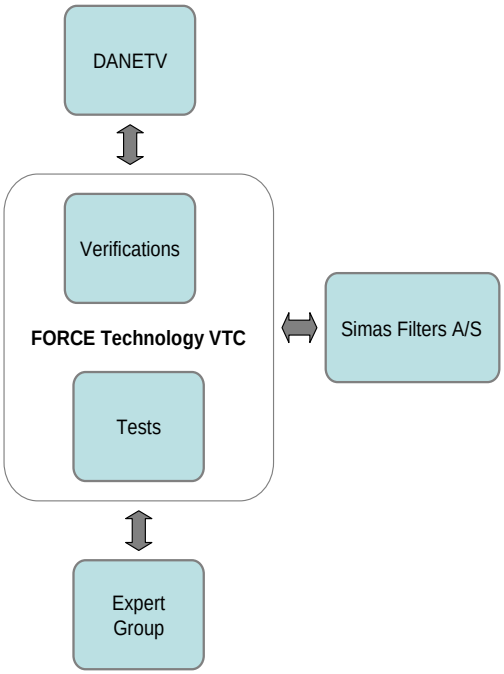
The verification was conducted by the Danish test centre DANETV. The verification was planned and conducted to satisfy the requirements of the ETV scheme currently being established by the European Union (EU ETV). Verification and test was performed by FORCE Technology as DANETV verification and test centre (VTC).

The day to day operations of the verification and tests was coordinated and supervised by FORCE Technology, with participation of the vendor, Simas Filters A/S. The testing was conducted in the FORCE Technology laboratories, Brøndby, Denmark. FORCE Technology will operate the oil mist filter during the verification. Simas Filters A/S will provide the oil mist filter, user manuals and operation instructions. In addition also participate in the development of the protocol and plans with FORCE Technology.

A part of the verification organization is the expert group who supports FORCE Technology in planning, conducting and reporting the verification and tests. The expert group makes the review.

The organization chart in Figure 2 identifies the relationships of the organization associated with this verification and tests.

Figure 2. Organization of the verification and tests.



2.7. Expert group

The expert group assigned to this verification and responsible for review of the verification plan and report documents includes:

Erik Balieu (EB)
Balieu Prudentia
Dianas Have 75
DK-2970 Hørsholm
E-mail ebalieu@mail.dk
Phone +45 20 55 17 64

Qualification:

Erik Balieu has an in-depth know-how of filtration theory, filtration mechanisms and performance of filters for removal of air-borne particles. He has more than 30 years of experience in standardization within DS and CEN as well as in testing of respiratory protective devices, including testing of air purifying particle filters for removal of oil aerosols.

Erik Bjarnov (EKB)
Specialist / Chemical Analysis FORCE Technology
Park Allé 345
DK-2605 Brøndby
E-mail: ekb@force.dk
Phone +45 43 26 72 58

Qualification:

Erik Bjarnov has many years of experience with standardisation and testing of respiratory protective equipment including testing of particle filters against oil aerosols.

3. Description of the technology

A wide range of technologies and products are available for removal of oil mist from ventilation air.

The technology product to be verified is applying the electrostatic precipitation technology for removal of oil mist from ventilation air from metal cutting machines.

The removal of oil mist is based upon electrostatic attraction. By using an electro filter the electrical forces are used to separate the aerosols from the ventilation air.

The filtration principle in electrostatic attraction is divided into 3 steps:

1. charging the particles
2. separation of the particles
3. removal of the separated particles

4. Description of the product

Simas (LTA) Oil Mist Filter AC 3002 is an electrostatic separator, but the unit is called a filter by the manufacturer. It is developed to remove cooling lubricant oil mist from metal cutting machinery. The oil mist is ventilated from the working centre by the integrated fan in the oil mist filter.

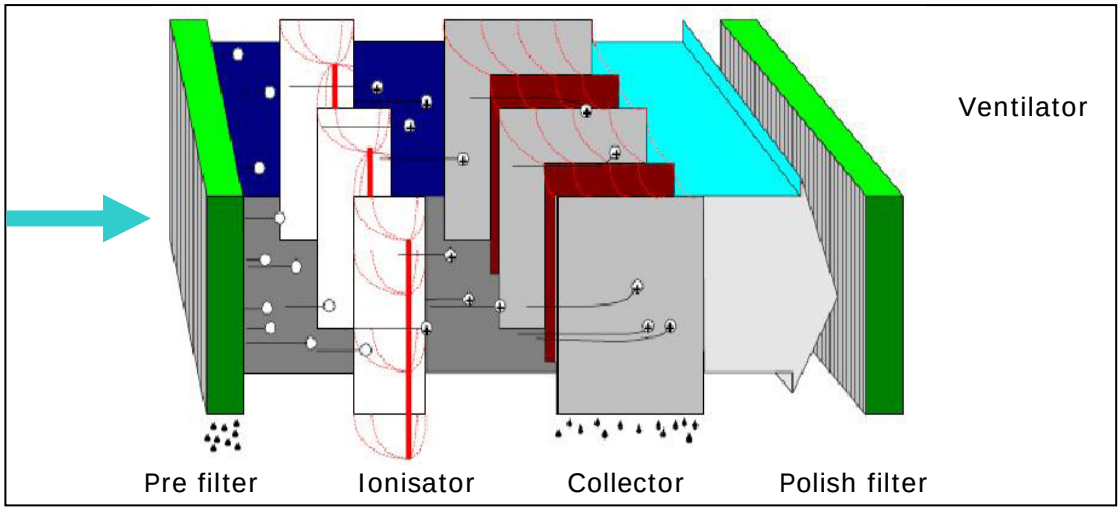
The filtration process is divided into 3 main filtration steps:

1. Pre filter: Consist of several layers of metal filters. As the oil mist passes through the pre filter the major part of the largest oil droplets and eventually solid particles is captured.

2. Electrostatic filter: Consist of an Ionisator and a Collector. The oil mist droplets (aerosols) are charged positively by the high voltage field in the Ionisator. The charged particles are attracted to the Collector, which is negative charged. This process enables an efficient removal of aerosols.

3. Polish filter: The final polish filter makes sure, that no aerosols are left after the filtration process.

Figure 3. Filtration principle.



The oil particles collected on the collector plates and in the pre and polish filter will by gravity flow to the bottom of the filter, where it can be lead back to the lubricant oil reservoir in the metal cutting machines.

Figure 4. Simas (LTA) Oil Mist Filter AC 3002.

The built in fan in the filter, has a capacity of 2400 m³/h, but the filter is designed for a flow of maximum 1200 m³/h, and the filter was operated with this flow in the test.

The filter is standard equipped with one pre filter type Primus D50 and one polish filter type Primus S-20, but the tested version is also equipped with a second pre-filter type Primus A-50, as it is the standard equipment for sale in Denmark.

5. Application and performance parameter definitions

The application is defined as detailed in the application definition appendix, Appendix 1, in terms of matrix for use, targets and effects.

5.1. Matrix

The matrix of the application is oil mist (aerosols) in ventilation air from metal cutting machines, using cooling lubricant oils.

5.2. Target

The targets of the application are aerosols.

5.3. Effect

The effect of the application is removal of aerosols, in terms of the percentage rate of removal of oil mist, and the outlet concentration.

The relative removal rate is calculated by the formula: $RR = [(C_I - C_O) / C_I] * 100$

Where:
RR is the removal rate for
C_I is the inlet concentration
C_O is the outlet concentration

5.4. Performance parameter for verification

The Performance parameter for the verification is the concentration of oil mist measured before and after the oil mist filter, after start up and again after 240 hours of operation.

5.5. Additional parameters

The following parameters are additional parameters measured and reported for the test period:

- Total operating time
- Oil consumption in the aerosol generator
- Oil separated regained from the filter
- Weight increase of the pre-filters and the polish filter

Besides this, the compilation of parameters describing the user manual and occupational health & safety issues of the product are required as a part of the verification.

6. Existing data

Test results from an earlier test with the Oil Mist Filter AC 3002 are available but it doesn't document the filtration efficiency on a long term basis, which is important in this test.

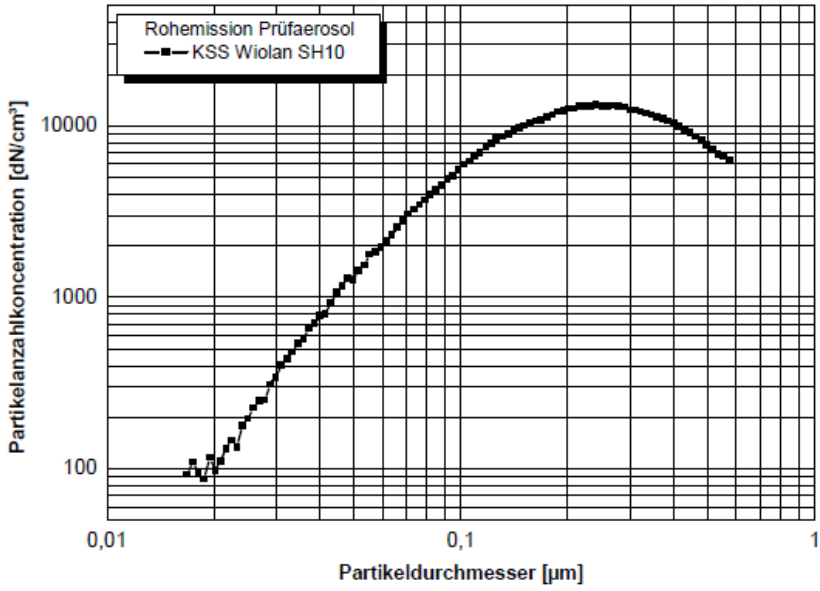
6.1. Summary of existing data

In October 2008 an AC 3002 R was tested for it ability to remove oil aerosol from air, by ILK Dresden and reported in Fachbericht ILK-B-33-08-1469 dated 24.10.2008. Attached as Appendix 2.

The test conditions were briefly:

- The test aerosols were made by an ATM 243 aerosol generator from Topas.
- The test oil used was an KSS Wiolan SH 10 from Houghton
- The target for the air flow through the filter was 1260 m³/h
- The target for the inlet oil aerosol concentration was 70 mg/m³
- The removal rate was calculated based on data from four samples of oil aerosol at the inlet and the outlet of the filter. Sampling time was 30 minutes for inlet samples, and 65 minutes for outlet samples.
- Oil aerosol was collected on glass fibre filter, extracted with tetrachloroethene and analysed by FT-IR spectroscopy.
- Aerosol particle size distribution was measured by an SMPS-System Model 3963 from TSI Inc.
- The test aerosol particle size distribution is shown in Figure 5.

Figure 5. Aerosol particle size distribution in the ILK Dresden test.



The measured removal rates together with the inlet and outlet aerosol concentration and the air flow for each measurement, are shown in Table 1:

Table 1. Results and removal rate from the ILK Dresden test.

Sample no.:		1	3	4	5	Average
Air flow	m³/h	1245	1270	1275	1280	1270
Inlet concentration	mg/m³	63.8	77.2	61.9	67.6	67.63
Outlet concentration	mg/m³	0.14	0.14	0.14	0.14	0.14
Removal rate	%	99.78	99.82	99.77	99.79	99.79

6.2. *Quality of existing data*

From the ILK Dresden homepage, www.ilkdresden.de , the following statement about the company was found:

- The ILK Dresden is an independent and free research enterprise with the legal status of a non-profit limited liability company.
- The ILK Dresden is certified according to ISO 9001.
- The ILK Dresden has 120 employed, and for their disposal is an experimental test area of 3000 m^2 with 60 experimental und test facilities as well as 25 scientific and technical laboratories.

Based on this information and their test report, which seems to be a professional work done by experienced people it is concluded, that these test results are reliable and has a very good quality.

6.3. *Accepted existing data*

The principle for the test set up and the test parameters will be followed in the new test, and the results for the aerosol particle size distribution will be used directly in the test report for information and comparison.

7. Test plan requirements

Based upon the application and performance parameter identified in section 5, the requirements for test design was set, as described in section 7.1. The detailed test report is in a separate document see Appendix 3.

7.1. *Test design*

The oil mist separator is tested in a set up which is imitating the set up of a metal cutting machine equipped with an oil mist separator. Instead of a metal cutting machine an oil mist generator was used.

The oil mist separator, which has a built-in fan, is connected to the oil mist generator, by means of 200 mm ducts (Trade name Spiro) being long enough to achieve proper sampling points and a uniform distribution of the oil mist in the constant air flow.

7.2. *Data management*

Data storage, transfer and control was carried out in accordance with the requirements of ISO 9001 /2/ enabling full control and retrieval of documents and records.

7.3. *Quality assurance*

The quality assurance of the tests includes control of the reference system, control of the test system and control of the data quality and integrity.

7.4. Test report

The test report is a result of the test plan as described in section 2.4 and follows the template of DANETV FORCE Technology verification centre quality manual /1/ with data and records from the tests presented.

8. Evaluation

The evaluation includes calculation of the additional parameters described in section 5.5.

Evaluation of the data quality is based upon the test quality assurance; see Section 7.3 for requirements, and compilation of the additional parameters specified in section 5.5.

8.1. Calculation of performance parameters

Calculations are done according to generally accepted mathematical and statistical principles such as those described in /2/ and as described in the Test Report (Appendix 3).

8.2. Performance parameter summary

The test was carried out over 11 day's with continuous operation around-the-clock. The operation was supervised twice a day by representatives from FORCE Technology in order to observe and secure that the operation conditions are inside the specified limits. The aerosol generator was also refilled, and during this the aerosol generator was stopped for a few minutes. Furthermore the whole test system was stopped three times for app. 10 minutes for weighing the internal pre- and after filter.

8.2.1. Test results

The overall results of the test, concerning the removal rate for oil mist removed from the air is shown in Table 2. Each of the concentrations is the average of three one hour successive samples.

Table 2. Main test results for removal rate at the beginning of the test and after 240 days of operation.

Date	Inlet concentration mg/m³	Outlet concentration mg/m³	Removal rate RR
14/10/2009	86.7	4.8	94.5 %
26/10/2009	109	4.1	96.3 %

The removal rate is much lower than the expected level, based on the previous test made by ILK Dresden (see Table 3), where the removal rate was measured to be > 99.5 %.

Table 3. Main results from the ILK Dresden test in 2008.

Sample no.:		1	3	4	5	Average
Inlet concentration	mg/m^3	63.8	77.2	61.9	67.6	67.63
Outlet concentration	mg/m^3	0.14	0.14	0.14	0.14	0.14
Removal rate	%	99.78	99.82	99.77	99.79	99.79

The operation conditions have been very similar to the conditions in the test made by ILK Dresden in 2008 (see the Test Report - Appendix 3). The aerosol particle distribution is shown in Figure 6 and Figure 7.

Figure 6. Aerosol particle size distribution - ILK Dresden test 2008.

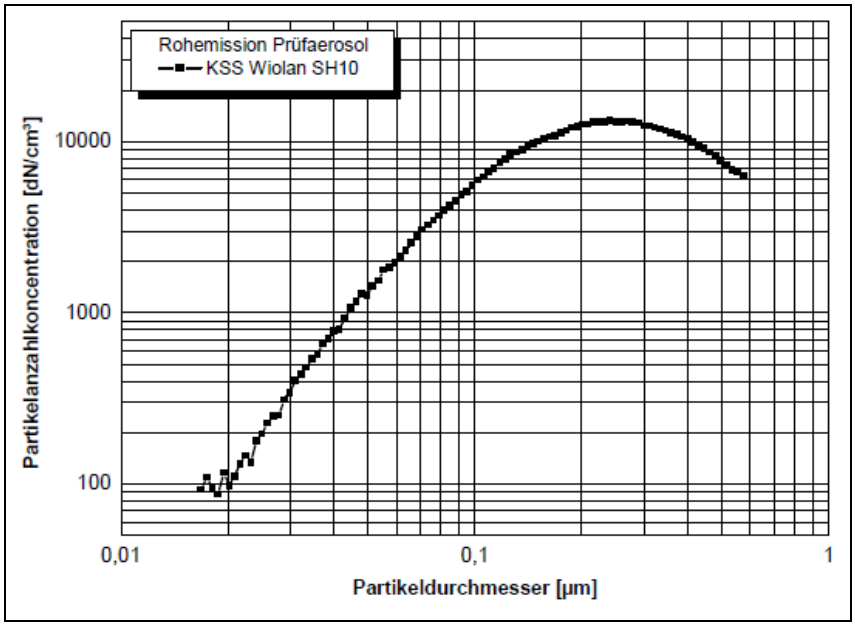
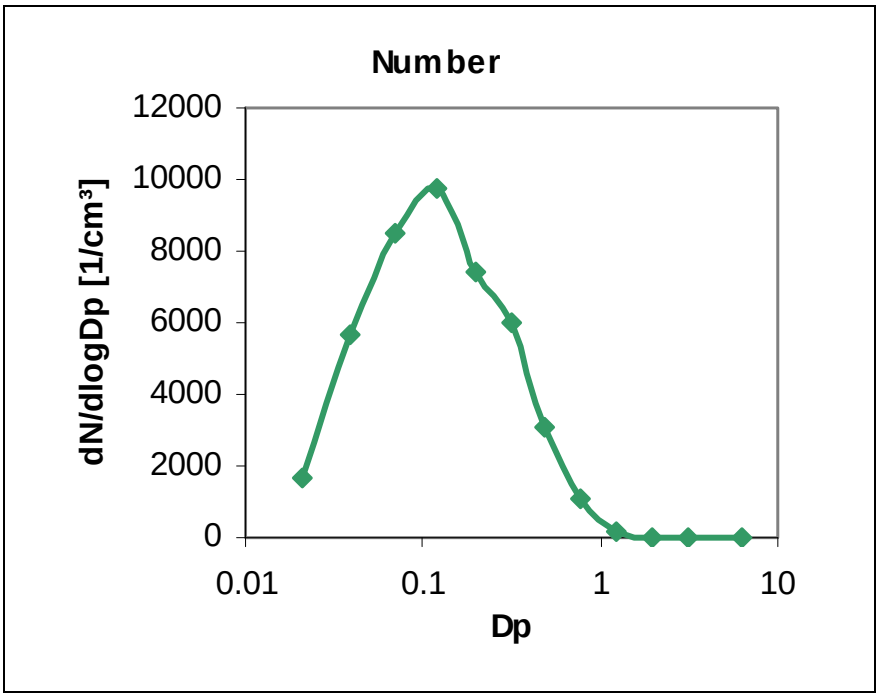


Figure 7. Inlet aerosol particle size distribution – FORCE test 2009.



Based on the similarity of the operation parameters, aerosol concentration and particle size distribution, the measured lower removal rate can't be explained by differences in the operation of the filter, but must be related to the filter performance.

8.3. Evaluation of test quality

All measuring, handling of data and calculation of results have been carried out according to the FORCE Technology DANAK accreditation No. 51 (also for parameters not covered by the accreditation).

The evaluation of the test and the results has proven that the quality and the accuracy fulfil the requirements stated in the DANAK accreditation No. 51 /2/.

8.4. Control of data quality

Transfer of data from handwritten form to computer, has been subjected to 100 % control by a second person.

The operational data verifies that the test has been in agreement with the determined conditions in the test plan /4/ is shown in Appendix 3 (Test Report).

8.5. Deviations

The test was performed according to the test plan. There were no deviations from the test plan regarding measurements, data logging and sampling, except for one

missing result for the oil aerosol concentration before and after the filter on the last day of the test. One of the three one hour manual filter samples could not be carried out, because the filter has mistakenly been used for an extra blank sample, and no spare filters remained.

8.6. Additional parameter summary

The filter has been in operation for 336 hours in the period from the 8th of November to the 27th of November 2009. The test period with continuously operation was from the 13th of November to the 26th of November 2009.

Oil consumption in the aerosol generator was on average 101 mg/m³ in the inlet to the filter, but app. 16 mg/m³ were drained out from the pipeline before the filter, leaving an average load to the filter of 85 mg/m³.

Separated oil regained from the filter during the test period was app. 22.66 kg. It was not possible to calculate the filter removal rate by the measured amount of oil, due to inexact making up of the amounts of oil, especially the amount of oil left in the generator, retained on the pipeline walls and in the filter.

The pre-filters and the polish filter retained app. 1.504 kg oil, which slowly drained out, when turning off the filter.

8.7. User manual

The user manual, which is covering different models of the electrostatic filter, is giving an understandable and adequate description. It is illustrated with figures and photos, from unpacking, installation, principle of operation, intended use, operation and maintenance. However, some information about the achievable performance of the different filter models, and which consequence a leak of regular cleaning of the inside part of the filter can have of performance, could be valuable to have in the manual.

8.8. Product costs

No exact information on the investment and operational cost has been available for the filter.

An indication for the investment cost is app. 5-6000 € for the filter ex works.

Cost for transportation and installation is very individual, depending on the company position and the actual way of installation.

Operational cost for electricity and maintenance cost for regular inspection and cleaning of the filter is expected to be relatively low.

8.9. Occupational health and environment

The LTA Oil Mist Filter AC 3002 has the CE mark, which guaranties focus on healthy and safety during productions and use.

An electrostatic precipitator requires special precautions, because of the very high voltage, and this is clearly explained and repeated in several parts of the user's manual.

8.10. Recommendations for verification statement

The verification of the electrostatic precipitation technology is completed as described in section 2.4.

On the basis of the verification process, relevant documents and the evaluation (see section 8) it is recommendable to issue a verification statement to the vendor.

Signed by	25/5 -10	Signed by	25/5 –10
Annemette Geertinger	Date	Ole Schleicher	Date
Deputy Manager		Verification Responsible	
DANETV Steering Committee member		DANETV Verification Centre	

9. References

1. DANETV. Verification Test Centre Quality Manual. 27-2-2009.
2. DANAK accreditation number 51
3. Verification Protocol, Simas (LTA) Oil Mist Filter AC 3002, September 2009.
4. Test Plan, Simas (LTA) Oil Mist Filter AC 3002, September 2009.

10. Appendix

Appendix 1	Application and performance parameter definitions
Appendix 2	ILK Dresden test report, Fachbericht ILK-B-33-08-1469, dated 24-10-2008.
Appendix 3	Test Report, Simas (LTA) Oil Mist Filter AC 3002, April 2010
Appendix 4	Review reports

Appendix 1

Application and performance parameter definitions

This appendix defines the application and the relevant performance parameters application as input for verification and test of an environmental technology following the DANETV method.

1. Application

The intended application of the product for verification is defined in terms of the matrix, the targets and the effects of the product.

1.1. Matrix

The matrix of the application is oil mist (aerosols) in ventilation air from metal cutting machines, using cooling lubricant oils.

Several parameters affect the generation and particle distribution of the oil mist from metal cutting machines, e.g. the velocity of the cutting edge, the flow and velocity of the lubricant oil to the cutting point, the temperature, the type and behaviour of the lubricant oil. These parameters are kept constant during the test, by using a standardized test set up, with an oil mist generator.

1.2. Target(s)

The targets of the application are oil aerosols.

1.3. Effects

The effect of the application is removal of aerosols, in terms of the percentage removal of oil mist, and the outlet concentration.

The relative removal rate is calculated by the formula: $RR = [(C_I - C_O) / C_I] * 100$

Where:
RR is the removal rate for
C_I is the inlet concentration
C_O is the outlet concentration

In order to be able to gain reproducible results the test is conducted under standardized and constant conditions imitating usual industrial operating conditions for metal cutting machines.

During the test it is expected to observe the effect of:

- Decreasing flow rate and or increasing pressure drop across the filter as both pre and end filter eventually will block more and more.
- Some amount of oil on vapour phase.

Appendix 1

Application and performance parameter definitions

1.4. Exclusion

The variations in the air temperature, humidity and pressure which can occur during the test, is expected to have an insignificant impact on the filter performance, and is thus not covered by the verification.

2. General performance requirements

No formal performance requirements for the application have been identified in the European Union or the US.

2.1. Regulatory requirements

The Danish ELV for oil aerosol is 1 mg/m³ according to the Environmental Guidelines Nr. 1, 2002, Guidelines for Air Emission Regulation – Limitation of air pollution form installations, by sampling and analysis of oil mist according to MEL-14, which is the method recommended by the Danish Environmental Protecting Agency.
MEL-14 is a slightly modified US EPA Method 0010, Method for Determining TCO/GRAV in Stack Gas, adjusted for the specific sampling and analysis of mineral oil aerosols.

2.2. Application based requirements

Not relevant.

3. State of the art performance

Not relevant.

4. Performance parameter definitions

No elaborating comments.

Appendix 2

ILK Dresden Test Report

ILK Dresden

Fachbericht
ILK-B-33-08-1469
24.10.2008
Seitenzahl 14

Untersuchung von elektrostatischen Abscheidern - Baureihenentwicklung

Dipl.- Ing. Ralf Heidenreich

Dipl.-Ing. Steffen Blei

(Zusammenfassung vom 06.03.09: LTA, Dipl.-Ing. (FH) Jürgen Kälble)

Zertifiziert nach ISO 9001

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Inhaltsverzeichnis

1 Aufgabenstellung

Für elektrostatische Abscheider (einstufig und doppelstufig) sollten der Fraktionsabscheidegrad und die Gesamtabscheideleistung unter Berücksichtigung der Gasphase für Kühlschmierstoff bestimmt werden. Wesentlich für die Charakterisierung des Abscheideverhaltens sind dabei

I. Gesamtabscheidegrad in %

a. Gesamtabscheidegrad Aerosol: $$\eta = \frac{k_1 - k_2}{k_1} \times 100$$

k_1…Gesamtkonzentration von Aerosol am Eintritt des Filters

k_2…Gesamtkonzentration von Aerosol am Austritt des Filters

Die Bestimmung erfolgt durch gravimetrische Messung der roh- und reingasseitigen Aerosolkonzentration.

b. Gesamtabscheidegrad Aerosol und Dampf: $$\eta = \frac{C_1 - C_2}{C_1} \times 100$$

C_1 ... Gesamtkonzentration von Aerosol und Dampf am Eintritt des Filters

C_2 ... Gesamtkonzentration von Aerosol und Dampf am Austritt des Filters

Für die simultane Bestimmung von Tröpfchen- und Gasphase ist das Verfahren nach BIA-Arbeitsmappe "Messung von Gefahrstoffen" Kennzahl 3110 anzuwenden.
Die partikelförmigen Stoffe werden isokinetisch erfasst und auf ein Planfilter abgeschieden, die Dämpfe werden in einer nachgeschalteten, mit Adsorberharz gefüllten Kartusche adsorbiert. Während die auf dem Planfilter abgeschiedene Fraktion gravimetrisch und extraktiv/ analytisch ausgewertet werden muss, kann die adsorbierte Fraktion mit Tetrachlorethen extrahiert und mittels FT-IR-Spektroskopie analysiert werden.

Verfahrenskenndaten:

Sammelphasen	Glasfaserfilter für Aerosol XAD - 2 für Dampf
Absaugraten	0,5 … 2,8 m³/h
Maximale Probenahme	120 min
Probenaufbereitung	
Mineralölaerosol	Eluieren des mit Mineralölen beaufschlagten Glasfaserfilters mit Tetrachlorethen
Mineralöldampf	Eluieren des XAD - 2 mit Tetrachlorethen
Analytische Bestimmung	FT-IR-Spektroskopie bei 3000-2800 cm mit 32-facher Spektrenaddition
Bestimmungsgrenzen	
Mineralölaerosol	0,25 mg/m³ bei 5,6m³ Probeluftvolumen
Mineralöldampf	0,5 mg/m³ bei 5,6 m³ Probeluftvolumen

Für die gesicherte Bestimmung einer Abscheideleistung ist je dreimal roh- und reingasseitig eine Messung durchzuführen.

II. Fraktionsabscheidegrad des Filters T (x) in %:

Abscheidegrad für eine bestimmte Partikelgröße x: $$T(x) = \frac{k_1(x) - k_2(x)}{k_1(x)} \times 100$$

$k_1(x)$ ... Partikelanzahlkonzentration der Partikelgröße x am Eintritt des Filters

$k_2(x)$ ... Partikelanzahlkonzentration der Partikelgröße x am Austritt des Filters

Mit der Kenngröße des Fraktionsabscheidegrades kann eine Aussage über die Abscheide-charakteristik des Filters getroffen werden. Der gemessenen Fraktionsabscheidegrad ist abhängig von der Art des Aerosols.

Mit der Kenngröße des Fraktionsabscheidegrades kann eine Aussage über die Abscheide-charakteristik des Filters getroffen werden. Der gemessenen Fraktionsabscheidegrad ist abhängig von der Art des Aerosols.

Die Messungen werden mit dem KSS Wiolan SH 10 der Fa. Houghton durchgeführt. Die Aerosoldosierung erfolgt mit einem Dosiersystem ATM 243 der Fa. Topas. Die eingestellte KSS-Konzentration soll 35 bzw. 70 mg/m³ betragen.

Die Anströmgeschwindigkeit ist über den in den Abscheider integrierten Lüfter festgelegt und beträgt ca. 1250 m³/h. Die Messungen erfolgen im Neuzustand der elektrostatischen Abscheider.

2 Messaufbau und Vorgehensweise

2.1 Aufbau des Prüfstandes

Für die Untersuchungen wurde im ILK Dresden ein separater Prüfstand für die Untersuchung der elektrostatischen Abscheider eingerichtet. Für die Durchführung der Messungen wurden Kanalelemente für die Einbindung der elektrostatischen Abscheider und Adapter für die Anpassung der Abscheider an das ILK-interne Absaugsystem gefertigt, sowie eine Roh- und Reingasmessstrecke ausgebildet.

Dabei sorgt die Gestaltung der Anlaufstrecke für eine gute Dispergierung des Prüfaerosols über den Kanalquerschnitt. Für die notwendigen Messstellen wurden entsprechende Sonden- und Sensorhalterungen vorgesehen.

Tabelle 2-0: Eingesetzte Mess- und Dosiertechnik

Mobilitätsspektrometer Model 3936	Ölnebelgenerator ATM 243 mit Einrichtung zur Ölnebelhomogenisierung

2.2 Elektrostatische Abscheider

Die untersuchten elektrostatischen Abscheider sind in Tabelle 2- charakterisiert. Die im Abscheider integrierten Filterelemente sind senkrecht zur Strömungsrichtung angeordnet.

Tabelle 2-1: Eingesetzte Filter

Filterbezeichnung	Typ	Abmessungen B x H x L	Rohgas-konzentration
AC 3001 R	Mechanische Vorfiltration 1 elektrostatische Reinigungsstufe	590 x 610 x 740	35 mg/m³
AC 3002 R	Mechanische Vorfiltration 2 elektrostatische Reinigungsstufen	590 x 610 x 1065	70 mg/m³

2.3 Bestimmung des Gesamtabscheidegrades und Fraktionsabscheidegrades

Die Bestimmung des Gesamtabscheidegrades erfolgt durch eine gleichzeitige gravimetrische Messung der roh- und reingasseitigen Aerosolkonzenration.
Die Bestimmung des Fraktionsabscheidegrades erfolgt durch abwechselnde, roh- und reingasseitige Messung mit dem Mobilitätsspektrometer Model 3936.

2.4 Partikelmesstechnik

2.4.1 Mobilitätsspektrometer Model 3963

Für Partikelgrößen im Nanometerbereich kommt das Mobilitätsspektrometer bestehend aus einem Elektroklassierer mit langem DMA und Kondensationskernzähler CPC zum Einsatz. In Abhängigkeit von vorgeschaltetem Impaktor, Probenahmedurchfluß und Probenahmedauer wird bei den vorliegenden Versuchen mit dem SMPS das Partikelgrößenspektrum von 18 bis 850 nm abgedeckt. In Tabelle 2-1 ist das verwendete Gerät in seinen Eigenschaften aufgeführt.

Tabelle 2-1: Eingesetzte Partikel- Messtechnik Mobilitätsspektrometer

Größe	Messprinzip	Messbereich	Sensor / Messgerät
Partikel-konzentration Patrikelgrössen-verteilung	Korrelation von Partikelgröße und Mobilität der Partikel, Kondensationskernzählung	0,02 µm ... 1 µm	SMPS- System Model 3963 Fa. TSI Inc.

2.5 Aerosoldosierung

Zur Dosierung des KSS- Aerosols wurde ein Aerosolgenerator bestehend aus drei Zweistoffdüsen und einem Prallplattenabscheider eingesetzt. Über die Ansteuerung der Zweistoffdüsen und den Düsenvordruck kann der Dosiermassenstrom eingestellt werden. Für die Prüfung ergab sich folgende mittlere Partikelgrößenverteilung (Bild 2-1).

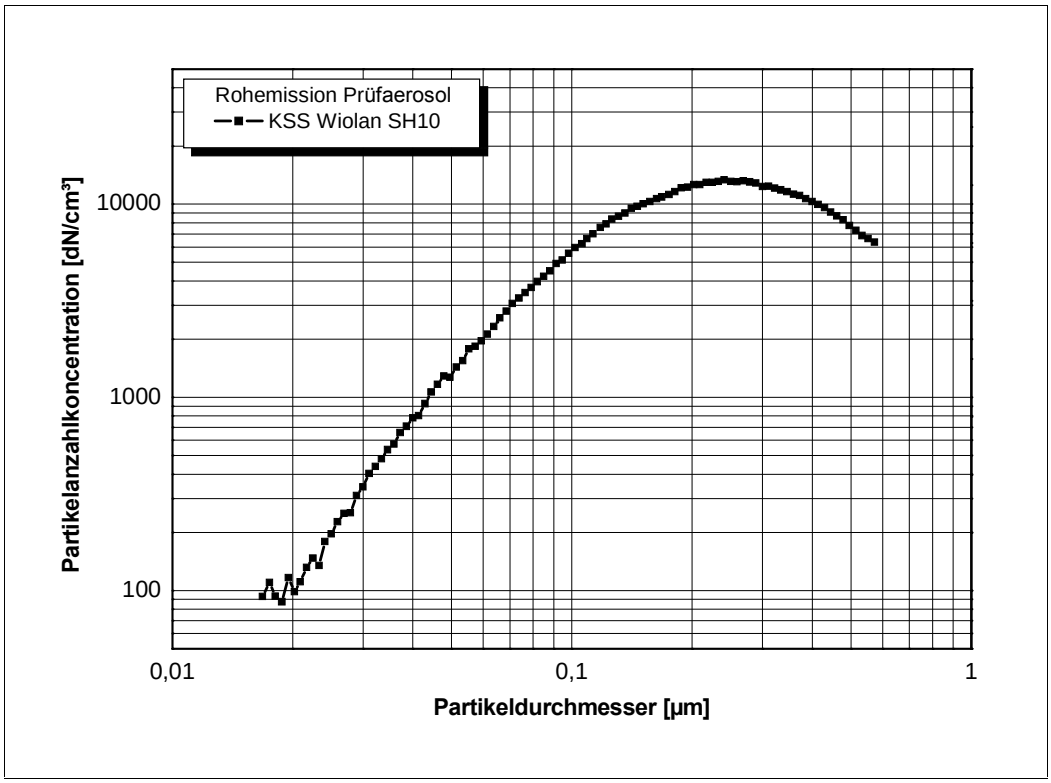

Bild 2-1 Rohgasseitige Partikelgrößenverteilung - KSS Wiolan SH 10

3 Bewertung der Versuchsergebnisse

Die Untersuchung von Gesamtabscheide- und Fraktionsabscheidegrad erfolgte bei einem Volumenstrom von ca. 1250 m³/h. Der Gesamtvolumenstrom wird dabei von einem in den Abscheidern integrierten Gebläse erzeugt. Die Abbildungen Bild 3-1 und Bild 3-2 zeigen die Volumenstrommessung für die beiden untersuchten Abscheider und geben jeweils den Mittelwert der Volumenstrommessung für Abscheider AC 3001 R (1260m³/h) und AC 3002 R (1270 m³/h) an.

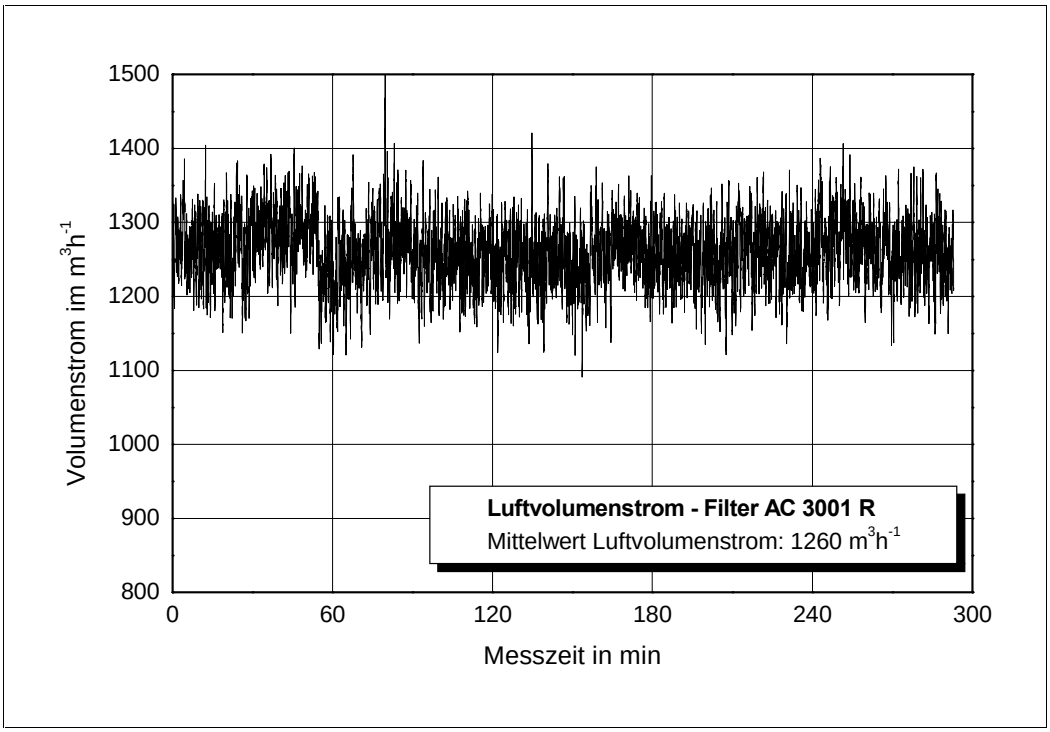

Bild 3-1 Luftvolumenstrommessung für Abscheider AC 3001 R

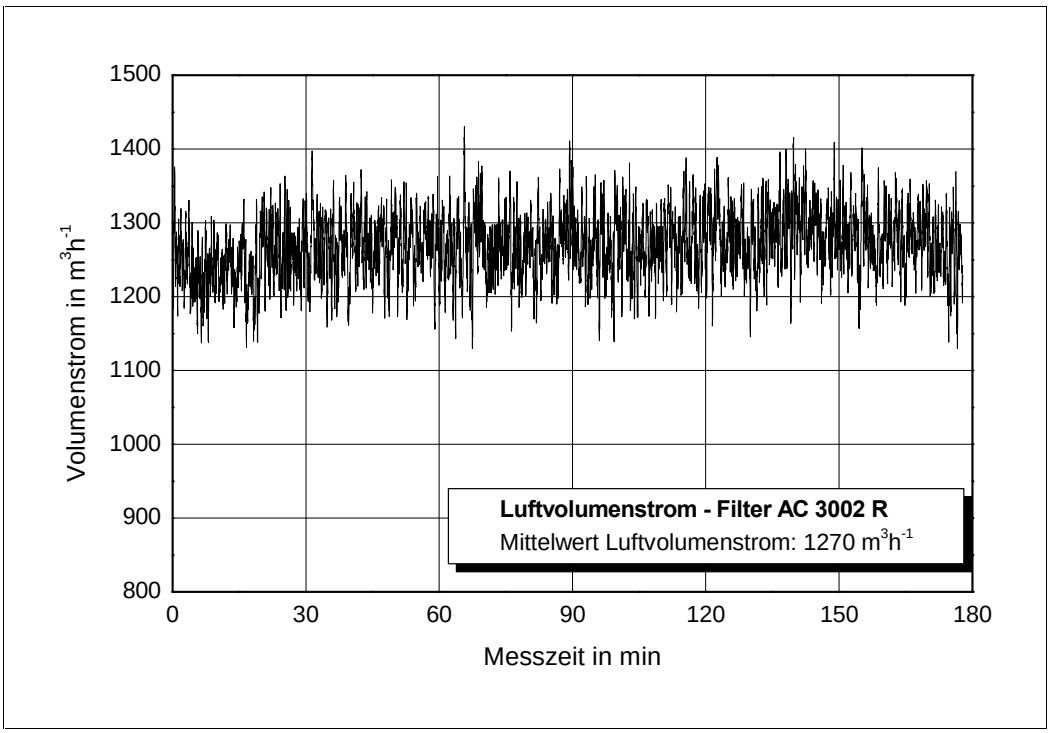

Bild 3-2 Luftvolumenstrommessung für Abscheider AC 3002 R

3.1 Fraktionsabscheidegrad

Bei den Prüfungen der Abscheider zeigte sich, dass eine Abscheidung von feinteiligen Aerosolen unterhalb von 1 µm bei beiden untersuchten Prüflingen sehr effektiv erfolgt. Für den Abscheider AC 3001 R mit einer elektrostatischen Reinigungsstufe konnte ein Fraktionsabscheidegrad von > 97 % bei einer Rohgaskonzentration von 35 mg/m³ festgestellt werden. Das Minimum der Abscheidung wurde für die Partikelgröße von ca. 0,1 µm erfasst, wie auch Bild 3-3 verdeutlicht.

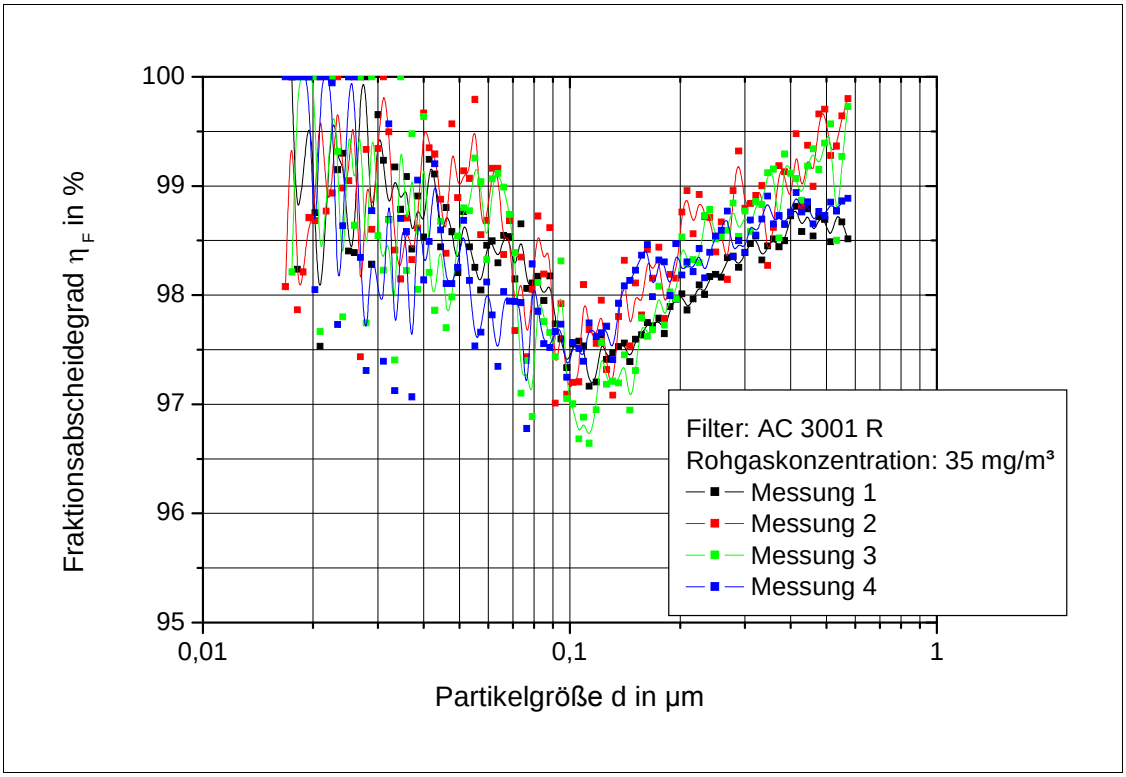

Bild 3-3 Fraktionsabscheidegrad für Abscheider AC 3001 R (1260 m³/h)

Der Abscheider AC 3002 R mit 2 elektrostatischen Reinigungsstufen erzielt ein noch effizienteres Ergebnis bei verdoppelter Rohgaskonzentration (70 mg/m³). Hier konnte ein Fraktionsabscheidegrad von > 99,5 % festgestellt werden. In Minimum in der Abscheideeffizienz ist nicht zu verzeichnen. Bild 3-4 verdeutlicht die gemessenen Fraktionsabscheidegrade für den Abscheider AC 3002 R.

Einen Vergleich des gemittelten Fraktionsabscheidegrades der untersuchten Abscheider AC 3001 R und AC 3002 R zeigt noch einmal Bild 3-5. Die noch effizientere Abscheidung des Prüfaerosols bei verdoppelter Rohgaskonzentration durch den Abscheider AC 3002 R zeigt sich deutlich.

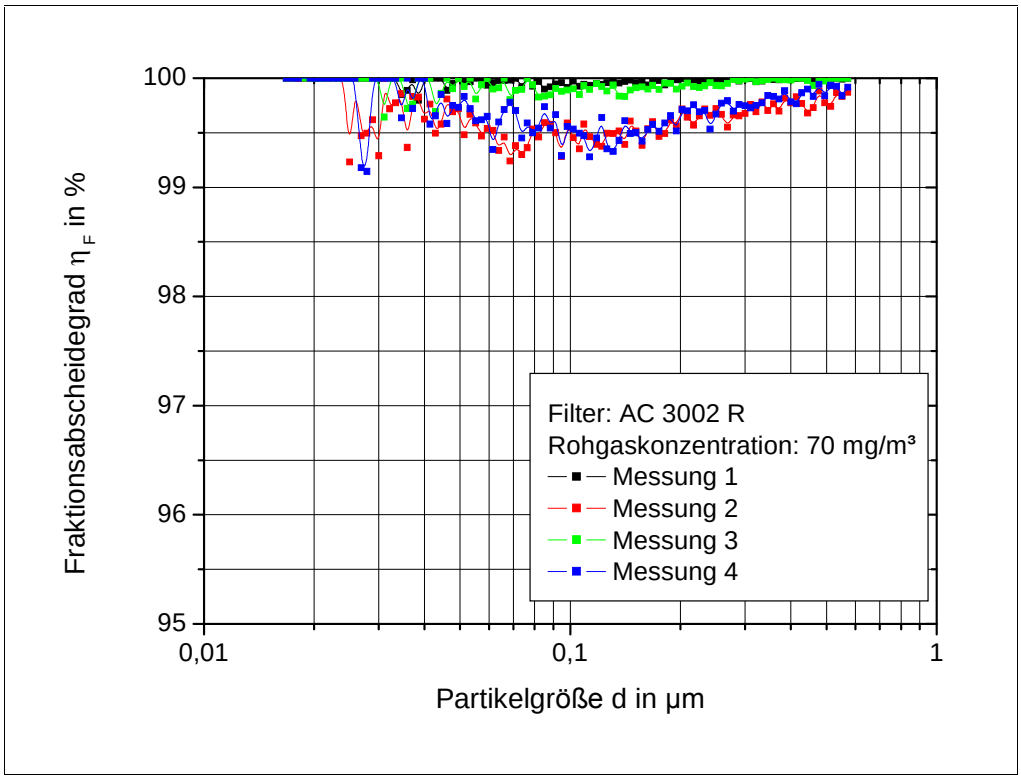

Bild 3-4 Fraktionsabscheidegrad für Abscheider AC 3002 R (1270 m³/h)

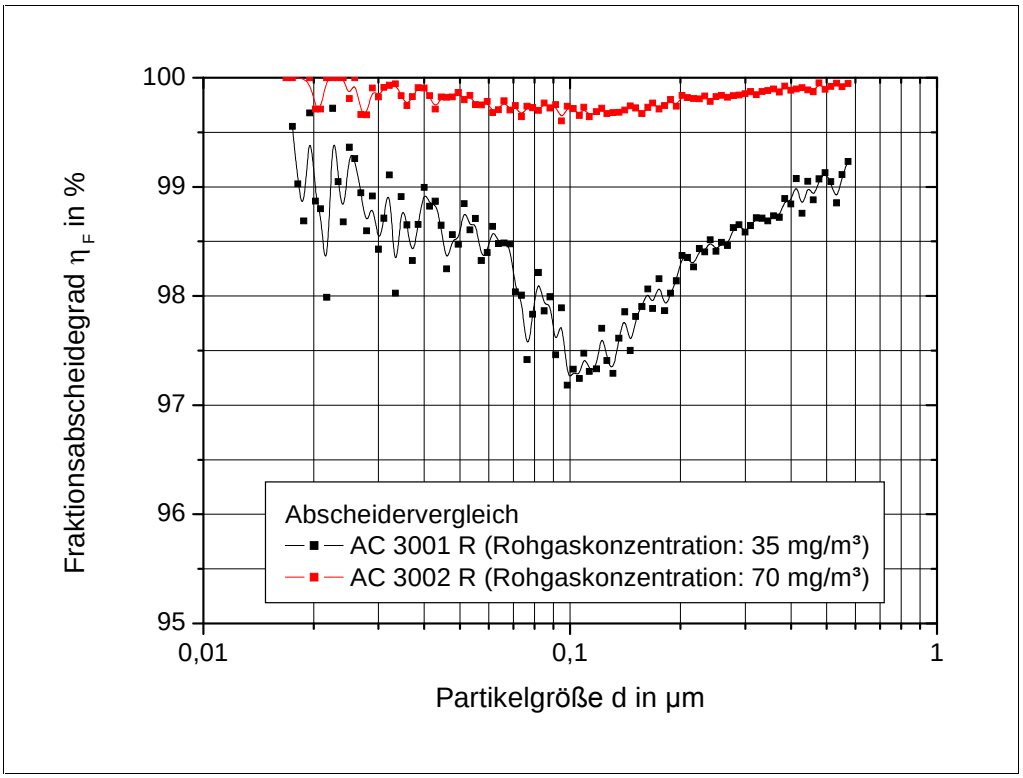

Bild 3-5 Fraktionsabscheidegrade für AC 3001 R und AC 3002 R

3.2 Gesamtabscheidegrad bei Nennluftvolumenstrom

Die Untersuchung des Gesamtabscheidegrades erfolgte bei Nennluftvolumenstrom von ca. 1250 m³/h für beide elektrostatischen Abscheider. Die Bestimmung erfolgt durch die gravimetrische Messung der roh- und reingasseitigen Aerosolkonzentration. Es wurden je 4 Messungen der Aerosolkonzentration im Rein- und Rohgas vorgenommen. Zusätzlich wurde die roh- und reingasseitige Gasphase in einer mit Adsorberharz gefüllten Kartusche adsorbiert.

Ohne Berücksichtigung der Gasphase ergeben sich die in Tabelle 3-1 dargestellten Ergebnisse.

Für den Abscheider AC 3001 R mit einer elektrostatischen Reinigungsstufe konnte ein gravimetrischer Gesamtabscheidegrad von 98,15 % als Mittelwert bei einer Rohgaskonzentration von 35 mg/m³ festgestellt werden.

Der Abscheider AC 3002 R mit 2 elektrostatischen Reinigungsstufen erzielt ein noch effizienteres Ergebnis bei verdoppelter Rohgaskonzentration (70 mg/m³). Hier konnte ein gravimetrischer Gesamtabscheidegrad von 99,79 % als Mittelwert festgestellt werden.

Tabelle 3-1 Gegenüberstellung der Mess- und Prüfergebnisse

Filterbezeichnung	**Gesamtabscheidegrad [%] ohne Berücksichtigung der Gasphase**
AC 3001 R	98,15
AC 3002 R	99,79

Die elektrostatischen Abscheider gliedern sich in die Filterklasse der HEPA-Filter nach EN 1822-1 ein. Der Abscheider AC 3001-R als Filterklasse H11 (Integraler Abscheidegrad > 95%) und der Abscheider AC 3002-R als Filterklasse H12 (Integraler Abscheidegrad >99,5%).

4 Zusammenfassung und Bewertung

Die elektrostatischen Abscheider wurden im Rahmen einer Prüfstandsuntersuchung mit dem Prüfaerosol KSS-Wiolan SH 10 beaufschlagt. Dabei wurden Fraktionsabscheidegrad und Gesamtabscheidegrad bestimmt. Der Fraktions- und Gesamtabscheidegrad wurden bei Nennluftvolumenstrom gravimetrisch ermittelt.

Mit den ermittelten Fraktionsabscheidegradkurven ist eine Beurteilung der Abscheideleistung im praktischen Anwendungsfall bei Kenntnis der Rohgaspartikelgrößenverteilung möglich.

Die elektrostatischen Abscheider reduzieren sehr effektiv feinteilige Aerosole unterhalb von 1 µm Partikelgröße. Für den Abscheider AC 3001 R mit einer elektrostatischen Reinigungsstufe konnte ein Fraktionsabscheidegrad von > 97 % bei einer Rohgaskonzentration von 35 mg/m³ festgestellt werden. Das Minimum der Abscheidung wurde für die Partikelgröße von ca. 0,1 µm erfasst.

Der Abscheider AC 3002 R mit 2 elektrostatischen Reinigungsstufen erzielte einen Fraktionsabscheidegrad von > 99,5 % bei verdoppelter Rohgaskonzentration (70 mg/m³). Ein Minimum in der Abscheideeffizienz ist nicht zu verzeichnen.

Für den Abscheider AC 3001 R mit einer elektrostatischen Reinigungsstufe konnte ein gravimetrischer Gesamtabscheidegrad ohne Berücksichtigung der Gasphase von 98,15 % bei einer Rohgaskonzentration von 35 mg/m³ festgestellt werden.

Der Abscheider AC 3002 R mit 2 elektrostatischen Reinigungsstufen erzielt bei verdoppelter Rohgaskonzentration (70 mg/m³) einen Gesamtabscheidegrad ohne Berücksichtigung der Gasphase von 99,79 %.

Die elektrostatischen Abscheider gliedern sich in die Filterklasse der HEPA-Filter nach EN 1822-1 ein. Der Abscheider AC 3001-R mit der Filterklasse H11 (Integraler Abscheidegrad > 95%) und der Abscheider AC 3002-R mit der Filterklasse H12 (Integraler Abscheidegrad >99,5%).

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Bericht über Abscheideleistung und Fraktionsabscheidegrad	**Meßprotokoll** **ILK-B-33-08-1469/01** 13.10.2008 Seitenzahl 2

1.	**Allgemeine Angaben**									
	Länge × Breite × Höhe		590 × 610 × 740 mm							
	Filtermedium/ Bezeichnung		AC 3001 R 1 elektrostatische Reinigungsstufe							
2.	**Prüfbedingungen:**									
	Prüfstandsaufbau:									
	Prüfmedium		Luft							
	Prüfaerosol		KSS Wiolan SH 10							
	Aerosoldosierung		Zweistoffdüsensystem, Fabrikat Fa. TOPAS ATM 243							
	Nenn- Aerosolkonzentration		35 mg/m³							
	Prüfluft - Volumenstrom		1260 m³/h							
3.	**Messergebnisse**									
	Prüf- Nr.		1		2		3		4	
	Datum der Prüfung		13.10.08		13.10.08		13.10.08		13.10.08	
	Prüfbeginn	Uhrzeit	10:41	10:41	11:21	10:41	12:40	12:07	13:31	13:31
	Prüfdauer	min	30	70	30	70	30	63	30	30
	Luftvolumenstrom (Mittelwert)	m³/h	1250	1250	1255	1250	1260	1255	1260	1260
	Barometerstand	hPa	1008	1008	1007	1008	1006	1006	1005	1005
	Lufttemperatur (Mittelwert)	°C	24,0	24,4	24,8	24,4	25,6	25,5	25,4	25,4
	relative Luftfeuchte (Mittelwert)	%	41,0	40,0	40,0	40,0	39,0	39,0	40,0	40,0
	Taupunkttemperatur (Mittelwert)	°C	9,9	9,9	10,3	9,9	10,6	10,5	10,8	10,8
	Wassergehalt (Mittelwert)	Vol.-%	1,19	1,19	1,21	1,19	1,24	1,24	1,26	1,26
	Wasseranteil (Mittelwert)	kg/m³	0,010	0,010	0,010	0,010	0,010	0,010	0,010	0,010
	Betriebsdichte (Mittelwert)	kg/m³	1,171	1,170	1,167	1,170	1,163	1,163	1,162	1,162
	Normdichte, trocken	kg/m³	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287
4.	**Probenahme**									
	Probenahmeverfahren		isokinetische Probenahme nach VDI 2066							
	Messort		Roh	Rein	Roh	Rein	Roh	Rein	Roh	Rein
	Absaugdüse ∅	mm	10	10	10	10	10	10	10	10
	Sammler - Nr.		6	7	2	7	5	4	6	8
	Gesammelte Staubmasse	mg	11,08	0,57	11,55	0,57	17,15	0,77	10,87	0,21
	Abgesaugtes Volumen	m³	0,373	1,020	0,367	1,020	0,389	0,855	0,371	0,417
	Aerosolkonzentration (KSS)	mg/m³	29,7	0,56	31,5	0,56	44,1	0,90	29,3	0,50
5.	**Auswertung der Analysenergebnisse**									
	Gesamt- Abscheidegrad	%	98,12%		98,22%		97,96%		98,29%	
	Mittlerer Gesamt- Abscheidegrad	%	98,15%							

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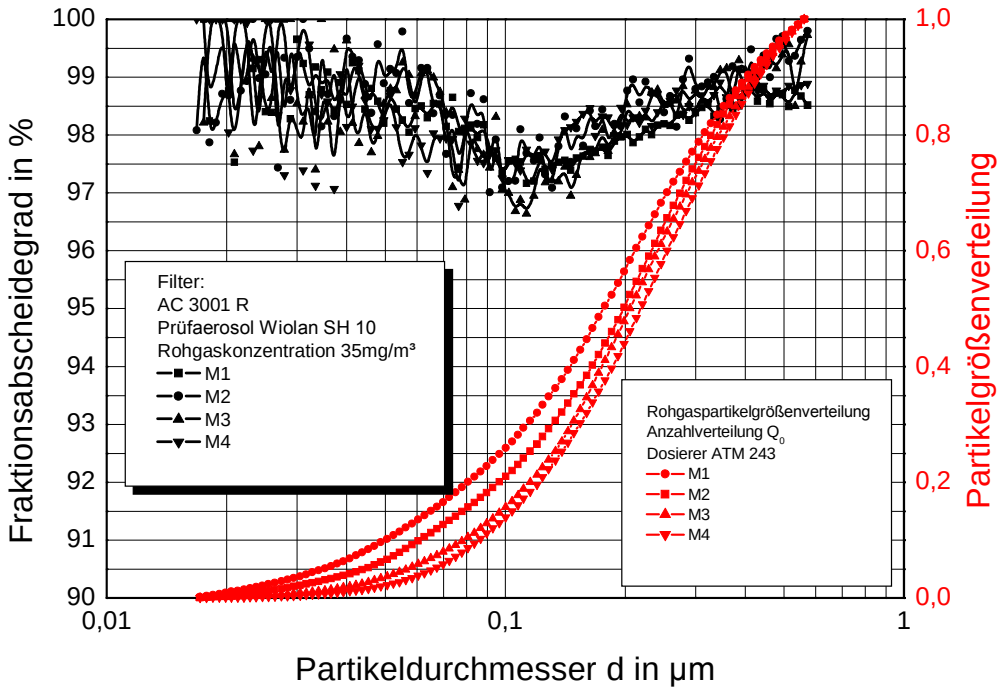
6. Fraktionsabscheidegrad

Mittelwerte aus je 4 Roh- und Reingasmessungen



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Bericht über Abscheideleistung und Fraktionsabscheidegrad	**Meßprotokoll** **ILK-B-33-08-1469/02** 13.10.2008 Seitenzahl 2

1.	**Allgemeine Angaben**									
	Länge × Breite × Höhe		590 × 610 × 1065 mm							
	Filtermedium/ Bezeichnung		AC 3002 R 2 elektrostatische Reinigungsstufen							
2.	**Prüfbedingungen:**									
	Prüfstandsaufbau:									
	Prüfmedium		Luft							
	Prüfaerosol		KSS Wiolan SH 10							
	Aerosoldosierung		Zweistoffdüsensystem, Fabrikat Fa. TOPAS ATM 243							
	Nenn- Aerosolkonzentration		70 mg/m³							
	Prüfluft - Volumenstrom		1270 m³/h							
3.	**Messergebnisse**									
	Prüf- Nr.		1		2		3		4	
	Datum der Prüfung		13.10.08		13.10.08		13.10.08		13.10.08	
	Prüfbeginn	Uhrzeit	15:04	15:04	16:15	16:15	16:49	16:15	17:33	17:33
	Prüfdauer	min	30	65	30	64	30	64	30	30
	Luftvolumenstrom (Mittelwert)	m³/h	1245	1260	1270	1270	1275	1270	1280	1280
	Barometerstand	hPa	1003	1003	1003	1003	1002	1003	1002	1002
	Lufttemperatur (Mittelwert)	°C	25,4	25,3	25,4	25,7	26,1	25,7	25,8	25,8
	relative Luftfeuchte (Mittelwert)	%	40,0	40,0	40,0	40,0	39,0	40,0	40,0	40,0
	Taupunkttemperatur (Mittelwert)	°C	10,8	10,7	10,8	11,1	11,1	11,1	11,2	11,2
	Wassergehalt (Mittelwert)	Vol.-%	1,26	1,25	1,26	1,28	1,28	1,28	1,29	1,29
	Wasseranteil (Mittelwert)	kg/m³	0,010	0,010	0,010	0,010	0,010	0,010	0,010	0,010
	Betriebsdichte (Mittelwert)	kg/m³	1,160	1,160	1,160	1,159	1,156	1,159	1,157	1,157
	Normdichte, trocken	kg/m³	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287
4.	**Probenahme**									
	Probenahmeverfahren		isokinetische Probenahme nach VDI 2066							
	Messort		Roh	Rein	Roh	Rein	Roh	Rein	Roh	Rein
	Absaugdüse ∅	mm	10	10	10	10	10	10	10	10
	Sammler - Nr.		2	3	5	6	2	6	7	8
	Gesammelte Staubmasse	mg	23,24	0,12	27,03	0,12	22,31	0,12	25,78	0,06
	Abgesaugtes Volumen	m³	0,364	0,844	0,350	0,868	0,360	0,868	0,381	0,431
	Aerosolkonzentration (KSS)	mg/m³	63,8	0,14	77,2	0,14	61,9	0,14	67,6	0,14
5.	**Auswertung der Analysenergebnisse**									
	Gesamt- Abscheidegrad	%	99,78%		99,82%		99,77%		99,79%	
	Mittlerer Gesamt- Abscheidegrad	%	99,79%							

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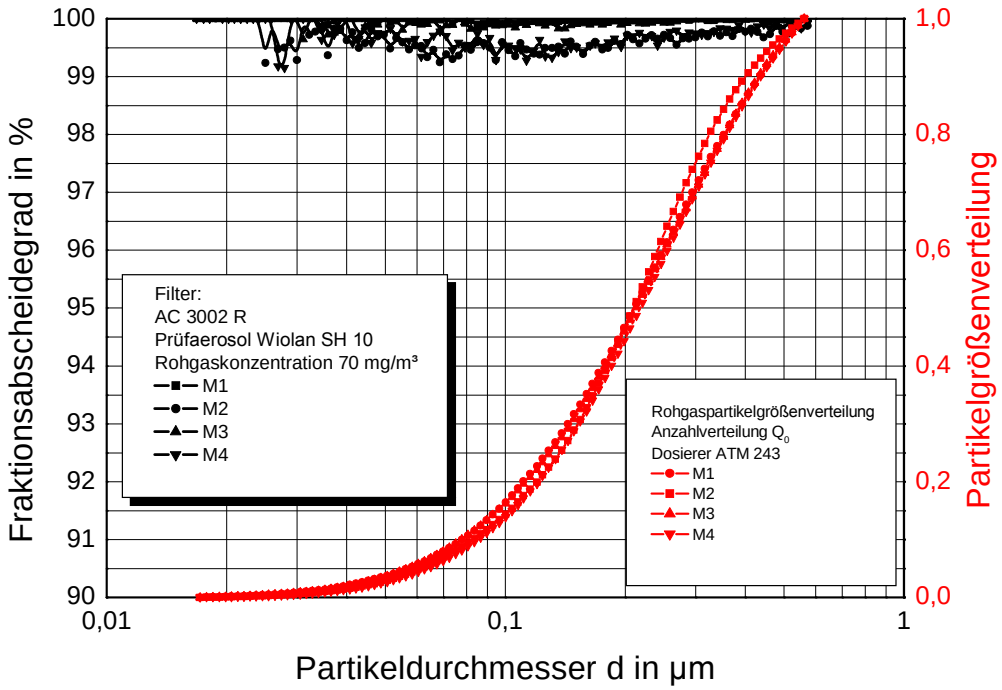
6. Fraktionsabscheidegrad

Mittelwerte aus je 4 Roh- und Reingasmessungen



Appendix 3

Test Report

Simas (LTA) Oil Mist Filter AC 3002

Oil mist from tooling machine exhaust air

0. Table of contents

1. Abbreviations and definitions

The abbreviations and definitions used in the verification report are summarized below.

Word	DANETV
Analytical laboratory	Independent analytical laboratory used to analyze reference samples.
Application	The use of a product specified with respect to matrix, target, effect and limitations.
CEN	European Committee for Standardization.
DS	Danish Standard.
Effect	The way the target is affected.
ELPI	Electrical Low Pressure Impactor is an instrument to measure airborne particle size distribution in real-time.
ELV	Emission Limit Value.
EN	European standard.
ETV	Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and adequate quality assurance.
Evaluation	Evaluation of test data for a technology product for performance and data quality.
Experts	Independent persons qualified on a technology in verification or on verification as a process.
GC	Gas chromatography.
ISO	International Standardization Organization.
Matrix	The type of material that the product is intended for.
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis.
Performance claim	The effects foreseen by the vendor on the target (s) in the matrix of intended use.
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance of an environmental technology product.
QA	Quality assurance.
RSD	Relative standard deviation in %.

SRM	Standard Reference Method is the approved method prescribed in a standard.
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis.
Target	The property that is affected by the product.
Test/testing	Determination of the performance of a product for parameters defined for the application.
TOC	Total organic carbon.
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance.
VTC	Verification and Test Centre.

2. Introduction

This test plan is the implementation of a test design developed for verification of the performance of an environmental technology following the DANETV method. See the verification protocol /1/ for details on organization and implications.

2.1. Verification protocol reference

Simas (LTA) Oil Mist Filter AC 3002 manufactured by LTA Lufttechnik GmbH in Germany, oil mist from tooling machine exhaust air, September 2009.

2.2. Name and contact of vendor

Simas Filters A/S
Rugvænget 10
DK- 8500 Grenaa
Phone +45 8758 1020
Contact Peter Rebsdorf
E-mail pre@simas.dk
Phone +45 8758 1020
Cell Phone +45 2160 4349

2.3. Name of centre / test responsible

Test centre:
FORCE Technology
Park Allé 345
DK - 2605 Brøndby
Denmark.

Test responsible
Ole Tvede Larsen
E-mail otl@force.dk
Phone +45 4326 7168
Cell Phone +45 4082 9873

2.4. Expert group

The expert group assigned to this test and responsible for review includes:

Erik Balieu (EB)
Balieu Prudentia
Dianas Have 75
DK-2970 Hørsholm
E-mail: ebalieu@mail.dk
Phone +45 20 55 17 64

Erik Bjarnov (EKB)
Specialist / Chemical Analysis
FORCE Technology
Park Allé 345
DK-2605 Brøndby
E-mail: ekb@force.dk
Phone +45 43 26 72 58

3. Test design

The oil mist separator is tested with a constant flow of oil mist generated in an aerosol generator into a constant flow of air.

The oil mist separator, which has a built-in fan, is connected to the oil mist generator by means of a 200 mm ventilation ducts (Trade name Spiro) being long enough to achieve a uniform mixing of aerosols and air, and to place a measuring point before the filter inlet. From the filter outlet is another duct with two 90° bends to achieve a uniform airflow after the blower, and a piece of straight duct of at least 6 times the diameter, to fulfil the requirements for suitable sampling points. Finally a 200 mm flexible duct connects the pipe to the exhaust point.

3.1. Test site

The test is conducted at the following test site:

3.2. Tests

The oil mist filter is tested for its ability to remove oil mist from a standardised oil aerosol with a constant concentration and a uniform size distribution in a constant flow of filtered air.

3.2.1. Test methods

Prior to the main test the following activities are done:

- Aerosol generator operation conditions for operation temperature and nozzle size are fixed, based on measurement of the oil mist rate, which should be around 70 g/h.
- The flow rate is regulated by a valve at the air outlet to be 1200 m³/h (±10%).
- Measuring devices for room temperature, process air temperature, velocity (flow rate) and differential pressure across the fan is mounted, tested and connected to the logging device for continuous storage of data as 5 minutes averages.
- DataRAM for continuous measurement of aerosols, is tested for its ability to detect the expected very low level of aerosols after the filter (the charge of the particles can disturb the measurement).

The main test procedure is as follows:

A standardized oil mist is generated by an ATM 243 Atomizer Aerosol Generator from TOPAS, using Wiolan sh10 oil from Houghton (trade name Cut-Max SG10 in Denmark), see details in Appendix D. The specific oil has been chosen for the test, because it is common and widespread used oil for metal cutting machines, and further more it has been used by other institutes for testing oil mist filters.

The oil mist from the aerosol generator is mixed with filtered air before entering the filter, to achieve a concentration of at least 70 mg/m^3 in a total flow of 1200 m³/h.

Prior to, and by the end of the test, the oil mist is tested for particle size distribution and concentration in real-time by an Electrical Low Pressure Impactor (ELPI™) instrument.

After the first 24 hours of operation, the concentration of oil mist is measured simultaneously before and after the filter according to the Danish Standard Reference Method (SRM) for mineral oil mist (MEL 14). These measurements are repeated after further 10 x 24 hours of operation, which is roughly equal to one months of operation in one shift.

The amount of oil used for the aerosol generator, and the amount of oil regained from the filter are measured by the weight for the whole test period.

A small amount of oil on vapour form is normally found in exhaust air from tooling machines, and the oil mist generator will without doubt also give some oil on vapour form, as the oil is heated to around 120°C. The filter is mainly capable of removing

oil aerosols, but to some extend oil on vapour form will also be reduced, e.g. by increase of condensation on larger particles caused by the electric field.

The test for oil mist will also include separate test and analysis of the oil on vapour phase, by adsorbing it on an XAD2 adsorption unit after the filter in the sampling system.

During the whole test period the operation is inspected and controlled twice a day (morning and afternoon). At each control, the oil level in the oil mist generator is checked and refilled with oil. The consumptions of oil are registered by weight.

The total amount of oil used in the aerosol generator and the total amount of oil regained from the filter is registered, together with the retained oil in the two pre-filters and the polish-filter, and the oil drained from the duct between the aerosol generator and the electro filter. The amount of regained oil from the filter is registered by weight.

During the test the following procedure is used – see Table 1:

Table 1. *Test procedure – day by day.*

Day	Description of method or measurements
1	The pre- and after filters are weighted, and the filter and aerosol generator are started up for continuously operation for the whole test period.
2	- Three 1 hour samplings of oil mist before and after the filter. - Particle size and distribution measured with the ELPR instrument before and after the filter.
3 – 11	Constant and steady operation with two daily control of operation.
12	Similar to day 2.

3.2.2. Test staff

Test responsible: Ole Tvede Larsen (OTL)

Field responsible: Tommy Hansen (TMH)

Test technician: Henrik Mathiasen (HMA) and Ole Pedersen (OPE)

3.2.3. Test schedule

The test schedule is showed in the following Table 2:

Table 2. *Test schedule.*

Task	**Week number 2009**												
	38	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
Testplan	X												
Mounting test set up and regulate flow		X	X										
Test og filter and aerosol generator functional performance			X	X									
Mounting, connection and testing of measuring devices				X	X								
Test periode					X	X	X						
Analysis								X	X	X			
Data handling and calculation								X	X	X			
Draft Test Report and QA											X	X	
Final Test Report												X	X

3.2.4. Test equipment

The test set up is schematically shown in Appendix E.

Data for the ATM 345 aerosol generator from Topas can be seen in Appendix B.

Data sheet for the test oil, Cutmax SG 10 can be seen in Appendix D.

Data for the tested AC 3002 Oil Mist Filter can be seen in Appendix F.

The test set up with the oil mist generator and the filters is made up with Ø200 mm Spiro ducts.

3.2.5. *Type and number of samples*

The types and number of samples are summarized in the Table 3.

Table 3. Number of samples for analysis of mineral oil.

Test day No.:	Samples before filter		Samples after filter	
	Aerosol on plane filter	Oil vapour on XAD-2	Aerosol on plane filter	Oil vapour on XAD-2
2	3	2	3	2
12	3	2	3	2
Total	6	4	6	4

Samples on filters and XAD-2 is analysed and reported separately.

3.2.6. *Operation conditions*

The operation conditions applied during the verification of the product are:

Operation parameters for the aerosol generator: Air pressure, temperature in the oil mist generator block, nozzle used (No. 1, 2 or 3).

Operation parameters for the filter: Air flow and air temperature.

Sampling conditions: Sampling in the centre of the duct, according to the requirements for sampling in the Danish Air guideline /2/.

Each sampling campaign for mineral oils will consist of three one hour samples, according to the requirements for sampling in the Danish Air guideline /2/.

3.2.7. *Operation measurements*

During operation, the following operation conditions are recorded:

- Flow
- Inlet air temperature
- Outlet air temperature
- Pressure air pressure

The data is stored in a data logging devise as 5 minutes average values.

The following operation parameters are measured for the whole test period:

- Total operating time
- Oil consumption in aerosol generator
- Oil separated regained from the filter
- Weight increase of the pre-filter and the polishing filter

See Appendix A for sampling and measurement methods.

3.2.8. Product maintenance

Regular maintenance can preserve the operation ability and life span of the oil mist filter. Recommended intervals are monthly for control and cleaning, but other periods may be more suitable, depending on the operational conditions.

All details on the recommendations for maintenance can be seen in Appendix I, which is a copy of the chapter on maintenance in the Operating Manual.

3.2.9. Health, safety and wastes

The use of the product does not imply special health, safety and waste issues.

The work during testing was done according to the FORCE Technology Safety Rules that are compliant with the extensive Danish rules for safe occupational health and the European regulations of work with chemicals. Work with the test oil was done using appropriate gloves.

Chemicals and test solutions are discarded according to Danish regulations for chemical waste by collection and controlled destruction.

4. Reference analysis

4.1. Analytical laboratory

Reference analyses of Mineral oils according to MEL-14 are done by:

Teknologisk Institut
Kongsvang Alle 29
8000 Århus C
Denmark
Phone +45 7220 1000
Contact: Paul Lyck Hansen
E-mail paul.lyck.hansen@teknologisk.dk
Phone +45 72 20 18 67

4.2. Analytical parameters

Mineral oil mist is collected on plane filer, and for two of each three samples oil on vapour form is subsequent sampled in a cartridge with XAD-2 adsorbent.

4.3. Analytical methods

See Appendix A for description of the sampling and measurement methods.

Sampling and analysis of mineral oil is performed according to MEL-14 (see Appendix C), which is the method recommended by the Danish Environmental Protecting Agency. MEL-14 is a slightly modified US EPA Method 0010, Method for Determining TCO/GRAV in Stack Gas, adjusted for the specific sampling and analysis of mineral oil aerosols.

Oil aerosols is sampled on a plane filter and oil on vapour form is sampled on an XAD-2 adsorbent. The filter and XAD-2 is extracted by toluene, and the extract is analysed by the means of gas chromatography Flame Ionisation Detector (FID). The

concentration of oil is determined by using a sample of the oil for calibration of the analysis.

4.4. Analytical performance requirements

The Danish emission limit value for mineral oil mist is 1 mg/m³ for oil mist sampled on the plane filter only.

The requirements for the detection limit for measuring emission of mineral oil is less than 0.1 mg/m³, according to Reference Document on the General Principle of Monitoring (2003) the detection limit for measuring the emission should be less than 10 % of the limit value.

Assuming a sampling volume of 1 m³, the requirement for the detection limit for the analysis is less than 0.1 mg/sample.

According to the laboratory the detection limit for the mineral oil analysis is 0.01 mg/sample.

4.5. Preservation and storage of samples

The filter and the toluene used for rinsing sampling compartments from sampling mineral oil aerosols is stored in a sealed glass bottle at maximum 5 °C, and analyzed within 14 days from sampling, according to the requirements in MEL-14.

5. Data management

Handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51 (also for parameters not covered by the accreditation).

Calculations are performed by existing approved spread sheets and new controlled spread sheet calculations.

5.1. Data storage, transfer and control

All reading data is stored in handwritten form on paper and schemes.

All the data stored in data loggers is transferred to the FORCE computer system, which is regularly backed up for data safety.

6. Quality assurance

All measuring, handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51 (also for parameters not covered by the accreditation).

All measuring data is present in handwritten form.

Approved spread sheets for calculations of results has been subjected to an intensive control, to assure correct calculations, and consequently no further control is necessary.

6.1. *Test report review*

The test report is subject to internal review by the verification responsible from FORCE Technology VTC Verifications:

Ole Schleicher
E-mail: osc@force.dk
Phone +45 4326 7540
Cell phone: +45 2269 7540

External review of the test report is done by the expert group assigned to this verification (see paragraph 2.4). The re-view of the verification report will include the full test report as an Appendix.

6.2. *Performance control – reference analysis*

One field blank samples and one laboratory blank are performed at each of the two sampling campaigns.

6.3. *Data integrity check procedures*

All transfer of data from handwritten form to computer, is subjected to 100 % control by another person.

New calculations in spread sheets are subjected to 100 % check of all formulas and spot check of at least 20 % of all copies of the formulas.

7. Test Results

7.1. *Test summary*

The test was conducted at the FORCE Technology test site, Park Allé 345, DK-2680 Brøndby, on behalf of Simas Filters A/S and coordinated by FORCE Technology.

The AC 3002 Oil Mist Filter manufactured by LTA Lufttechnik GmbH in Germany was tested for its ability to remove oil mist from exhausted air from metal cutting machines.

During operation, the operation conditions were recorded and sampled as mentioned in section 3.2.1 to 3.2.7.

The test was carried out over 10 day's with continuous operation around-the-clock. The operation was supervised twice a day by representatives from FORC Technology in order to observe and secure that the operation conditions are inside the specified limits. The aerosol generator was also refilled, and during this the aerosol generator was stopped for a few minutes. Furthermore the whole test system was stopped three times for app. 10 minutes, for weighing the internal pre- and after filter.

On day two and ten, in total 12 samples of oil mist aerosols was collected on a filter, and 8 samples of oil vapor collected on XAD adsorbent.

Operational data that verify that the test has been in agreement with the determined conditions in the test plan is shown in appendix X.

7.2. Test results

The overall results of the test, concerning the removal rate for oil mist removed from the air is shown in Table 4. Each of the concentrations is the average of three one hour successive samples.

Table 4. Main test results.

Date	Inlet concentration mg/m³	Outlet concentration mg/m³	Removal rate RR
14/10/2009	86.7	4.8	94.5 %
26/10/2009	109	4.1	96.3 %

The removal rate is much lower than the expected level, based o the previous test made by ILK Dresden, where the removal rate was measured to be > 99.5 %.

Table 5. Main results from the ILK Dresden test in 2008.

Sample no.:		1	3	4	5	Average
Inlet concentration	mg/m^3	63.8	77.2	61.9	67.6	67.63
Outlet concentration	mg/m^3	0.14	0.14	0.14	0.14	0.14
Removal rate	%	99.78	99.82	99.77	99.79	99.79

The operation conditions have been very similar to the conditions in the test made by ILK Dresden in 2008. The main operation parameters for the two tests are compared in Table 6, and the aerosol particle distribution in Figure 1 and Figure 2.

Table 6. Comparison of operation parameter.

Parameter	Unit	FORCE test 2009	ILK Dresden test 2008
Filter		AC 3000 R	AC 3000 R
Prefilter		Yes	Yes
After filter		Yes	Yes
Aerosol generator	Type	Topas ATM 243	Topas ATM 243
Test oil	Type	Cut-Max SH10*	KSS Wiolan SH 10
Air flow	m³/h	1170	1270
Air temperature	°C	20.5	25.6
Aerosol concentration	mg/m³	97.9	67.6

*Cut-Max SH10 is the Danish trade name for KSS Wiolan SH 10

Figure 1. Aerosol particle size distribution - ILK Dresden test 2008.

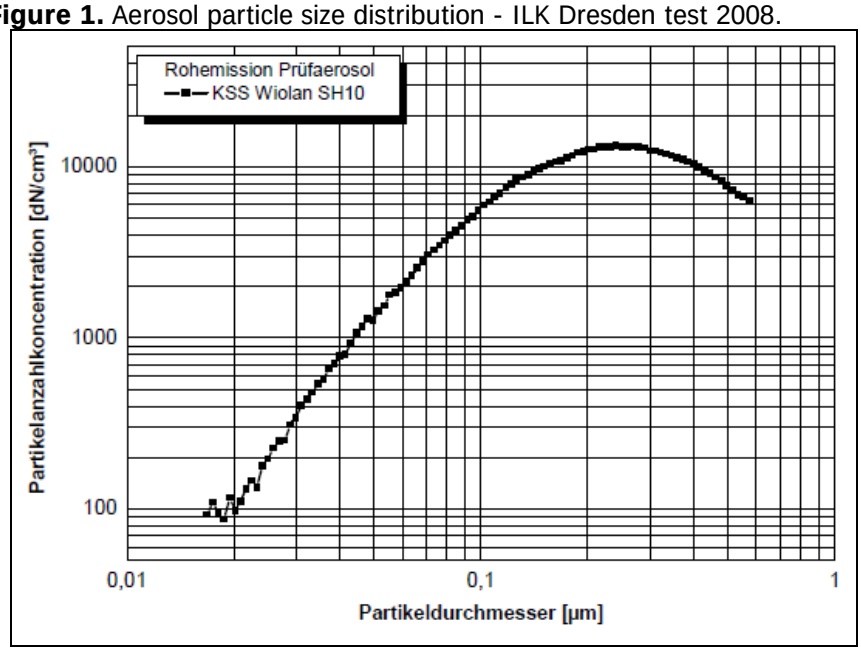
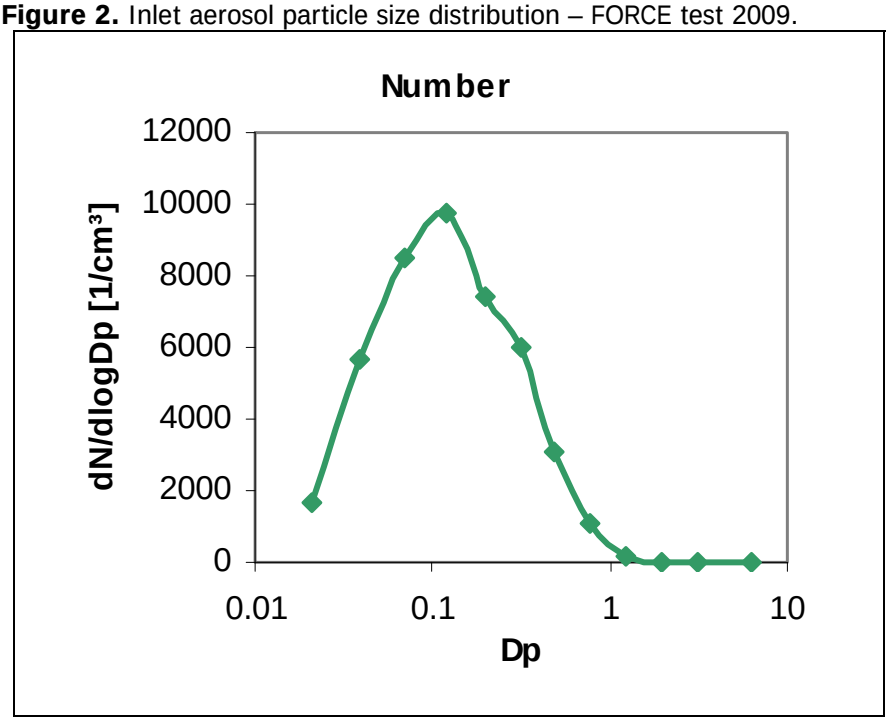


Figure 2. Inlet aerosol particle size distribution – FORCE test 2009.



Based on the similarity of the operation parameters, aerosol concentration and particle size distribution, the measured lower removal rate can't be explained by differences in the operation of the filter, but must be related to the filter performance.

7.3. Deviations from test plan

The test was performed according to the test plan. There were no deviations from the test plan regarding measurements, data logging and sampling, except for one missing result for the oil aerosol concentration before and after the filter on the last day of the test. One of the three one hour manual filter samples could not be carried out, because the filter has mistakenly been used for an extra blank sample, and no spare filters remained.

Signed by	25/5-10	Signed by	25/5 - 10
Annemette Geertinger	Date	Ole Tvede Larsen	Date
Deputy Manager		Test Responsible	
DANETV Steering Committee member		DANETV Verification Centre	

8. References

1. Verification Protocol, Simas (LTA) Oil Mist Filter AC 3002, September 2009.
2. Environmental Guidelines No. 1, 2002. Vejledning fra Miljøstyrelsen. Guidelines for Air Emission Regulation. Limitation of air pollution from installations (Guideline from the Danish EPA).
3. DANETV. Verification Test Centre quality manual. 27-2-2009.
4. Untersuchung von elektrostatischen Abscheidern – Baureihenentwicklung. ILK Dresden. Fachbereicht. ILK-B-33-08-1469. 24.10.2008

9. Appendix

Appendix A	FORCE Technology Measuring Methods (In Danish).
Appendix B	Atomizer Aerosol Generator ATM 243
Appendix C	MEL-14. Bestemmelse af koncentrationen af mineralsk olie (olieaerosoler) i strømmende gas (In Danish).
Appendix D	Product data sheet for Cutmax WL SG 10 oil
Appendix E	Test set up
Appendix F	AC 3002 Electrostatic Oil Mist Filter
Appendix G	Pre- and after filters for AC 3002
Appendix I	Maintenance
Appendix K	Test results

Appendix A

FORCE Technology Measuring Methods (in Danish)

Manuelle metoder
Detektionsgrænsen er opgivet som den normalt opnåelige ved en normal præstationskontrol, dvs. ved 60 minutters måletid, normal sugehastighed og akkrediteret analyse. Detektionsgrænsen kan i det enkelte tilfælde være lavere eller højere end den angivne værdi. Lavere detektionsgrænser kan f.eks. opnås ved højere sugehastighed og ved længere prøvetagningstid. Metoder, der omfatter flere stoffer (f.eks. spormetaller), kan have forskellig detektionsgrænse for de forskellige stoffer; den laveste værdi er opgivet. Detektionsgrænsen defineres som middelværdien af gentagne blindprøver plus tre gange spredningen på samme. Usikkerheden er beregnet som den normalt opnåelige usikkerhed ved et målested, der opfylder kravene i kap. 8 i Luftvejledningen. Ved afvigelse fra krav til målestedet kan usikkerheden være betydelig, men det er ikke muligt at vurdere dens størrelse. Usikkerheden opgives i % af målt værdi (95% konfidensinterval svarende til 2 gange RSD). Ved måleværdier mellem 5 og 1 gange detektionsgrænsen stiger usikkerheden fra den angivne %-værdi til 50-100% ved detektionsgrænsen.

Volumenstrøm: Gashastigheden måles ved hjælp af et pitotrør i forbindelse med et skrårørsmanometer eller mikromanometer, hvormed det dynamiske tryk måles. Hastigheden bestemmes i et antal målepunkter over kanaltværsnittet. Ud fra hastigheden og måleplanets areal beregnes volumenstrømmen.
Range: 0 - 40 m/s
Limit of detection: 2,3 m/s
Uncertainty: 10 % of measured value (95% confidence interval).
FORCE Technology method: EM-02-01
Reference/standard: ISO 10780

Mineralsk olie (olietåge og oliedampe): En delgasstrøm udsuges isokinetisk gennem et filter, og en i serie med filteret forbunden kolonne indeholdende en polymer adsorbent (XAD-2). Ved risiko for kondensation opvarmes prøvetagningssystemet (filter og sonde) under målingen til 120°C, og systemet forsynes med en (kølet) kondensatfælde mellem filter og polymer adsorbent. Det opsamlede kondensat udgør en del af prøven. Filter, kondens, skyllevæske og XAD-2 ekstraheres med toluen, og ekstraktet analyseres ved gaskromatografi med flammeionisationsdetektor (FID). Mineralolien bestemmes som summen af samtlige komponenter imellem n-C14 og n-C40. Kalibrering sker i forhold til n-hexadecan (n-C16). I henhold til udmelding fra Miljøstyrelsen, gengivet i Nyhedsmail fra Referencelaboratoriet nr. 3, November 2005 (se www.ref-lab.dk) skal der på eksisterende anlæg indtil videre kun måles for aerosoldelen af mineralolieemissionen. Metoden er ikke akkrediteret.
Range: 0.1 - 50 mg/m³(n,t)
Limit of detection: 0,01 mg/m³(n,t)
Uncertainty: 15 % of measured value (95% confidence interval).
FORCE Technology method: EM-51-01
Underleverandør: Teknologisk Institut, DANAK akk. nr. 380
Reference/standard: USEPA Method 0010

Kontinuerte metoder (monitorer, følere etc.)
Detektionsgrænsen er opgivet som den normalt opnåelige ved en normal præstationskontrol. Detektionsgrænsen er defineret som middelværdien plus 3 gange spredningen på målerens drift i spanpunktet ved gentagne feltmålinger. Lavere detektionsgrænser kan f.eks. opnås, ved optimeret valg af kalibreringsgas og hyppig kalibrering.

Usikkerheden er beregnet som den normalt opnåelige usikkerhed ved et målested, der opfylder kravene i kap. 8 i Luftvejledningen. Ved afvigelse fra krav til målestedet kan usikkerheden være betydelig, men det er ikke muligt at vurdere dens størrelse. Usikkerheden opgives i % af målt værdi. Ved måleværdier mellem 5 og 1 gange detektionsgrænsen stiger usikkerheden fra den angivne %-værdi til 100% ved detektionsgrænsen.

Gastemperatur: Måles med en pt100-termoføler eller en NiCr/NiAl-termoføler tilsluttet et digitaltermometer eller datalogger. Visningen aflæses med korte intervaller, og/eller signalet opsamles på datalogger.
Range: -40 - 600 °C
Limit of detection: -40 °C
Uncertainty: 4 °C (absolute)
FORCE Technology method: EM-03-01
Reference/standard: VDI 3511 bl. 1-5, IEC 584-2, IEC 584-2 amd. 1

DataRAM kontinuert bestemmelse af partikelemission: DataRAM er et højfølsomt nefelometer, hvis måleprincip er lysspredning. DataRAM suger via en pumpe en luftprøve ind i sit målekammer. Her afgives en lysstråle i det nærinfrarøde spektrum fra en linse. En del af lysstrålen reflekteres i de passerende partikler, og en del af det reflekterede lys modtages af en anden linse, aflæses af en fotocelle og omregnes i forhold til kalibreringen til en koncentration af luftbårne partikler eller støv.
DataRAM måler koncentrationer af alle luftbårne partikler (støv, røg, tåge eller væskedråber), og displayet viser niveauet i mikrogram eller milligram pr. kubikmeter.
Partikelstørrelse for maksimal respons er 0,08 – 10 µm, og responsen på partikler større end 10 µm er stærkt reduceret.
Måleren er som standard kalibreret efter Arizona vejstøv, SAR Fine fra Powder Technology Inc., med median aerodynamisk partikel diameter på 2 til 3 µm, men kan feltkalibreres til andre specifikke støvsammensætninger, enten ved vejning af internt filter eller ved parallelmålinger. Den beregnede kalibreringsfaktor kan tastes ind i DataRAM, så de korrigerede resultater vises direkte i mg/m³.
Metoden er ikke akkrediteret.
Range: 0 - 400 mg/m³
Limit of detection: 0,0001 mg/m³
Uncertainty: 20 % of measured value (95% confidense interval).
FORCE Technology method: EM-53-01
Reference/standard: No international reference

TOC-koncentration (totalkulbrintekoncentration): På en partikel fri og opvarmet (120°C) delgasstrøm bestemmes TOC-koncentrationen ved kontinuert registrering med en flammeionisationsdetektor (FID) af mærket Bernath Atomic. Detektoren er kalibreret overfor propan kalibreringsgasser.
Korrektion for responsfaktor: Detektorens visning korrigeres med en responsfaktor, som er specifik for den enkelte detektor og det enkelte opløsningsmiddel. Detektorens responsfaktorer kan for opløsningsmidler variere fra ca. 0,5 - 1,2. Ved måling på røggasser benyttes normalt en responsfaktor på 1,0. Visningen på detektoren deles med responsfaktoren for at få korrekt værdi.
Omregning fra ppm propan til mg C/m³(n): Værdier i ppm propan ganges med 3 (antallet af kulstofatomer i propan) for at få værdier i ppm C. Værdier i ppm C ganges med molvægten af kulstof (M_C=12,01 g/mol) og deles med molvoluminet af idealgasser ved 0°C og 1013 mbar (V= 22,41 l/mol) for at opnå værdier i mg C/m³(n).
Omregning fra mg C/m³(n) til mg opløsningsmiddel/m³(n): Værdier i mg C/m³(n) ganges med molvægten af stoffet og deles med antallet af kulstofatomer i stoffet ganget med molvægten af kulstof. Omregningsfaktoren for acetone er således: ($M_{acetone}$ = 58 og 3 kulstofatomer) 58/(12*3) = 1,6. Ved måling på blandinger af opløsningsmidler er det nødvendigt at kende

opløsningsmiddelsammensætningen i gassen med henblik på at beregne en resulterende responsfaktor og en resulterende omregningsfaktor.
Ranges: 0 - 30, 0 - 300, 0 – 3.000, 0 – 30.000, 0 – 300.000 ppm C
Limit of detection: 1 mg C/m³
Uncertainty: 5 % of measured value (95% confidense interval).
FORCE Technology method: EM-12-01
Reference/standard: EN 12619, EN 13526, VDI 3481 bl.3

ELPI measuring particle number and size distribution

The ELPI (Electrical Low Pressure Impactor) sampling technique is a real time measurement of the number concentration and size distribution through 12 particle size intervals (from 7nm to 10,000 nm). Particles are collected from the submicron range (from 30 nm) on 11 individual substrates according to their aerodynamic size. The ELPI makes a real-time measurement of each impactor stage by charging the particles before the impactor, and by counting the number of particles collected at each stage. The mass concentration can be calculated assuming a unit density, e.g. 1 g/cm³, for all particles.

When measuring high concentrations of particles, a dilution can be necessary. Sampling can be performed through a dilution system comprising of a two-step dilution (dilution factor approximately 1:100). Dry, HEPA filtered pressurized air is added as dilution air to the diluters. The actual dilution ratio can be measured by means of propane gas and a flame ionization detector. The diluted gas will reached a temperature slightly above ambient before the inlet of the ELPI instrument.

The effect of non-isokinetic sampling is rather small for particles < 2500 nm, however isokinetic sampling is sought. An out-stack pre-separator (cyclone) for separation of particles > 10 µm was used.

Appendix B

Atomizer Aerosol Generator ATM 243

Atomizer Aerosol Generator ATM 243

Atomizer Aerosol Generator ATM 243

The aerosol generator of the ATM 243 series is a special development for testing oil mist separators. Its innovative design is protected by a utility model and the generated aerosols comply with the requirements regarding particle size and concentrations for testing oil mist separators. The design of this generator ensures a very constant particle size distribution and concentration while at the same time providing a high degree of reproducibility. The device features the possibility to adjust the temperature of the generated aerosols and can be used on a variety of oils. Depending on the type of oil and the pressure of the carrier gas various mass flow rates can be adjusted for a set working temperature.

Special Advantages

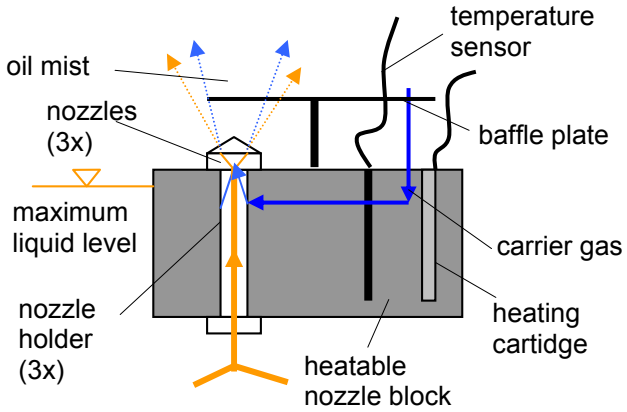
- Very stable particle size distributions and concentrations
- Generates polydisperse test aerosol with a mean particle size of 1 – 2 µm
- Very high aerosol particle concentration and particle mass flow
- Adjustable and regulated aerosol temperature
- For pressures up to 0.3 bar

Applications

- Testing of oil mist separators
- Capacity tests of filters
- Research & Development

Operating Principle

The oil is atomised via 3No. two-component jet nozzles which are located under a baffle plate. The carrier gas and the oil are heated in the nozzle block to the set temperature.

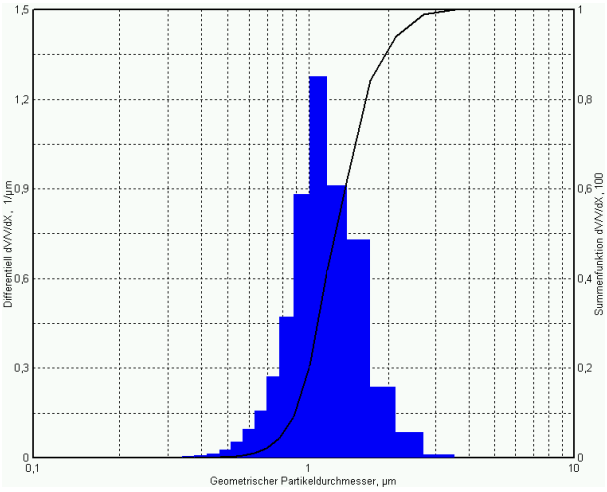


Schematic of the nozzle assembly

Details

The adjustment of the particle production rate (mass flow) can be done by

- Changing the temperature
- Varying the carrier gas pressure or manually activating / deactivating the nozzles 1-3, this is at a constant temperature and depending on the used oil



Particle size distribution of an aerosol generated by the ATM 243 with a $d_{50.3}$ < 1.5 µm (Motor oil 15W40, 130°C)

The ATM 243 is equipped with a temperature limiter to avoid overheating. This safety device switches off the heating cartridges in case of the temperature exceeding 130°C.

An externally mounted level control for the liquid in the vessel can be supplied optionally.

Technical Data

Particle material	Motor oil
Particle concentration	>10^8 Particles/cm^3
Particle size (modal value)	1.3...1.9 µm
Maximum counter pressure	3 x 10^4 Pa (0.3 bar)
Aerosol outlet	∅ 24 mm
Maximum filling amount	4 l
Temperature range of test aerosol	20°C…130°C
Flow rate	1.5…18 m³/h
Examples for mass flow	1…72 g/h (at 80…120°C, carrier gas pressure 1…4 bar; Motor oil 0W30) 5…75 g/h (at 80…120°C, pressure 1…5 bar; Motor oil 15W40)
Compressed air supply	100…max. 600 kPa (1…max. 6 bar)
Dimensions (WxDxH)	530 x 650 x 710 mm
Weight	48.6 kg

As manufacturers of instruments in the field of particle technology and filter testing Topas GmbH has been certified to comply with the high requirements as specified in DIN EN ISO 9001:2000 (and its predecessors) since 1999.

For more information please visit our website at www.topas-gmbh.de.

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Appendix C

MEL-14. Bestemmelse af koncentrationen af mineralsk olie (olieaerosoler) i strømmende gas (in Danish)

Bestemmelse af koncentrationen af mineralsk olie (olieaerosoler) i strømmende gas

Parameter	**Mineralsk olie (olieaerosoler)**
Anvendelsesområde	Måling af mineralsk olie (olieaerosoler) i luftemissioner fra virksomheder.
Metode	Manuel prøvetagning, isokinetisk opsamling af aerosolfraktion på filter. Efterfølgende analyse ved gaskromatografi med flammeionisationsdetektor.
Reference	US EPA Method 0010, modificeret [1]
År	Revision 2 (revideret 2007) - første udgave 2003, revision 1: 2003.

Indholdsfortegnelse

1. Brugervejledning for miljømyndigheder

Kapitel 8 i Luftvejledningen [2] indeholder en liste over Miljøstyrelsens anbefalede metoder til måling af luftforurening fra virksomheder (emission). Metodelisten revideres og opdateres af Miljøstyrelsens Referencelaboratorium for måling af emissioner til luften. Den reviderede metodeliste er (kun) tilgængelig www.ref-lab.dk. Ud over metodelisten udgiver Referencelaboratoriet endvidere en række metodeblade for udvalgte parametre. Disse metodeblade er i nyeste version tilgængelige på www.ref-lab.dk. Metodeliste og metodeblade sendes i høring inden udgivelse og væsentlige ændringer.

Metode**listen** er beregnet til brug ved miljøgodkendelser og sagsbehandling. Et vilkår bør altid indeholde målemetode samt henvisning til metodeblad, såfremt der er udarbejdet et. Vilkår uden angiven målemetode står juridisk svagt i en eventuel klagesag.

Metode**bladene** er målrettet til målefirmaer og andre med specialinteresse for målinger, og giver information, på dansk, om hvordan målingerne skal udføres og hvilke særlige forholdsregler og modifikationer der kan forekomme efter danske forhold. Formålet er at sikre ensartede måleresultater samt at oplyse om særlige forhold, hvor modifikationer eller andre forholdsregler er påkrævet. For miljømyndighederne har metodebladene kun interesse i det omfang der foreligger en mistanke om at målingerne ikke er udført med tilfredsstillende kvalitet eller hvis der er tvivl om tolkningen af resultater mv. I situationer, hvor målefirmaer eller virksomheder henvender sig til myndigheden med et måleteknisk problem eller problemstilling kan miljømyndigheden have glæde af at læse metodebladet.

Metodebladet for planlægning og rapportering, MEL-01, er aldrig blevet udgivet, men er i stedet indarbejdet som en del af kapitel 8 i Luftvejledningen [2], der indeholder generelle forskrifter vedr. indretning af målested samt adgangsforhold til målestedet. Indretningen af et målested kan være et væsentligt bidrag til et måleresultats troværdighed, og bør være en del af virksomhedens vilkår. Miljømyndighederne bør således ud over de almindelige vilkår, også stille vilkår om målestedets indretning samt adgangsforhold til målestedet.

Vilkår bør i øvrigt indeholde krav til relevant produktion under præstationskontrol samt rapportering af produktionens reelle størrelse/omfang under målingernes gennemførelse. Uden et sådan krav kan præstationskontrol i værste fald være misvisende og ikke nødvendigvis et mål for den reelle emission på andre dage. Et sådant vilkår bør udarbejdes i samarbejde med virksomheden.

Når vilkår indeholder et krav om målemetode samt krav om akkrediteret måling bør der være tillid til at målingen så også er gennemført efter forskrifterne i metodeblad, standard mv. Der kan dog være situationer, hvor miljømyndigheden ønsker at vurdere kvaliteten af målingen eller ønsker at vurdere om målemetoden rent faktisk er egnet til formålet. Til disse formål kan metodebladet læses af miljømyndigheden specielt med fokus på følgende emner:

- Målestedets indretning.
- Dokumentation for produktionsforhold under målingen.
- Anvendt prøvetagnings system (materiale og temperatur).
- Feltblind.

- Varme fugtige gasser (er der taget højde for risiko for kondensation).
- Interferens.
- Isokinetisk udsugning (skal ligge mellem 95 % og 115 % af korrekt isokinetisk flow ved alle partikelmålinger).
- Antallet af travers punkter.
- Laboratorieblind.

Usikkerhed
Det er krævet i ISO 17025 [3], som laboratorierne akkrediteres efter, at laboratorierne beregner usikkerheden på målingerne[I]. Usikkerheden på målingen angives i rapporten.

I Luftvejledningen [2] kapitel 5.4.1 er det angivet, at: Emissionsvilkåret anses for overholdt, når det aritmetiske gennemsnit af alle enkelt-målinger udført ved præstationskontrollen er mindre end eller lig med kravværdien. Usikkerheden indgår således ikke i vurderingen af en præstationskontrol, og det er op til den enkelte tilsynsmyndighed om den opnåede usikkerhed på målingen er tilfredsstillende.

2. Anvendelsesområde

Mineralsk olie anvendes bl.a. som køle/smøremiddel i metalindustrien, hvor den kan forekomme som en emulsion af olie og vand samtidig med, at olien indeholder diverse tilsætningsstoffer (additiver).

Dette metodeblad beskriver måling af emissioner af mineralsk olie til luften fra afkast med strømmende gasser. Med afkast menes her skorstene, ventilationsafkast eller kanaler gennem hvilke, der udsendes varm eller kold gas til atmosfæren.

Den beskrevne prøvetagningsprocedure tager udgangspunkt i den amerikanske metode US EPA Method 0010: Modified Method 5 Sampling Train [1]. US EPA Method 0010 er udviklet til måling af SVOC (semivolatile organic compounds) i emissioner fra affaldsforbrændingsanlæg, men den kan benyttes generelt til måling på stationære anlæg. Prøvetagningsmetoden kan samtidig anvendes til prøvetagning af andre olier end mineralsk olie (vegetabilsk olie, syntetisk olie m.v.).

Metodebladet baseres på en national eller international standard for en stofgruppe, der omfatter den eller de pågældende komponenter. Standarden angiver ikke en tilstrækkelig validering specifikt for mineralsk olie.

2.1 Baggrund

B-værdi vejledningen [7] indeholder følgende om mineralsk olie:

2.2.5 Olietåger, mineralsk olie

[I] Skal gennemføres i overensstemmelse med GUM [4], det vil sige enten ISO 14956 [5], eller de rapporter på Referencelaboratoriets hjemmeside (www.ref-lab.dk), der findes om emnet. For visse komponenter er der nyttig information i den standard der beskriver metoden. Målestedets indretning bør indgå i beregningen af usikkerheden.

Miljøstyrelsen har fastsat en ny, administrativ B-værdi for mineralske olier (olietåge og evt. oliedampe) til 0,003 mg/m³.

Den tidligere B-værdi for mineralsk olietåge var angivet som et interval fra 0,01-0,001 mg/m³, hvor anvendelse af konkret værdi afhang af en vurdering af indhold af kritiske komponenter i olien, bl.a. PAH-forbindelser. Anvendelsen af et sådant interval har i praksis vist sig at være vanskeligt at håndtere, derfor anføres B-værdien nu som én specifik værdi, idet denne værdi også anses for at kunne anvendes for mindre raffinerede olietyper.

For olietåge gælder en vejledende emissionsgrænse på 1 mg/normal m³ jævnfør Brancheorientering for autoværksteder. Orientering nr. 13, 2000, Appendiks B.

Miljøstyrelsen har meldt følgende ud vedr. olietåge (efterår 2007):

- Emissionsgrænseværdien på 1 mg/m³ for olietåger skal fremover dokumenteres gennem bestemmelse af aerosolfraktionen. Der stilles således ikke krav til gasformige forbindelser.
- B-værdien ændres til kun at omfatte aerosolfraktionen.

Denne udmelding har ført til nærværende udgave af metodebladet, hvor alle referencer til analyse af gasfraktionen er udeladt i forhold til tidligere udgaver.

Mineralsk olie er en multikomponent, der typisk består af flere hundrede alifatiske og aromatiske kulbrinter. Ved atmosfæretryk og stuetemperatur vil den - grundet sit lave damptryk - fortrinsvis forekomme i partikelform (aerosoler). Den gasformige andel afhænger af olietype, temperatur m.m. I indeværende metode bestemmes summen af alle kulbrinter med kogepunkter imellem 250°C (svarende til n-C14) og 525°C, svarende til n-C40).

Dette betyder i praksis, at B-værdi og emissionsgrænse gælder for den samlede mængde af mineralsk olie - herunder et evt. indhold af polyaromatiske kulbrinter - og at disse stoffer rent administrativt er reguleret via den fælles grænseværdi. Den beskrevne målemetode i dette metodeblad omfatter derfor det totale indhold af mineralsk olie og PAH.

Har olien et højt[II] indhold af stoffer med en lavere B-værdi end B-værdien for mineralsk olie, skal disse stoffer reguleres som enkeltstoffer i henhold til Luftvejledningen [2] og B-værdi vejledningen [7].

Grænseværdierne gælder således ikke for vegetabilsk olie, organiske opløsningsmidler og andre organiske forbindelser, der kan tænkes at forekomme i samme afkast, men som kan have væsentlig højere B-værdi end mineralsk olie. Den beskrevne analyseprocedure benytter sig af gaskromatografi med flammeionisationsdetektor. I modsætning til infrarød spektrometri (IR) kan teknikken skelne mineralolien fra volatile solventer (fx. kulbrinteblandinger som fx. ekstraktionsbenzin og mineralsk terpentin), således at virksom-

[II] Højt indhold defineres således, at spredningsfaktoren (Vejledning 2, 2001 side 47) for stoffet er større end spredningsfaktoren for olien. Kendes kildestyrken ikke, kan vægtandelen anvendes i stedet for kildestyrken.

heden bedømmes på et korrekt grundlag. Da metoden med nærværende revision ikke mere omfatter gasfraktionen er ovenstående separation af volatile solventer mere aktuel.

2.2 Måleområde

Fra 0,1-50 mg svarende til 0,1-50 mg/m³(n,t) ved et prøvevolumen på 1 m³ (kan dog også afhænge af prøvetagnings- og analysebetingelserne). Måleområdet kan ændres ved at ændre på prøvetagningstiden.

2.3 Begrænsninger

Andre organiske stoffer i det pågældende kogepunktinterval kan give anledning til positiv interferens, idet en FID-detektor ikke kan skelne disse fra mineraloliekomponenter (fx. vegetabilske olier). Disse kan normalt frasepareres ved at oprense ekstraktet på en aluminiumsoxid kolonne i henhold til DS 209 [8].

3. Princip

3.1 Prøvetagning

En delgasstrøm udsuges isokinetisk gennem et filter. Filteret kan placeres i kanalen eller uden for efter behov. Prøvetagningssystemet skal bestå af materialer, der ikke reagerer kemisk eller fysisk med prøvegassen (normalt rustfrit stål, glas eller teflon). Ved risiko for kondensation skal prøvetagningssystemet (filter og sonde) under målingen være opvarmet til 120°C.

Gasprøven udsuges isokinetisk med en pumpe efterfulgt af et flowmeter til regulering af den udsugede mængde, en kalibreret gasmåler samt et termometer til registrering af temperaturen. Den tørre gasmængde bestemmes ved hjælp af den kalibrerede gasmåler, som aflæses før og efter hver prøvetagning. Se endvidere MEL-02 [9] vedr. isokinetisk prøvetagning.

3.2 Analyse

Filteret ekstraheres med toluen, og ekstraktet analyseres ved gaskromatografi med flammeionisationsdetektor (FID).

Mineralolien bestemmes som summen af samtlige komponenter imellem n-C14 og n-C40. Kalibrering sker i forhold til n-hexadecan (n-C16).

4. Udstyr

4.1 Prøvetagning

- *Sonderør* i rustfrit stål, glas, teflon eller lign. inert materiale, der ikke reagerer kemisk eller fysisk med prøvegassen i passende længde i forhold til kanalen/skorstenens diameter.
- In-stack eller out-stack *partikelfilter, planfilter eller dybdefilter* af glasfiber eller kvartsfiber i filterholder.
- *Prøvetagningsforbindelser* imellem dyse og filter af rustfrit stål, glas, teflon eller lign. materiale, der ikke reagerer kemisk eller fysisk med prøvegassen.

- *Skyllevæske*, toluen.
- *Udstyr til isokinetisk udsugning*, jf. MEL-02 [9] (tørreenhed, pumpe, flowmeter, gasmåler, termometer etc.).
- *Rengjorte beholdere* til skyllevæske og filter. Disse flasker skal være tætte, rene og fremstillet af glas. Indlæg i skruelåget skal være af inert og resistent materiale – fx. teflon. Det anbefales at lade laboratoriet levere disse særligt rengjorte flasker, idet selv en meget minimal kontaminering med kulbrinter er alvorlig for validiteten af resultaterne.

4.2 Analyse

- *Gaskromatograf* (GC) forsynet med flammeionisationsdetektor og dataopsamling (GC/FID).
- *Kapillarkolonne* - fx. af typen RTX-5, HP-5 eller lignende.
- *GC-vials* til samme.
- *Toluen*, HPLC-kvalitet.
- *Intern standard:* n-C14 og n-C30 i forholdet 1:1.
- *Ekstraktionsvæske:* Toluen indeholdende ca. 100 mg/liter intern standard.
- *Natriumsulfat, vandfri* – analysekvalitet.
- *Kalibreringsstandard* – Sporbar opløsning af hexadecan i toluen.

5. Planlægning

Se kap. 8 i Miljøstyrelsens vejledning nr. 2, 2001 ”Luftvejledningen”.

6. Fremgangsmåde

6.1 Rensning af prøvetagningsudstyr inden måling

Dyse, filterholder og sonde skylles med toluen og tørres inden måling.

6.2 Samling af prøvetagningsudstyret og lækagekontrol

1. Prøvetagningssystemet samles. Evt. opvarmning af prøvetagningssystemet tilsluttes.

2. Prøvetagningssystemets indgang blokeres, og pumpen startes. Såfremt prøvetagnings-systemet er tæt, vil gasmålerens tæller efter kort tid stå stille. Vær forsigtig når blokeringen fjernes igen!

   Som alternativ kan der indskydes et manometer imellem pumpe og vaskeflasker. Indgangen blokeres, og pumpen startes. Når der er opbygget et vacuum på 4-600 mbar, stoppes pumpen. Såfremt prøvetagningssystemet er tæt, vil det opbyggede vacuum ikke ændre sig (konstant visning på manometeret).

6.3 Måling

1. Gasmålerens visning aflæses og noteres.

2. Udstyret monteres på prøvetagningsstedet i det første traverspunkt i kanal/skorsten.

3. Pumpen startes, og tidspunktet herfor noteres.

4. Der gennemføres isokinetisk prøvetagning i henhold til MEL-02 [9] (traversing, justering af flow m.v.).

5. Efter endt prøvetagning stoppes pumpen, udstyret demonteres fra kanal/skorsten, og gasmålerens visning aflæses og noteres. Tidspunkt for afslutning af prøvetagningen noteres - prøvetagningstiden er normalt 60 minutter.

6.4 Skylning af udstyret efter hver måling

Umiddelbart efter at det eksponerede filter er taget ud af filterholderen:

- Den tomme filterholder monteres på sonde og dyse.
- Dyse, filterholder og sonde skylles med toluen.
- Syllevæsken opsamles i en ren beholder af glas.
- Resterende skyllevæske fordampes, ved at der blæses ren luft igennem dyse, filterholder og sonde.

Af sikkerhedsmæssige grunde udføres skylningen under ventilerede forhold eller i det fri.

6.5 Overførsel og transport af prøver

1. Skyllevæske samles i prøveflasker af glas. Prøveflaskerne mærkes entydigt.

2. Filteret placeres i en egnet beholder og mærkes entydigt.

3. I umiddelbar forlængelse af prøvetagningen udtages en feltblindprøve, idet filteret monteres i udstyret, uden at der suges gas igennem. Herefter skylles udstyret som beskrevet i 5.4, og skyllevæsken sendes til analyse sammen med filteret. Det hele mærkes entydigt som feltblindprøve.

4. Der udtages en prøve af den i produktionen anvendte olie / olieemulsion, som mærkes entydigt og medsendes til laboratoriet. Den anvendes ikke til kalibrering, men kan være nyttig, hvis der på et senere tidspunkt opstår usikkerhed om olietypen.

5. Prøverne opbevares ved max. 25°C og transporteres til laboratoriet så hurtigt som muligt.

6.6 Prøveopbevaring

Prøverne skal analyseres inden 14 døgn efter prøvetagning. Såfremt prøverne ikke analyseres omgående, skal de opbevares ved max. 5°C.

6.7 Analyse, prøveforberedelse

1. Sammenhørende filter og skyllevæske overføres til en 100-ml målekolbe.

2. Blindprøve (ueksponeret filter) samt feltblindprøve behandles på samme måde som prøverne.

3. Der fyldes op til mærket med ekstraktionsvæske (toluen med intern standard).

4. Ekstraktionen sker ved ultralydsbehandling i 5 minutter efterfulgt af rystning af kolben i 30 minutter.

5. Der tilsættes vandfri natriumsulfat (tørringsmiddel). Der anvendes ca. 0,5g pr. 10 ml toluen. Indeholder prøven store mængder vandfase fra et kondensat, skal dette fjernes forinden.

6. Efter nogle minutters henstand udtages en delprøve af supernatanten til en GC-vial. Om nødvendigt kan der filtreres igennem et inert papirfilter.

7. Ved måleresultater over øvre måleområde fortyndes prøven med ekstraktionsmiddel (toluen med intern standard).

6.8 Kalibrering

Der kalibreres i forhold til n-hexadecan (n-C16). Der fremstilles en sporbar stamopløsning ved afvejning af n-hexadecan i en målekolbe, og opfyldning til mærket. Herudfra fremstilles en passende standardrække.

6.9 Analyse, kromatografi

Standardrække blind, feltblind, prøver og standardrække analyseres i nævnte rækkefølge.

Eksempel på kromatografiske betingelser er vist nedenfor:

Kolonne:	Fused silica, 0,2 mm id, 25 meter, 0,5um
Kolonnetemperatur:	40°C i 2 min - derefter 10°C/min til 300°C - 300°C i 5 min
Injektor	Splitless, 280°C, 1 ul
Detektor	FID, 300°C
Bæregas	Hydrogen, 2 ml/min
Makeup gas	Nitrogen, 30 ml/min

6.10 Beregning

Indholdet i absorptionsvæskerne bestemmes ved addition af samtlige peaks imellem n-C14 og n-C40, og kvantifikation i forhold til n-hexadecan (C16).

Der korrigeres for intern standard.

Resultatet af feltblindprøven bestemmes og medrapporteres. Der korrigeres for laboratorieblindprøven.

Indholdet i gasprøven bestemmes ud fra følgende formel:

$$C = \frac{m}{V \cdot 1000}, \quad hvor$$

C = koncentration af mineralsk olie i kanal/skorsten (i mg/m³(n,t))
m = mængden af mineralsk olie i prøven (i μg)
V = volumen af den tørrede luftmængde i normal tilstand (i m³(n,t))

7. Kvalitetssikring

7.1 Prøvetagning

- Tæthed af prøvetagningssystemet skal kontrolleres umiddelbart før prøvetagning (se afsnit 6.2).
- Gasmåler og flowmeter kalibreres regelmæssigt.
- Der udtages altid en feltblindprøve umiddelbart efter prøvetagning for at kontrollere evt. kontaminering af filter eller skyllevæske under prøvetagning eller transport.

7.2 Analyse

- Der anvendes intern standard for at sikre korrektion for afdampning eller injektionsvolumen
- Laboratorieblindprøver medtages for at kontrollere evt. kontaminering under oplagring eller analyse.
- Der udføres dobbeltbestemmelse – dvs. alle ekstrakter analyseres to gange. Afvigelsen imellem dobbeltbestemmelserne bør ikke overstige 10%. Middelværdien anvendes som resultat.
- Standardkurven skal være lineær i hele måleområdet.
- Der skal anvendes kontrolprøver og føres kontrolkort for analysen.
- Metodens sporbarhed skal kunne dokumenteres.
- Laboratoriet bør regelmæssigt deltage i præstationsprøvninger omfattende bestemmelse af alifatiske kulbrinter ved gaskromatografi – evt. i andre matricer.

8. Sikkerhed

Toluen er et opløsningsmiddel, der er både sundhedsskadeligt (mærkningskode Xn) og brandfarligt (mærkningskode F). Sikkerhedsbriller og engangshandsker skal benyttes. Laboratoriearbejde med toluen med risiko for spredning til omgivelserne bør ske i et stinkskab. Skylning og rensning af udstyret i felten bør foregå udendørs, eller i et velventileret lokale - der kan evt. suppleres med anvendelse af en kulfiltermaske.

9. Usikkerhed

Rapporten skal altid indeholde en prøvetagningsusikkerhed og en analyseusikkerhed eller en samlet usikkerhed for både prøvetagning og analyse.

Usikkerheden er normalt estimeret i et usikkerhedsbudget. Der henvises til DS/EN ISO 14956 [5] for beregninger af usikkerheden ved prøvetagning og analyse.

10. Rapportering

Den målte koncentration af mineralsk olie rapporteres i enheden mg/m³(n,t), hvilket betyder mg mineralsk olie pr. m³ tør gas ved 0°C og 101,3 kPa.

Der tilføjes følgende bemærkning til prøveresultatet:

"Prøven er udtaget og målt i henhold til metodeblad MEL-14 (Miljøstyrelsens anbefalede metoder). Den målte værdi er summen af mineralsk olie og PAH, som direkte kan sammenholdes med grænseværdierne angivet i B-værdivejledningen."

Rapporten udformes som beskrevet i kapitel 8 i Miljøstyrelsens vejledning nr. 2, 2001 Luftvejledningen [2] samt i ISO 17025 [3]. Afvigelser fra standard og metodeblad skal angives i rapporten.

Anvendelsen af DS 209 [8] til at oprense ekstraktet skal kommenteres i rapporten (fra separation af polære forbindelser).

Feltblindværdi skal angives i rapporten.

11. Modifikationer

Mineralsk olie indeholder semiflygtige forbindelser, og den beskrevne metode tager udgangspunkt i den amerikanske US EPA Method 0010: Modified Method 5 Sampling Train [1]. US EPA Method 0010 er udviklet til måling af SVOC (semivolatile organic compounds) i emissioner fra affaldsforbrændingsanlæg, men den kan benyttes generelt til måling på stationære anlæg.

Den anførte referencemetoder (US EPA Method 0010 [1]) er modificeret på følgende punkter:

- Filteret kan placeres in-stack eller out-stack efter ønske.
- Opvarmning af sonde og filter til 120°C kan undlades ved måling i kolde afkast uden højt vandindhold.
- Metoden omfatter udelukkende aerosoldelen af mineralsk olie (analyse af kondensat og anvendelse af back-up adsorbent er udeladt) vaskeflasker til HCl er udeladt.

- Af hensyn til miljø og arbejdsmiljø anvendes toluen som ekstraktionsmiddel i stedet for de traditionelle klorerede opløsningsmidler diklormethan eller tetraklorkulstof.

12. Referencer

[1] US EPA Method 0010: *Modified method 5 sampling train.* September 1986.

[2] Miljøstyrelsens vejledning nr. 2, 2001: *Luftvejledningen. Begrænsning af luftforurening fra virksomheder.*

[3] DS/EN ISO/IEC 17025: *Generelle krav til prøvetagnings- og kalibreringslaboratoriers kompetence.*

[4] DS/ISO/CEN: *Guide to the expression of uncertainty in measurement (GUM).* 2000.

[5] ISO/DIS 14.956: *Air Quality - Evaluation of the suitability of a measurement method by comparison with a stated measurement uncertainty,* 1998.

[6] Draft ISO/DIS 11.338 part 1: *Stationary source emissions - Determination of mass concentration of polycyclic aromatic hydrocarbons.* Metode B og C for prøvetagning

[7] Miljøstyrelsens vejledning nr. 2, 2002: *B-værdi vejledningen.*

[8] DS/R 209 *Vandundersøgelse: Bestemmelse af mineralolie. Infrarødspektrofotometrisk metode,* 1980.

[9] Miljøstyrelsens anbefalede metoder, metodeblad MEL-02: *Bestemmelse af koncentrationen af totalt partikulært materiale i strømmende gas* (www.ref-lab.dk).

Appendix D

Product data sheet for Cutmax WL SG 10 oil

HOUGHTON
Fluid Technology & Service Worldwide

Cutmax WL SH 10

Cutmax WL SH 10 is an amber metal working oil based on a combination of polar and chemically active substances.

Cutmax WL SH 10 is free from chlorine and zinc-containing additives and does not contain any PCBs or other known dangerous additives.

- ❑ High performance oil
- ❑ Good cooling properties
- ❑ High flushing properties
- ❑ Clean surface finish
- ❑ High tool life
- ❑ High separation between tool and workpiece

Application:

Cutmax WL SH 10 was especially developed for grinding. It can be used for grinding of hardened as well as soft surfaces. Excellent results are achieved with both structure conditions and the use of CBN as grinding medium.
Cutmax WL SH 10 gives extented service life. It is also excellent for honing, fine boring and finishing.
A specially selected additive combination ensures excellent cooling and surface rinsing.
Abrasive wheel-life, between redressing es extented, ensuring dimentional stability and high surface quality. These factors have obvious quality assurance benefits.

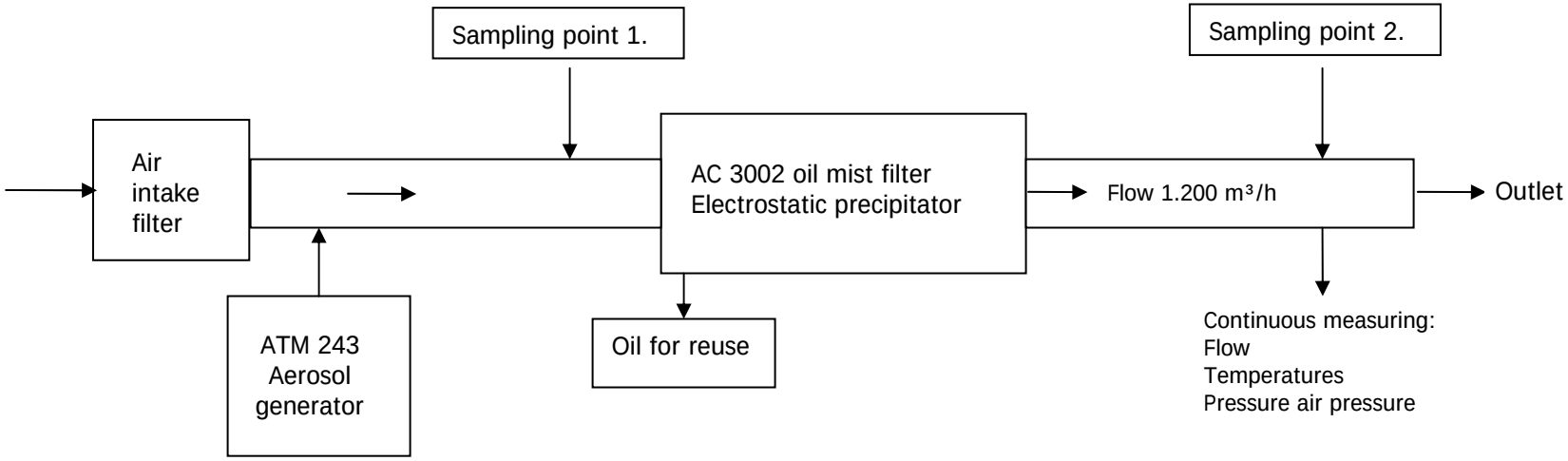
Appearance	amber			
Density at 20°C	0,85	[g/cm³]	± 0,02	DIN 51757
Viscosity at 40 °C	10	[mm²/s]	± 1	DIN 51562
Viscosity at 20 °C	18	[mm²/s]	± 2	DIN 51562
Flashpoint	> 155	[°C]		DIN ISO 2592
Pourpoint	- 20	[°C]		ISO 3016
Copper Corrosion	1 a			DIN 51759
WGK	1			

Appendix E

Test set up

Test set up for testing Simas Oilmist filter AC 3002

FORCE Technology
14/09/2009



Appendix F

AC 3002 Electrostatic Oil Mist Filter

Elektrostatische Luftfilter
Electrostatic air filters

AC 3000

AC 3001

AC 3001

AC 3002

Technische Daten Technical data	AC 3001 Einfache elektrostatische Reinigung One-insert electrostatic cleaner	AC 3002 Doppelte elektrostatische Reinigung Two-insert electrostatic cleaner
Normgebläseleistung*1,2 (m^3/h) Standard blower capacity*1,2 (m^3/h)	2300	2300
Absaugleistung effektiv bis …*2 (m^3/h) Sucking capacity effective, till …*2 (m^3/h)	1200	1200
Druckdifferenz*2 (Pa) Standard pressure*2 (Pa)	1100	1100
Geräuschpegel max. (dB (A)) Noise level max. (dB (A))	< 70	< 70
Abmessungen (L x B x H mm) Dimensions (L x W x H mm)	740 x 623 x 613	1070 x 623 x 613
Gewicht ca. (kg) Weight approx. (kg)	97	130
Hochspannung einstellbar für High voltage adjustable for	Öl oder Emulsion Oil or emulsion	
Vorfilter System Pre-filter System	1 x PRIMUS D (optional PRIMUS X / PRIMUS A)	

Die Geräte sind modular erweiterbar
*1 über Stufenschalter einstellbar
*2 bei 50 Hz Netzfrequenz

Modularly extendable devices
*1 adjustable by step switch
*2 at 50 Hz cycles

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Appendix G

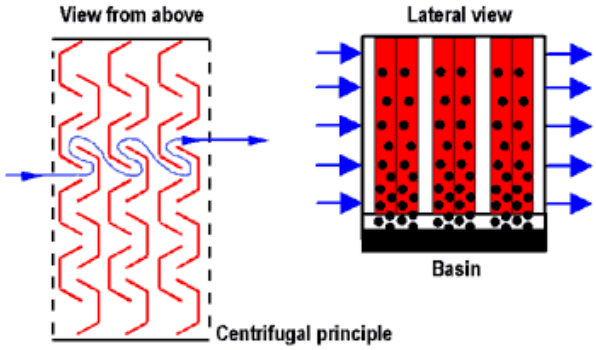
Pre- and after filters for AC 3002

Pre-filters

The pre-filters allow to perform an efficient pre-separation and extraction of large dirt particles from the next filters. This determines how often the cleaning operations shall be carried out and also how good the separation process is made.

In all filters of our series AC 3000 & AC 1000 are pre-filters integrated.

As Standard we quote the mounting with one Primus D 50.
Please note deviations on your order.



Item and designation	Article code	Number
PRIMUS S 20 as afterfilter	48.00061	memorize
PRIMUS D 50	420645	memorize
PRIMUS A 50 Agglomerator	420613	memorize
Pipe-filter dia 200	420795	memorize
Pipe-filter dia 250	420620	memorize
pipe-filter dia 200 Pipe-filter insets	420797	memorize
pipe-filter dia 250 Pipe-filter insets	420830	memorize
filter-inset F9 Afterfilter radial for AC 3001 &. AC 3002	46.00742	memorize
filter-inset H11 Afterfilter radial for AC 3001 &. AC 3002	46.00741	memorize
Replacement-filter (solid) F9	420860	memorize
Replacement-filter (solid) H11	420764	memorize
Replacement-filter (active carbon)	420756	memorize
Primus D 30	420996	memorize
Primus D 10	420997	memorize

Appendix I

Maintenance

11 Maintenance

11.1 General information

Regular maintenance can preserve the operation ability and life span of the machines.

	NOTE
	These instructions have to be read carefully and observed by all persons who maintain the machine. All safety regulations must be observed. Safety circuits and earths may not be deactivated under any circumstances.

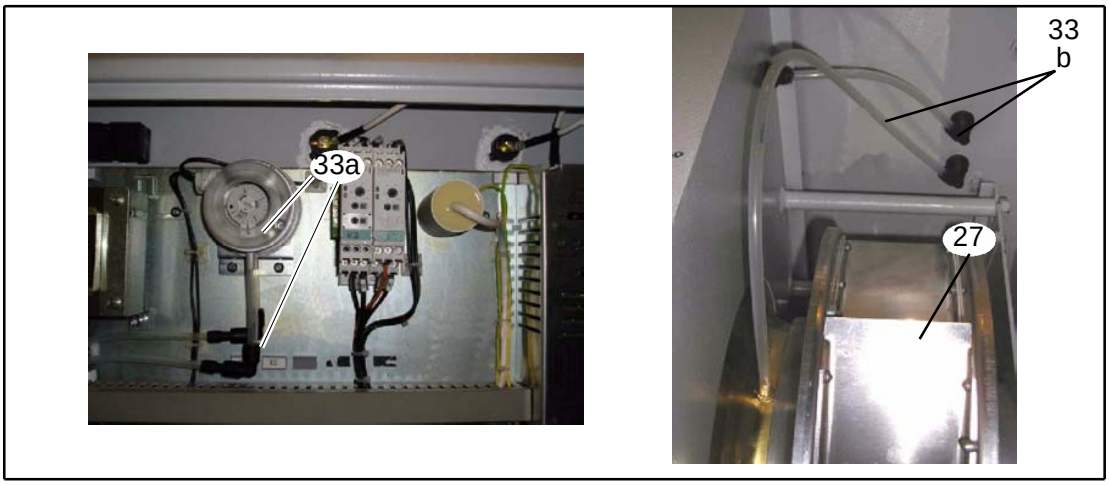
	DANGER
	Maintenance personnel are required receive appropriate training before carrying out maintenance work on equipment under voltage. Main switch must be switched off under all circumstances before any cleaning or maintenance activities. Allow a discharge time of about 1 minute to pass (depending on the degree of soiling) before opening the machine.

	ATTENTION
	Some particles that have been filtered out of the air may be environmental pollutants. These substances may not be allowed into drinking water supply. Position a collecting pan beneath the machine before cleaning the return line and the siphon. The contaminants need to be disposed of as hazardous waste.

11.2 Maintenance table

	NOTE
	The intervals given are recommendations. Other periods may be necessary depending on the operational conditions.

Interval	Item	Maintenance
monthly	9 and 12	Check mechanical pre- and post-filter elements
monthly	8,13	Check electrostatic filter cells (ioniser, collector) for mechanical damage and function, clean if needed
monthly	23	Check for dirt and sealing and if necessary clean drainage plug (and return line)
monthly	25	Check collector plates (bent, soiled, etc.)
monthly	26	Check ioniser wires (broken, position, etc.)
quarterly	6	Check high-voltage leadthroughs for burns and soiling
quarterly	22	Check and clean door insulations (tears, loose)
semi-annually	4	Control door switch and its function
semi-annually	10	Control contact springs for tears, mounting, and shape etc., and check its function
semi-annually	33a	Check settings. Check firm fit of the hose connections
semi-annually	33b	Check hoses for soiling and cracks
jearly	26 and 23	Check blower (radial/axial) (impeller, cables)


33a
33
b
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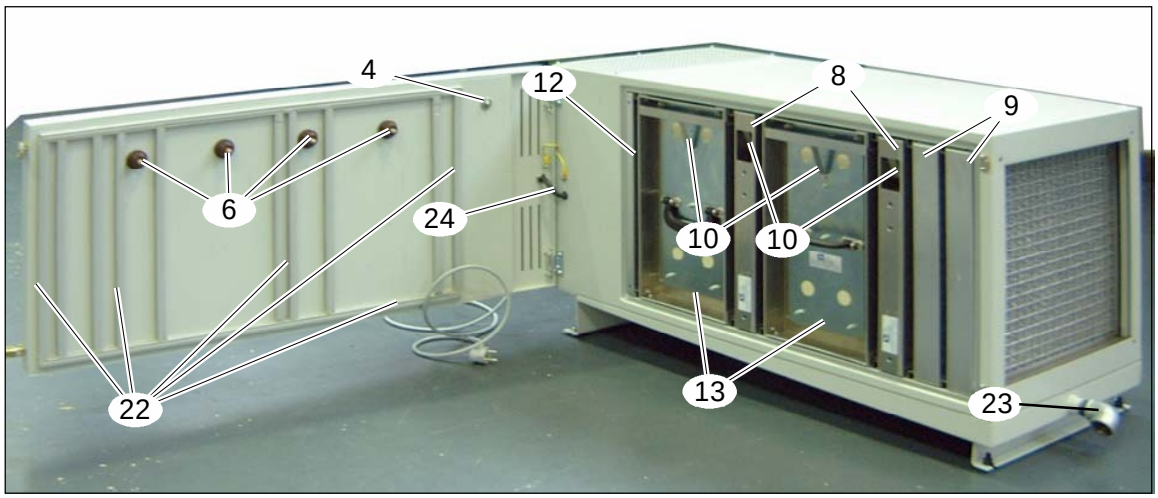
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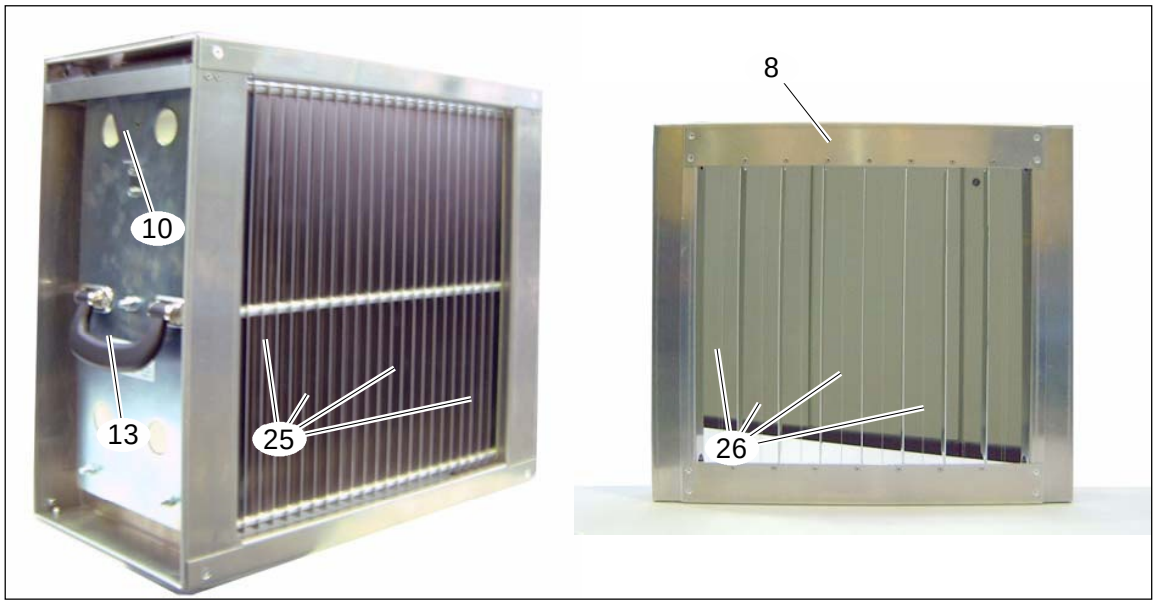
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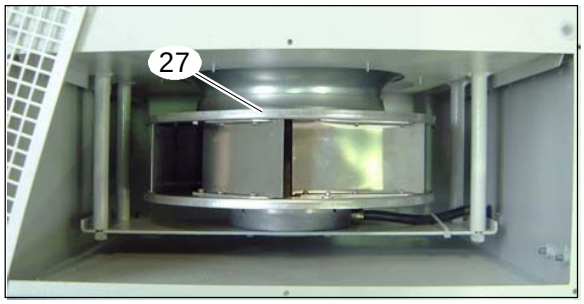


11.3 Clean mechanical filter, collector, and ionizer

To maintain the separator function of electrostatic filters and the exhaust function of mechanical filters, the filter elements need to be cleaned regularly.

	IMPORTANT
	Changes or damage to the ionization wires, collector plates, and mechanical pre- and post-filters reduce the cleansing performance considerably. It is generally recommended to purchase a complete replacement kit for the filter inserts in order to ensure nearly uninterrupted filter operation.

No recommendation can be given for the intervals, because the soiling of the filters depends on many factors (machining process, materials, cooling lubricant, crude gas exposure, and so forth).

Nevertheless the filters ought to be cleaned every 4 weeks. The resulting experiences can then lead to empirically adapting the cleaning interval step-by-step depending on the type of application.

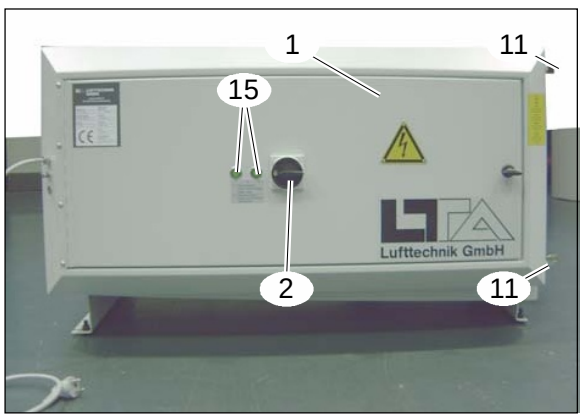
1. Switch off the main switch [2].

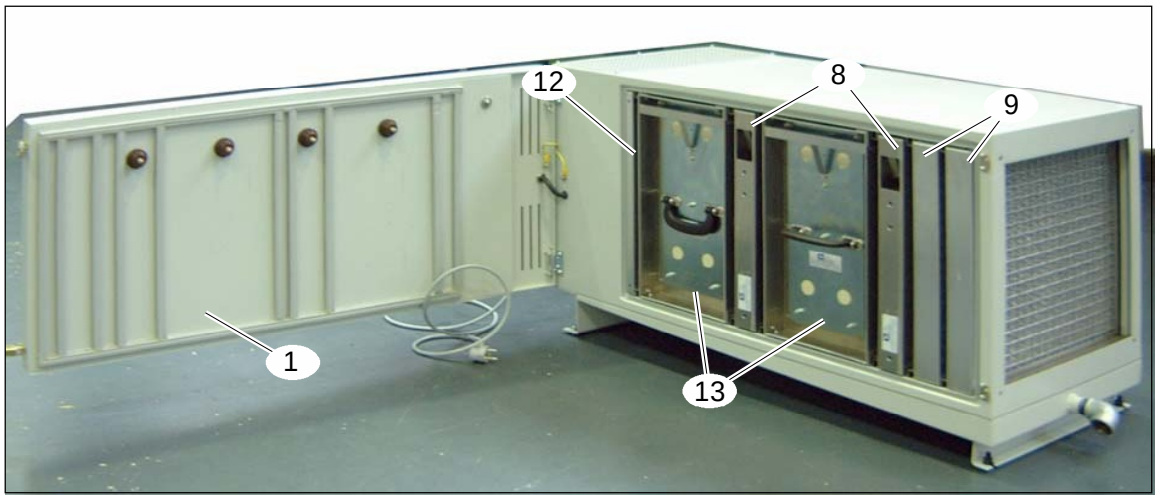
` 5HDG\IRUSHUDWRU/('>@VRII

2. Secure main switch against accidental switch-on.
3. Unlock closing clamps [11].
4. Open machine door [1].

` Collectors and ionizers are closed briefly and the remaining voltage is grounded.

5. Secure machine door [1] against shutting.





	NOTE
	Danger of damage! When removing and inserting the collector, ionizer, and filters make VXUH WKDW WKH P RYHP HQWLV SDUDOOHO WR WKH J XLGHV GRQ¶W GP Secure the ionizer, filter, and especially the about 12 kg heavy collector against falling at the rear (hold with second hand).

6. Pull out collectors [13], ionizers [8], and mechanical filters [9] and [12].

	NOTE
	Danger of damage! Avoid mechanical damages when cleaning the filter inserts or ionization wires. The cleansers may not cause any chemical reaction with aluminum.

	WARNING
	Fire danger! Cleaning with gasoline or other unsuited (flammable) materials is strictly forbidden.

7. Clean collectors, ionizers, and mechanical filters.

	IMPORTANT
	Cleaning of the mechanical pre- and post-filters as well as the collectors and ionizers can be done by conventional steam jets, in ultrasonic baths, and by industrial washing machines. Special care should be taken with the electrostatic filter cell to remove all CL residues even within the collector plates. Look out especially for ´GLUW QRVHV´ Z KLFK FDQ FDXVH VKRUWFLUFXLWV Elements such as hair, flakes, lint, etc., have to be removed, because otherwise sparks or short circuits may occur. If the soiling is difficult or heavy, it is generally recommended to let the filter inserts soak in a vat ahead of time. In practical use industrial washing machines with integrated oil skimmer for continuous bath preparation have proven their worth. Neutral tenside cleaner with 3-4 weight% is dosed into the cleaning water, which is heated to about 60 °C. The cleaning process is done with cleanser fed in at about 3-5 bar pressure and a flow rate of ≥ 250 l/min. The required cleaning time per wash cycle is about 5-10 minutes and can be individually adapted. The useful life of the cleanser (140 l) with bath preparation for light-density material separation is about 40 wash cycles. When using a conventional steam jet keep sufficient distance and observe the cleaning parameters just as with the industrial washing machines.

8. Dry collectors, ionizers, and mechanical filters or blow them out with air.

	IMPORTANT
	Before inserting the correct filter inserts make sure that there is no water, cleanser or the like between the collector and pasted plates. When inserting the collector make sure that the contact springs fit exactly to the high-voltage leadthroughs.

9. Insert collectors, ionizers, and mechanical filters.

10. Close machine door [1].

11. Lock closing clamps [11].

12. Switch on the main switch [2].

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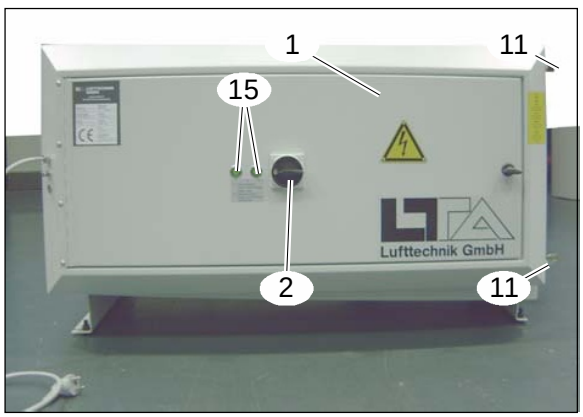


Appendix K

Test Results

Detailed test results

Manual samples and analysis for mineral oil as aerosols collected on a filter, and oil on gas phase sampled on XAD adsorbent, has been carried out according to the test plan in section 3.2.5. The results for each sample, together with the calculated removal rates, are shown in Table 1.

Tabel 1. Results of manual samples of oil aerosols on filter and gas phase on XAD.

Date	Sample	Inlet concentration C_I [mg/m³]		Outlet concentration C_O [mg/m³]	
dd.mm.yy	No.	Aerosols	Average	Aerosols	Average
14/10 2009	1	77.9	86.7	5.6	4.8
	2	91.9		4.8	
	3	90.3		4.0	
	No.	Gas phase	Average	Gas phase	Average
	1	14.2	14.7	11.4	11.8
	2	15.1		12.2	
Date	No.	Aerosols	Average	Aerosols	Average
26/10 2009	1	111	109	4.6	4.1
	2	107		3.9	
	3	109		3.7	
	No.	Gas phase	Average	Gas phase	Average
	1	7.0	6.0	6.4	4.35
	2	5.0		2.3	

The overall results of the test, concerning the removal rate for oil mist removed from the air is shown in Table 2. Each of the concentrations is the average of three one hour successive samples.

Table 2. Concentration and removal efficiency for oil mist aerosols.

Date	Inlet concentration C_I [mg/m³]	Outlet concentration C_O [mg/m³]	Removal rate RR
14/09/2009	86.7	4.8	94.5 %
26/10/2009	109	4.1	96.3 %

The concentration of oil on vapour form is also reduced somewhat in the filter. The removal rates based on two one hour samples is shown in Table 3.

Appendix K

Test Results

Tabel 3. Concentration and removal efficiency for oil on vapour form.

Date	Inlet concentration C_I [mg/m³]	Outlet concentration C_O [mg/m³]	Removal rate RR
14/09/2009	14.7	11.8	19.5%
26/10/2009	6.0	4.35	27.5%

Based on weighing the amount of oil supplied to the aerosol generator and the amount of oil drained from the pipe before the filter, the average concentration of oil aerosols in the air to the filter is calculated to be 85 mg/m³. This figure complies with the inlet concentration of 86.7 mg/m3 measured at the start of the test on the 14.10.2010. The outlet concentration of 109 mg/m3 measured at the end of the test on the 26.10.2010 is much higher than the calculated average of 85 mg/m³, which might be caused by relative big variations in the inlet concentration depending on the level of oil in the aerosol generator and the actual compressed air pressure.

Operation parameters

The aerosol generator was operated with nozzle no. 3, which gives the highest production of oil aerosols. The compressed air pressure was fixed to 6 bars. The pressure was measured continuously, and the data is shown in Table 4.

Table 4. Compressed ait pressure.

Compressed air	Unit	Average	Max.	Min.	Std.dev
Pressure	Bar	5.92	6.33	5.83	0.06

The air flow through the filter was measured continuously, and regulated manually by a valve to achieve a flow of 1200 m³/h. The measured flow and temperature is shown in Table 5, together with the room temperature.

Table 5. Filter air flow data.

Air flow	Unit	Average	Max.	Min.	Std.dev
Flow	m³/h	1170	1261	1082	38.2
Inlet temperature	°C	20.5	21.4	19.7	0.34
Outlet temperature	°C	22.5	23.4	20.6	0.33
Room temperature	°C	20.1	21.1	19.3	0.31

The flow should be 1200 m3/h ±10 %, which is the interval from 1080 m3/h to 1320 m3/h. The flow is controlled and regulated manually if necessary at the two daily inspections. The average flow is a little lower (2.5%) than the planned average flow, but it is within the fixed viability limits.

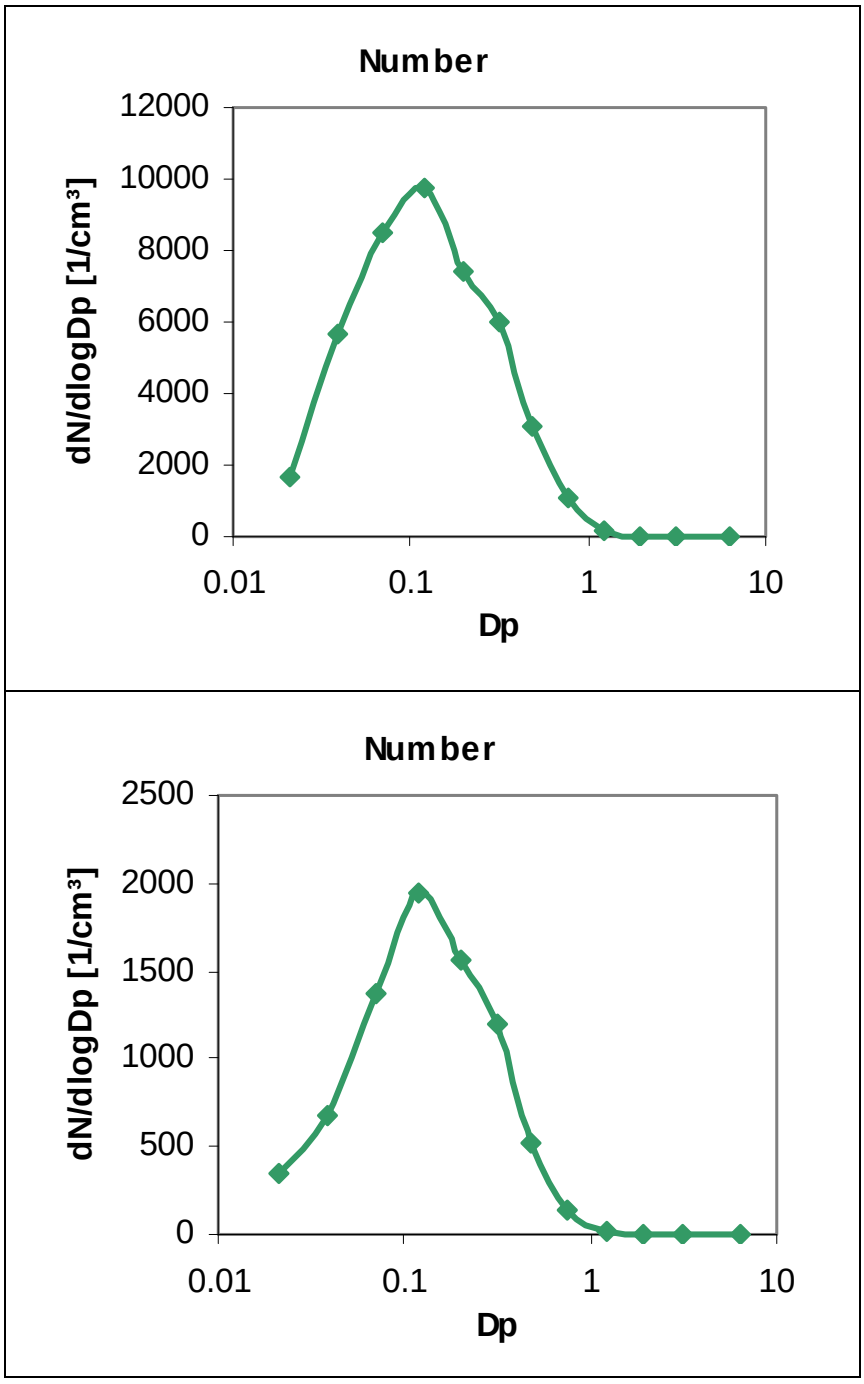
The aerosol particle size distribution was measured for both the filter inlet and outlet, at the start and the end of the test period. The particle size distribution was nearly the same for all four measurements, even though the outlet number was much lower than the inlet number.

Appendix K

Test Results

The inlet and outlet particle size distribution measured the 19.10.2010 and the 26.10.2010 is shown in Figure 1 and Figure 2.

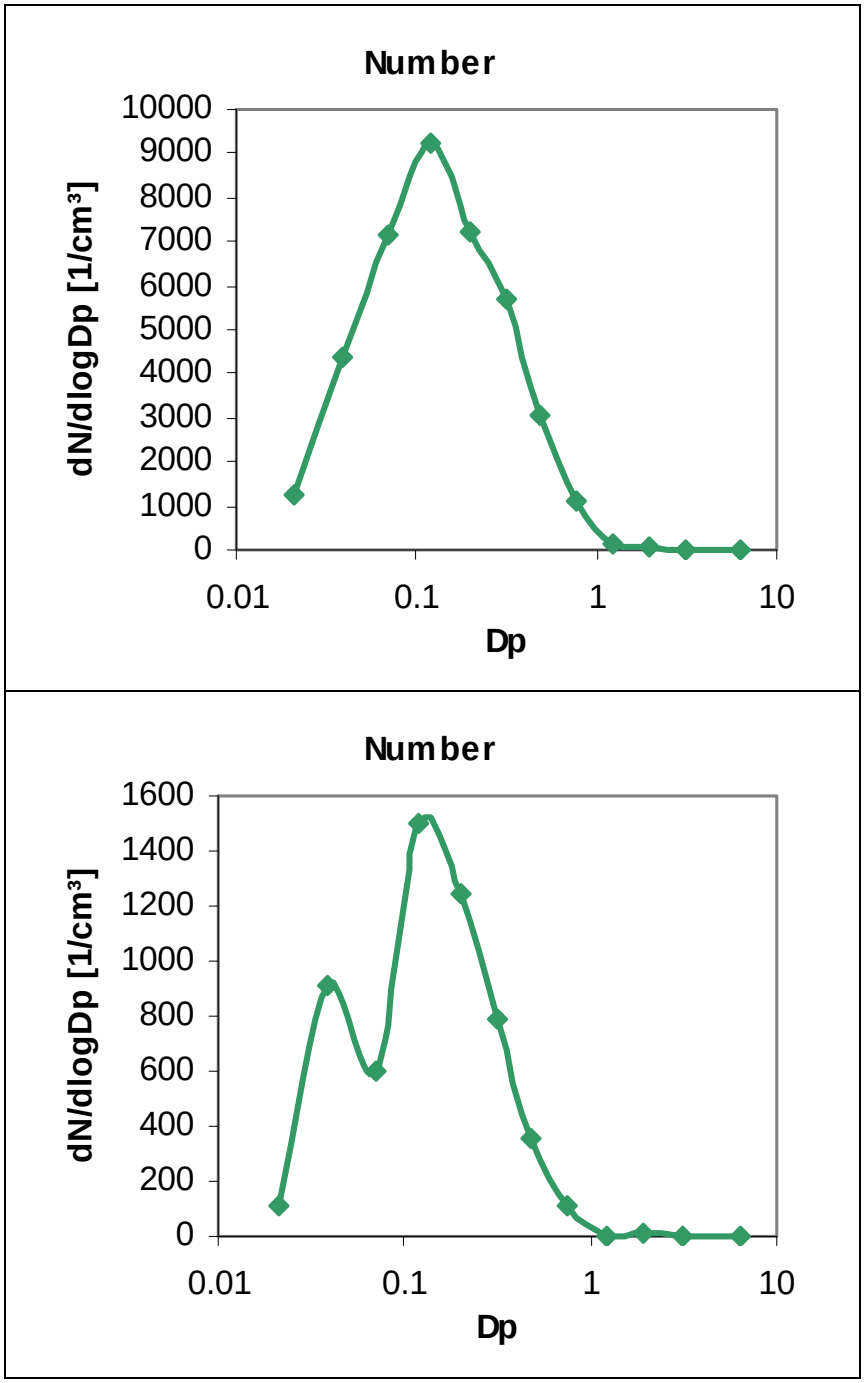
Figure 1. Inlet and outlet aerosol particle size distribution 19.10.2010.



Appendix K

Test Results

Figure 2. Inlet and outlet aerosol particle size distribution 26.10.2010.



Appendix 4

Review Reports

Reviewer				
Document title:	Simas Test Plan draft 0.4	Document date:		18.09.2009
Reviewer name:	Erik Balieu	Review	date:	27.09.2009
			meeting:	29.09.2009
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Reviewer				
Document title:	Simas Test Plan draft 0.4	Document date:		18.09.2009
Reviewer name:	Erik Bjarnov	Review	date:	27.09.2009
			meeting:	29.09.2009
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Organization:	FORCE Technology			
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	2605 Brøndby			
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E-mail	ekb@force.dk			

Revision	
Overall	The test plan has been reviewed and there has been made adjustments accordingly.
Particlesize distribution	is favorised by small particles (≤ 1 µm) as they are the most difficult particles to capture and the most harmful to health.