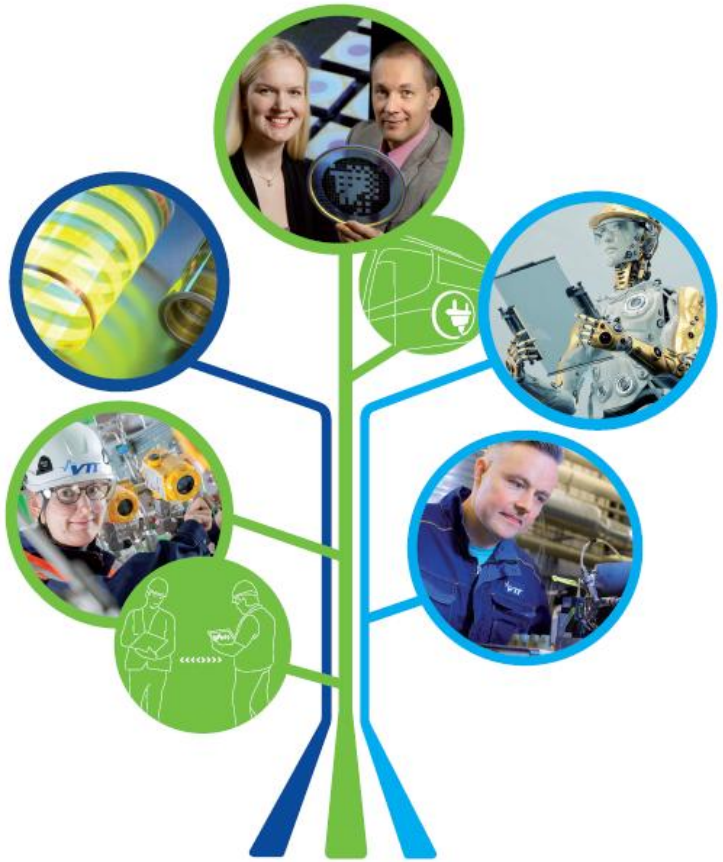
VTT TECHNICAL RESEARCH CENTRE OF FINLAND LTD



VTT Technical Research Centre of Finland Ltd

Air filtration meeting
GE Florence Learning Center
11.4.2016

Tapio Kalliohaka

Contents of the presentation

- VTT presentation
- VTT Clean air solution team research activities
- Filtration test for hydrophobic properties of static air filter
- Theory of the residual particle method

VTT Technical Research Centre of Finland Ltd

- A leading R&D organisation in Nordic countries
- We provide expert services for our domestic and international customers and partners, both in private and public sectors

TOP 2
VTT is second most active patenting organisation in Finland (2014)

36%
of Finnish innovations include VTT expertise

We use
4 million hours
of brainpower a year to develop new technological solutions

Net turnover and other operating income 272 M€ for VTT Group in 2015
(VTT Group's turnover 185 M€ in 2015)

Personnel 2,470
(VTT Group 31.12.2015)

Unique research and testing infrastructure

Wide national and international cooperation network

VTT’s status as performer of R&D work

BASIC RESEARCH

UNIVERSITIES

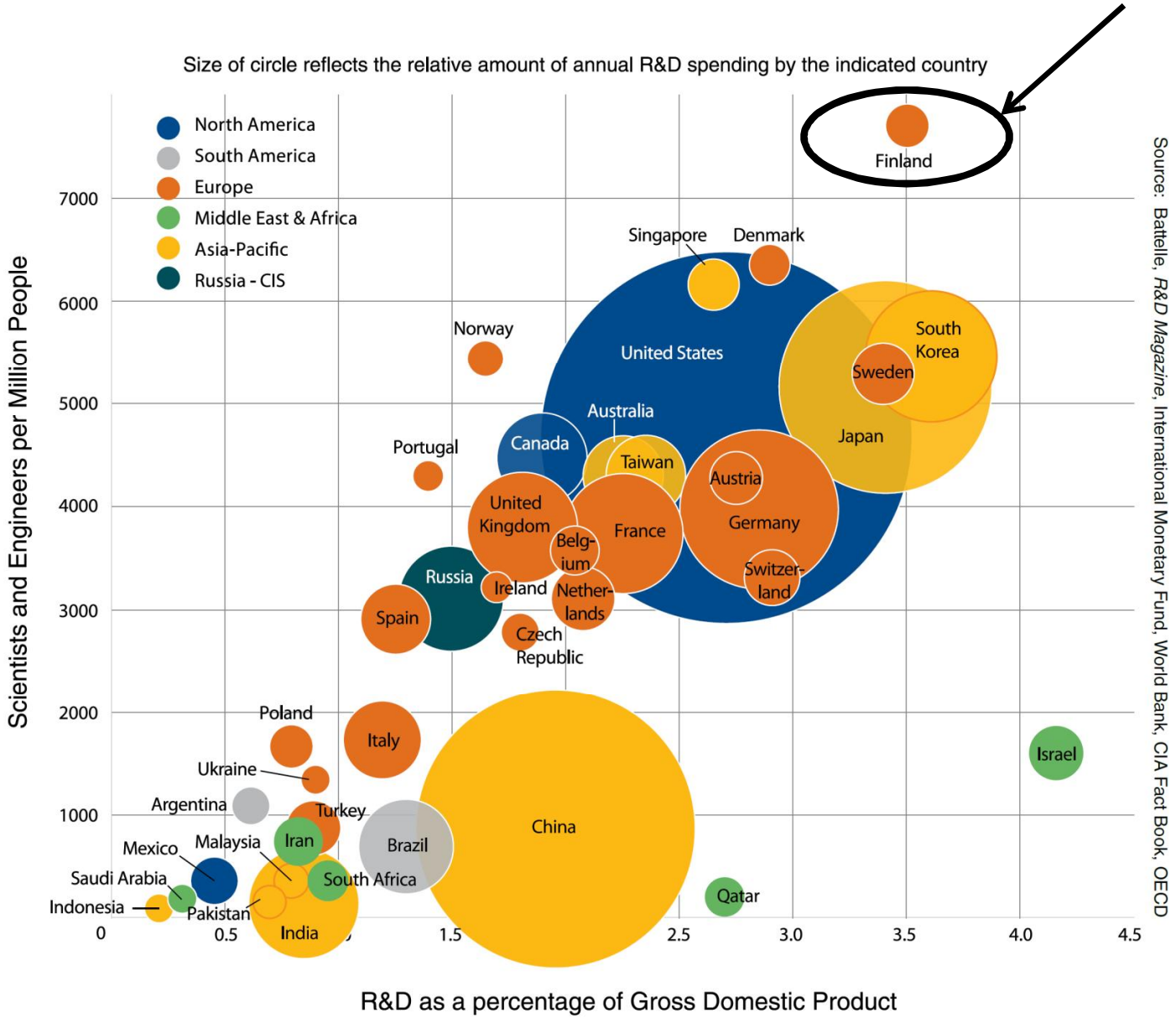
APPLIED RESEARCH

VTT

DEVELOPMENT

INDUSTRY

Finland is a land of scientists and engineers



Note: Figures are from 2013

VTT Expert services Ltd

Testing of air filters

We determine the performance of general ventilation air filters according to the European standard EN 779:2012. The most essential characteristics measured are pressure drop, particle efficiency, arrestance and test dust holding capacity. We are one of the most experienced laboratories in the world. Our clients are the world leaders in the field of air filters.

EUROVENT CERTITA CERTIFICATION and DIN CERTCO are agreed our laboratory to carry out the tests in accordance with their certification schemes regarding the air filters.

Accredited test method (FINAS T001)

- EN 779:2012 Particulate air filters for general ventilation - Determination of the filtration performance.

Read more about our accreditation scope.

www.finas.fi

Typical Building Services products tested

- Ventilation and air conditioning products
- Heat pumps
- Plumbing products
- Plastic pipes
- Small wastewater treatment plants

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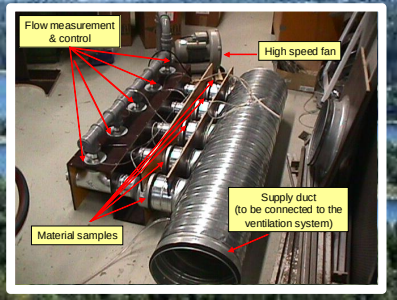
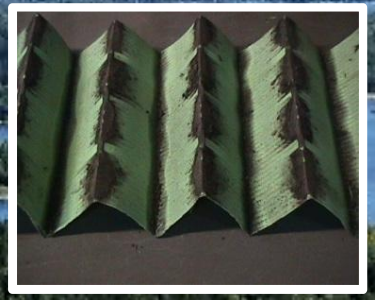
Opening hours 9:00 - 11:00 and 12:00 - 15:00, GMT +2 time zone

VTT Clean Air Solutions

- Active research areas
  - Fine particle exposure control
  - Electrical air filtration technologies
  - IAQ and building protection
  - Automotive cabin air filtration
  - Power plant combustion air filtration
  - Clean production systems
  - CBRN protection

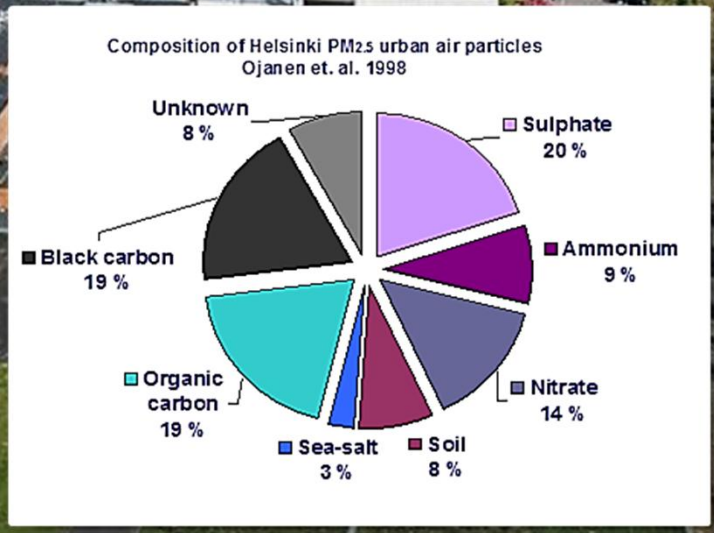




Gas turbine inlet air filter performance evaluation

- **Filter performance evaluation on site**
  - in land, on shore and off-shore
- **Tailored laboratory tests**
  - Special expertise on wet condition evaluation
  - Chemical analysis of penetrated particles
- **Filter material and filter development**
  - Mechanical fiber filters
  - Electrical filtration systems
- **References**

  GE Energy Products France SNC • Solar Turbines Inc • Donaldson • AAF • Camfil • W.L.GORE & Associates GmbH • Northern Technical L.L.C. • Eagle Filters • Ahlstrom Oy…



Activities in standardization and development work with new measuring methods.

nordtest method NT VVS 117 Approved 1997–11

1(6)

UDC 697.94

ELECTRET FILTERS:
DETERMINATION OF THE ELECTROSTATIC ENHANCEMENT FACTOR OF FILTER MEDIA

Key words: Air filter, electret filter, electrostatically charged filter, test method

CONTENTS

1 SCOPE

This Nordtest method is intended to be used in the testing of fibrous filter materials, The purpose of the test is to determine whether the efficiency of a filter material is dependent on the electrostatic removal mechanism and to provide quantitative information about the importance of the electrostatic removal mechanism.

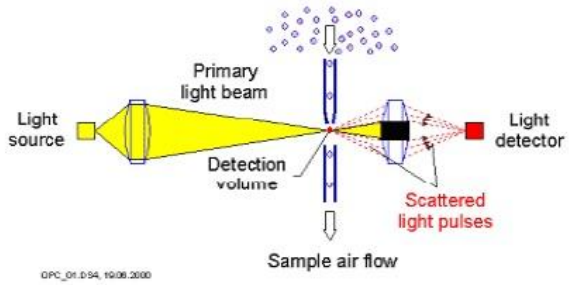
2 FIELD OF APPLICATION

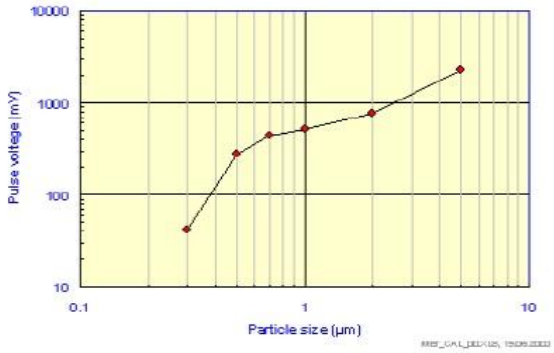
The method is primarily intended to be used in the testing of filter materials used in general ventilation filters. The method can be applied to any fibrous filter material which is known or suspected to be made of electrostatically charged fibers.

NORDTEST Report TR 531 Approved 2002-10

Field Test Method for the Measurement of Filter Efficiency

Matti Lehtimäki
Aimo Taipale





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Field test methods

NORDTEST Method | NT VVS 128 Approved 2001-11

1(7)

UDC 697.94

VENTILATIONS FILTERS:
FIELD TEST OF EFFICIENCY

Key words: Air filter, efficiency, penetration, filter testing, *in situ* testing, test method

CONTENTS

1 SCOPE

This Nordtest method is intended to be used in testing ventilation filters in their normal operating conditions. The purpose of the test is to determine if the fractional efficiency of the filter(s) differs significantly from that expected from the laboratory tests.

2 FIELD OF APPLICATION

The method is primarily intended to be used in the testing of filters used in general ventilation systems. The method can also be applied to any filter which is used in comparable conditions.

3 REFERENCES

1. ASHRAE 52.2:1999. Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size. The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 1999.
2. EN 779:1993. Particulate air filters for general ventilation – Requirements, testing, marking. CEN European Committee for Standardization, Brussels 1993.
3. EUROVENT 4/9. Method of Testing Air Filters Used in General Ventilation for Determination of Fractional Efficiency. Eurovent 1997.
4. Eurovent 4/10-1996. In Situ Determination of Fractional Efficiency of General Ventilation Filters. Eurovent 1996.

4 DEFINITIONS

Aerosol

An assembly of liquid or solid particles suspended in a gaseous medium long enough to enable observation or measurement.

Aerosol particle

A small discrete object suspended in gaseous media.

Particle size

For spherical particles the size of a particle is defined as the diameter of the spherical object. When using optical particle counter the equivalent PSL (polystyrene latex) particle size is used. This is the particle size indicated by the particle counter calibrated with monodispersed PSL particles.

Aerodynamic particle size is an equivalent particle size defined as a diameter of a unit density sphere having the same aerodynamic properties as the particle in question. Aerodynamic particle size is used e.g. when measuring the particle size distribution with a cascade impactor.

Particle concentration

The number of particles in a specified volume of air. Particle number concentration is defined as the number of particles in a unit volume of air. Number concentration is typically used e.g. when making measurements with an optical particle counter.

Particle mass concentration is defined as the particle mass in unit volume of air. Mass concentration is normally used when measuring particle concentration with filter sample or gravimetric method.

Particle size distribution

A relationship expressing the quantity of a particle property (number or mass) associated with particles in a given size range. An optical particle size analyzer is typically used to measure particle number size distribution while a cascade impactor is used when particle mass size distribution is to be measured.

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ISSN: 0283–7226
Project: 1474-99

Guideline for Field Testing of General Ventilation Filtration Devices and Systems for Removal Efficiency In-Situ by Particle Size and Resistance to Airflow

ASHRAE GPC 26

Draft 2, January 2006

Based on working draft 1.4 dated October 25, 2005

Electret filters

Investigation of Mechanisms and Operating Environments that Impact the Filtration Efficiency of Charged Air Filtration Media (1189-RP)

Phase II Report

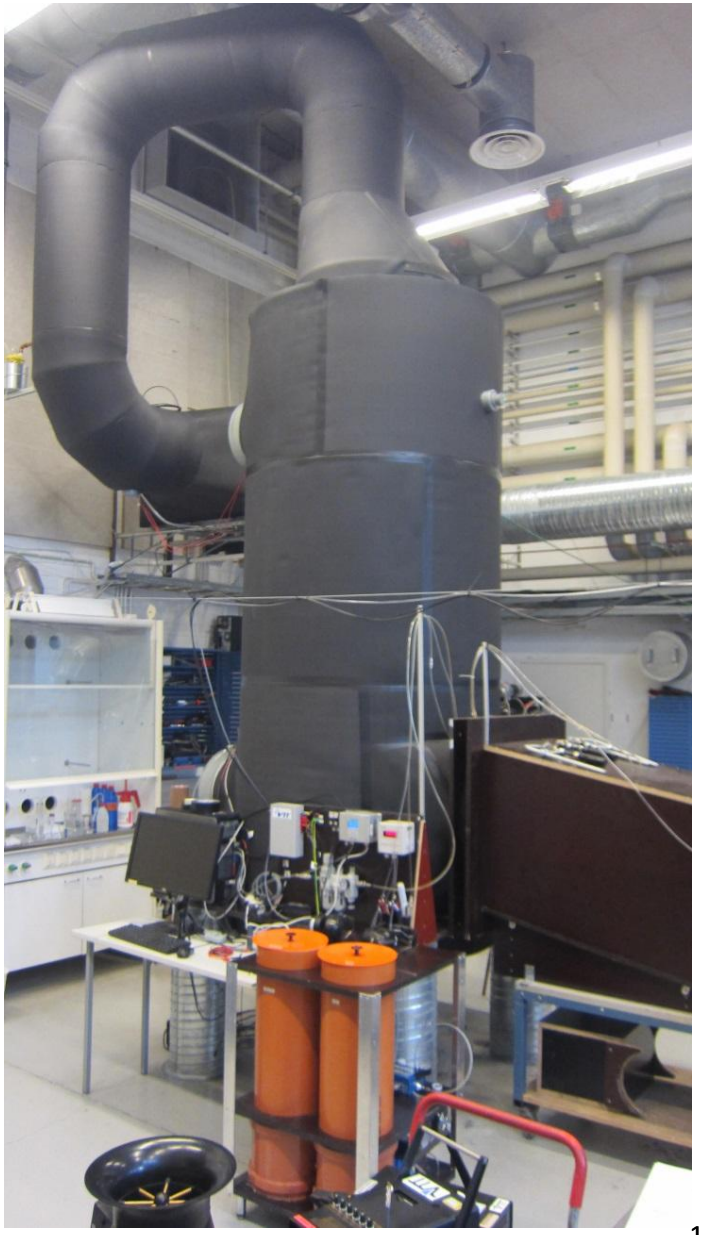
DRAFT

Submitted to: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)

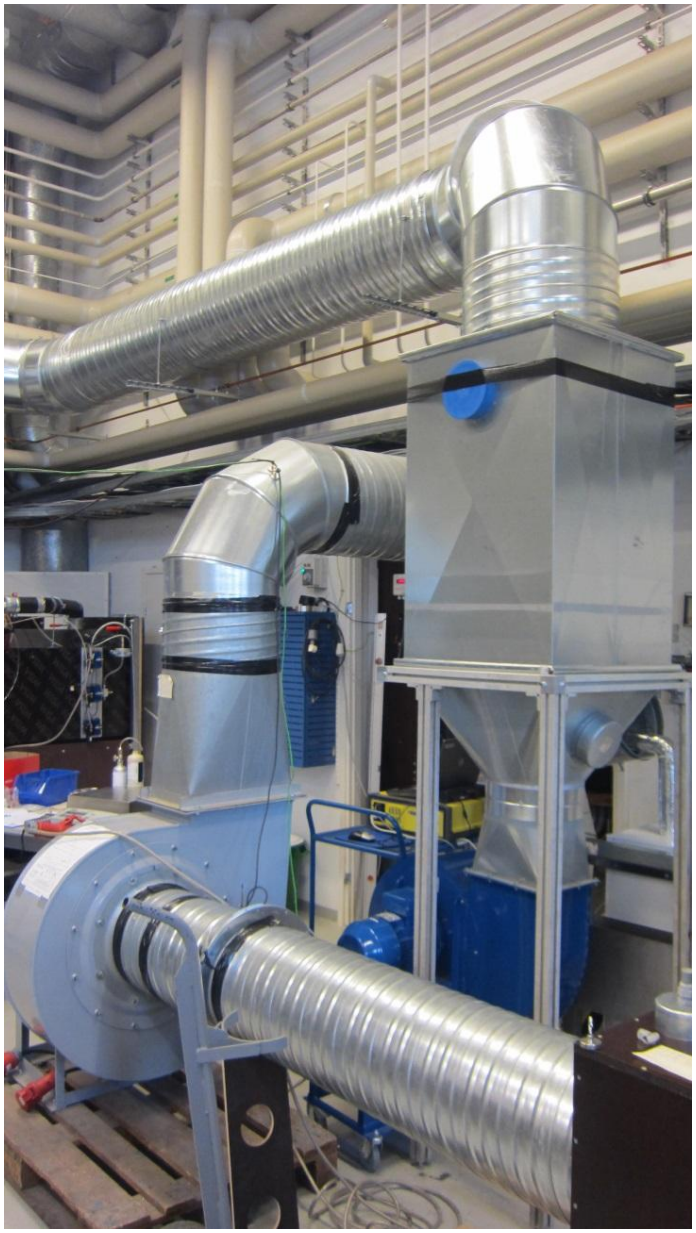
Filtration test for hydrophobic properties of static air filter

Background for the hydrophobicity measuring system

- Development of the system started at the end the year 2009 by Dr. Matti Lehtimäki.
- At the first phase the system was build for static air filters and first filters were measured.
- At the second phase ducting for cartridge filters were build
- System is further developed to be more automated



Main components of the system 1

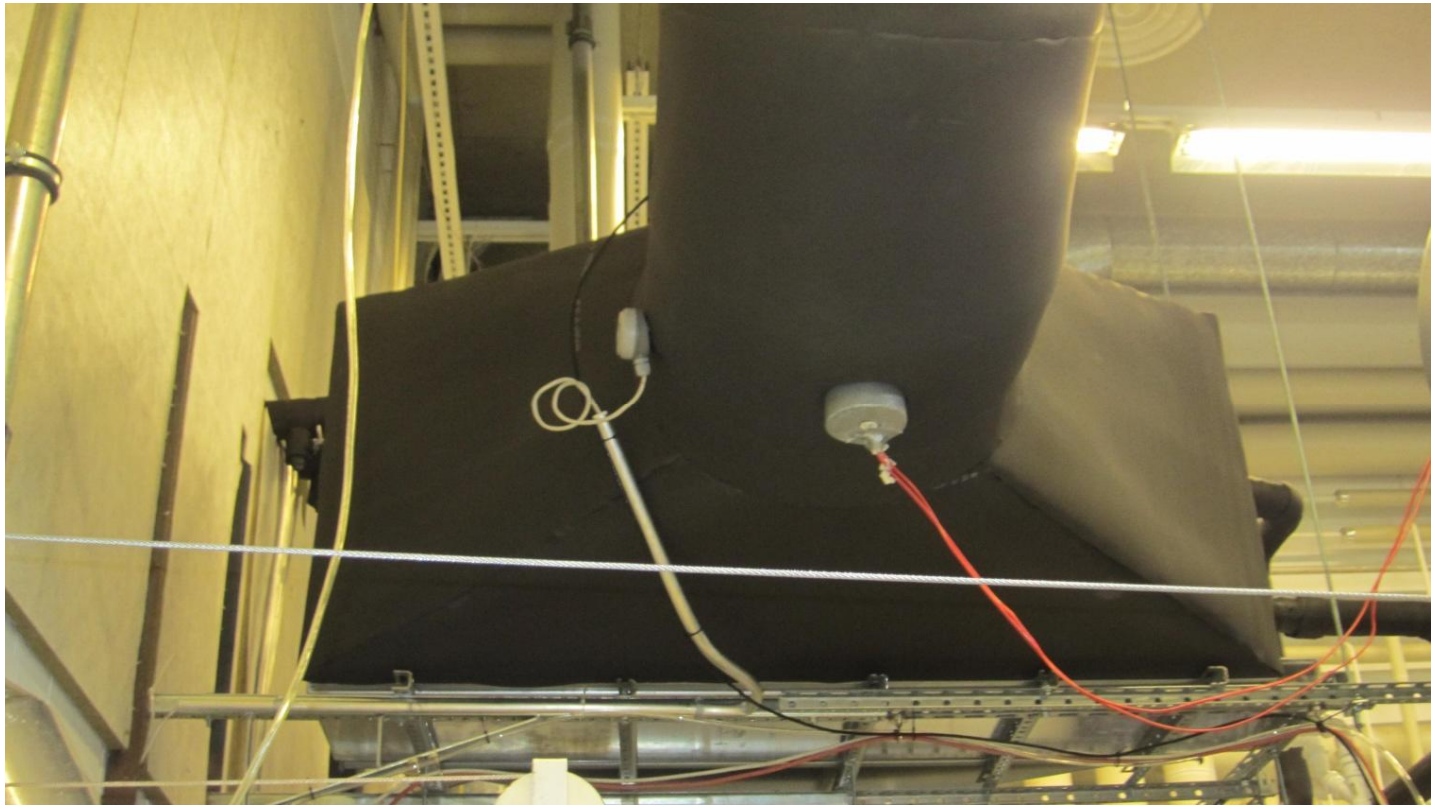


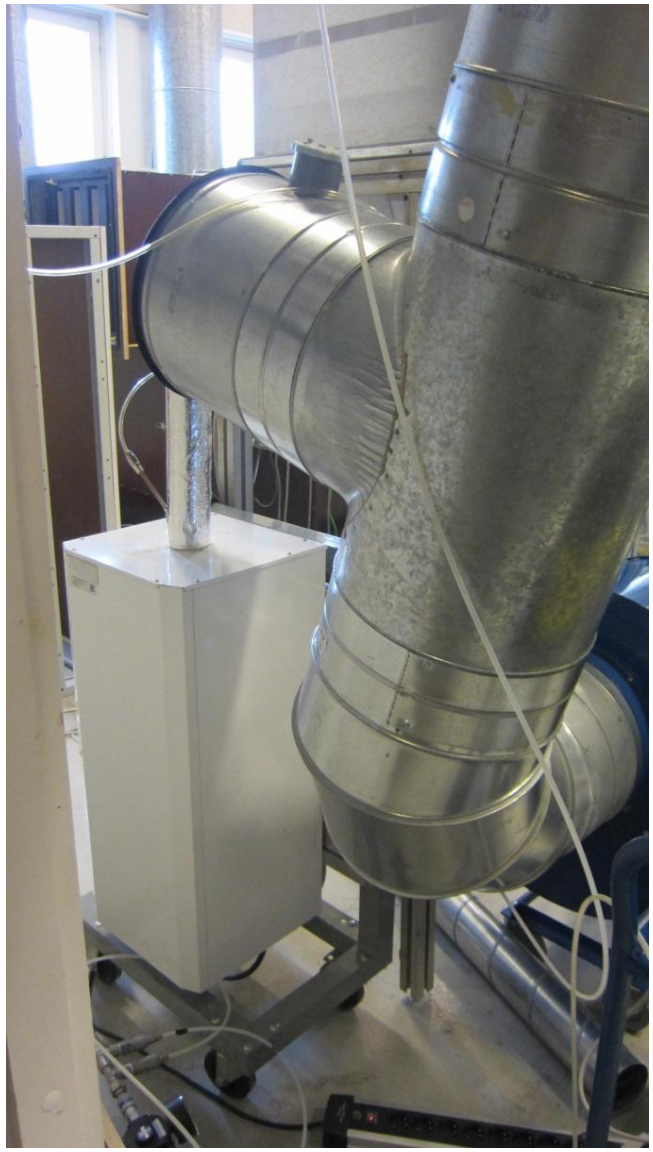
Fans and frequency converters

Airflow is kept constant by measuring orifice pressure with pressure transmitter and controlling the frequency converter

Main components of the system 2

Cooling coil for 2m^3/s ariflow
and steam generator

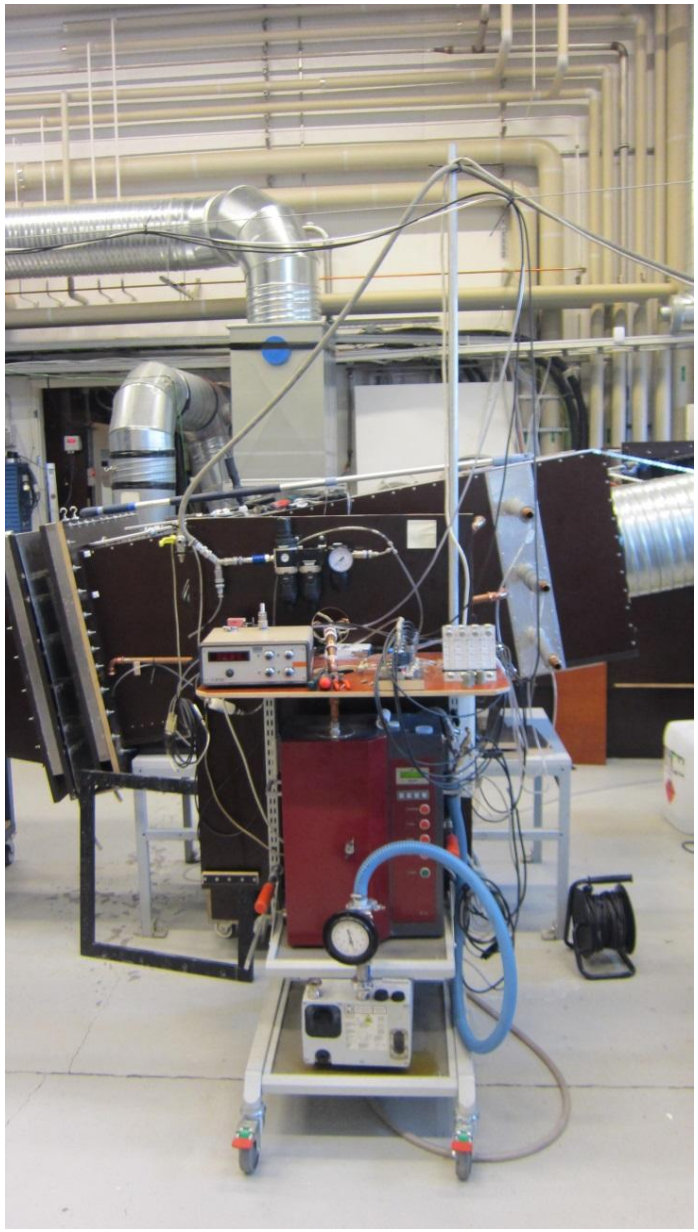




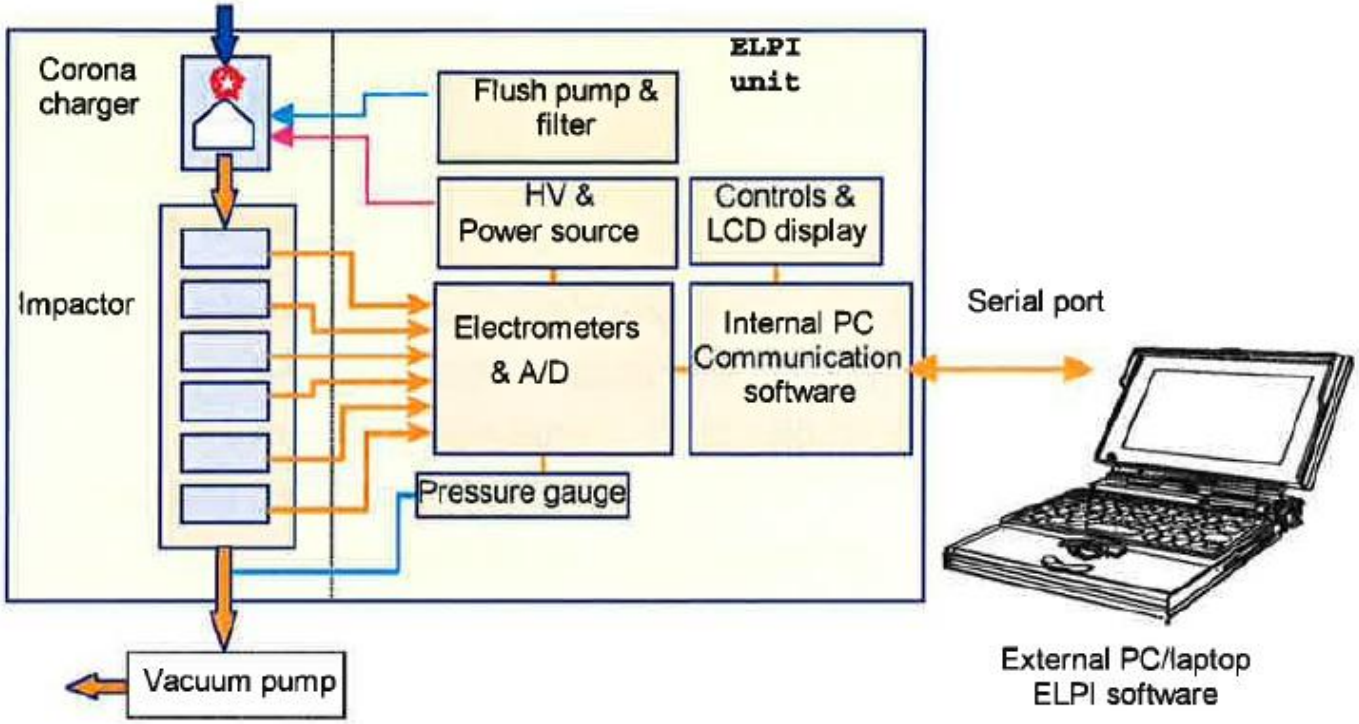
Main components of the system 3

←Salt water container, pump and mass flow controller for the salt water flow control

ELPI device with vacuum pump and sampling valve control system→

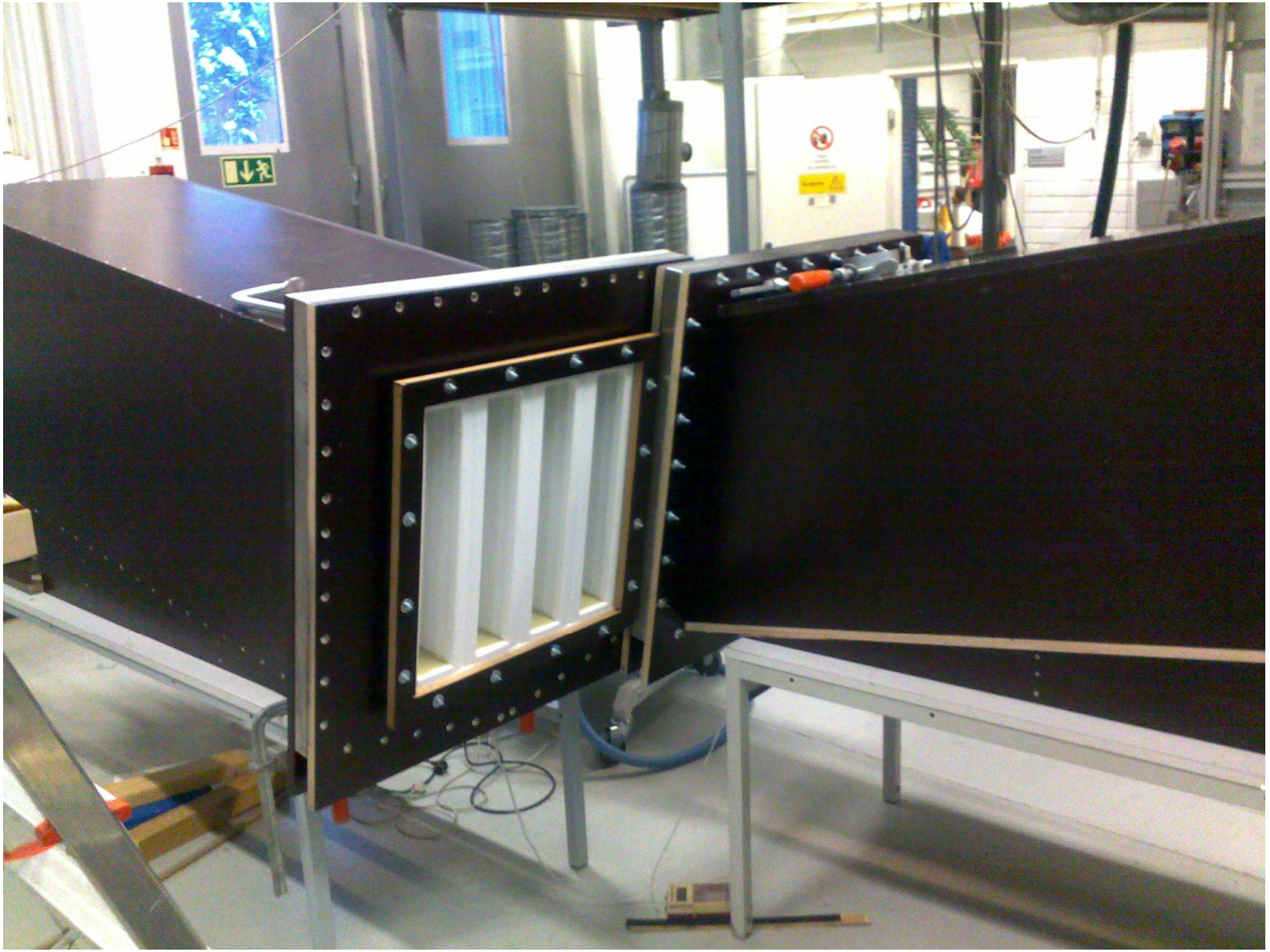


1 INSTRUMENT DESCRIPTION



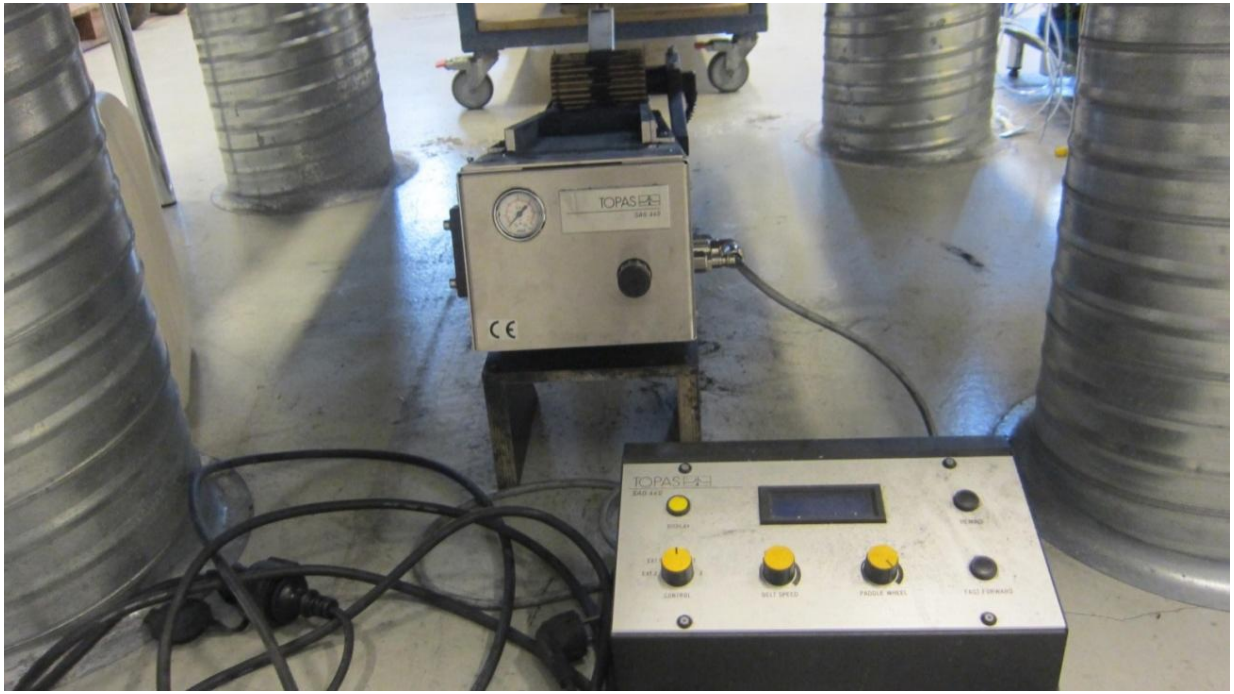
The ELPI (Electrical Low Pressure Impactor) is a real-time particle size spectrometer designed at the Tampere University of Technology for real-time monitoring of aerosol particle size distribution[1]. The ELPI measures airborne particle size distribution in the size range 0.03 - 10 µm with 12 channels. The principle is based on charging, inertial classification, and electrical detection of the aerosol particles. The instrument consists primarily of a corona charger, low pressure cascade impactor and multi-channel electrometer.

Fixing of the filter to the test rig

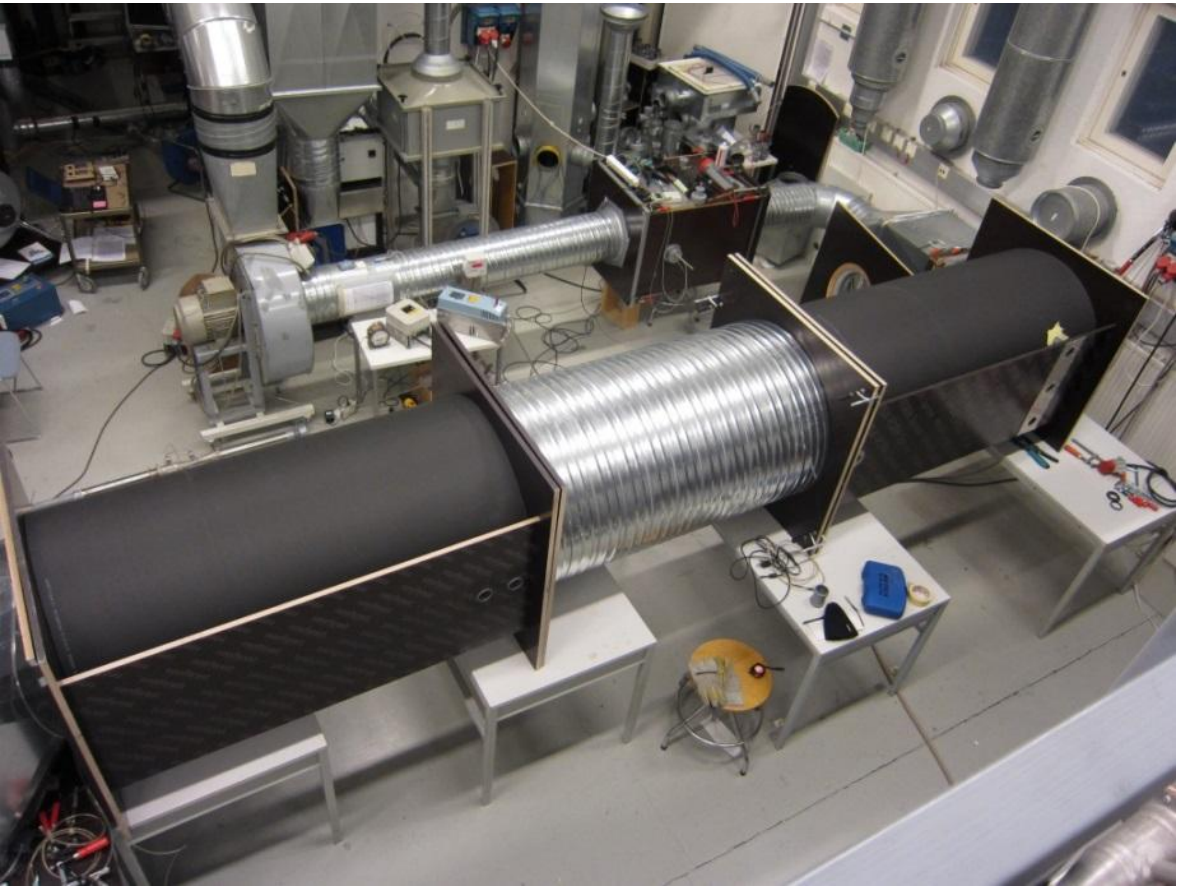


Instruments for measuring temperature, humidity, dP, mass flow etc.

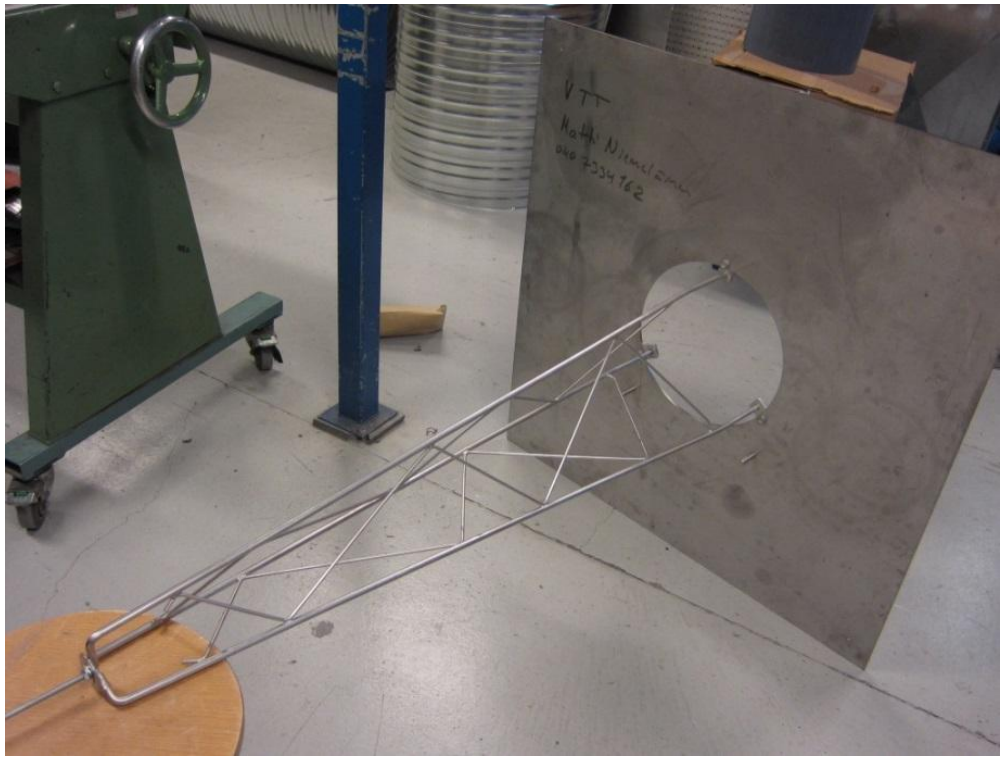
Topas test dust feeder for filter loading with ASHRAE test dust →



Ducts for cardridge filter measurements



Fixture for attaching cardridge filters



Advantages of the method

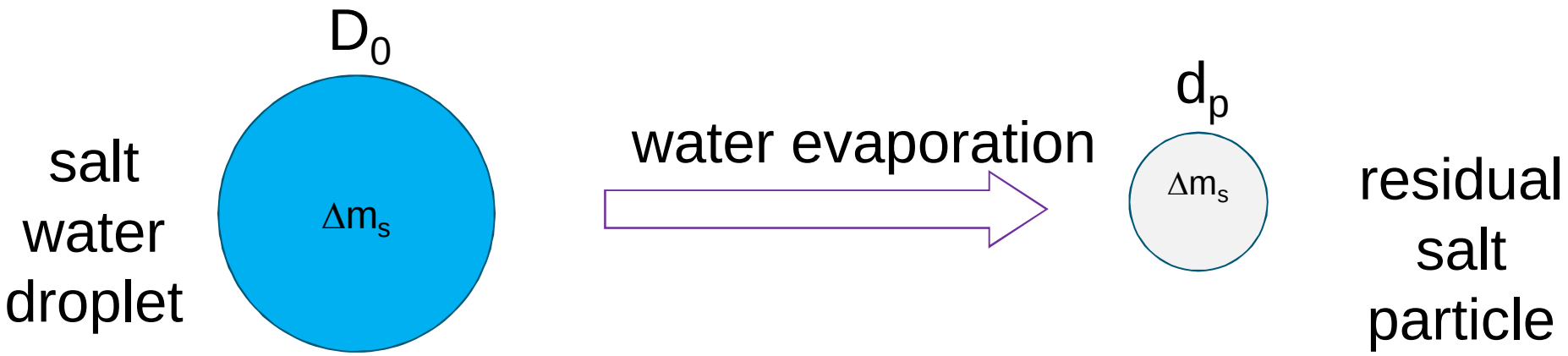
- Number of spraying cycles and loading phases are suffcient to prove filter behaviour in harsh conditions
- Water leakages in the filter frame structure and in the gasket will be noticed
- Frame and gasket leakage is not shown in the filtration efficiency measurement
- Salt traces in the dried downstrean duct gives a good visual sign of the leak amount and type
- Collected water amount in the downstream side is the most important result of the test

Disadvantages of the method

- Leaking water which penetrates the filter media forms big droplets and the droplets falls down in the bottom of the downstream duct
- Therefore the water leakage of the filter is not seen in the filtration efficiency measurement
- Flooding of the filter is possible, this means the water is collected in the filter and finally it blocks the airflow.
- Test requires lot of work and working days

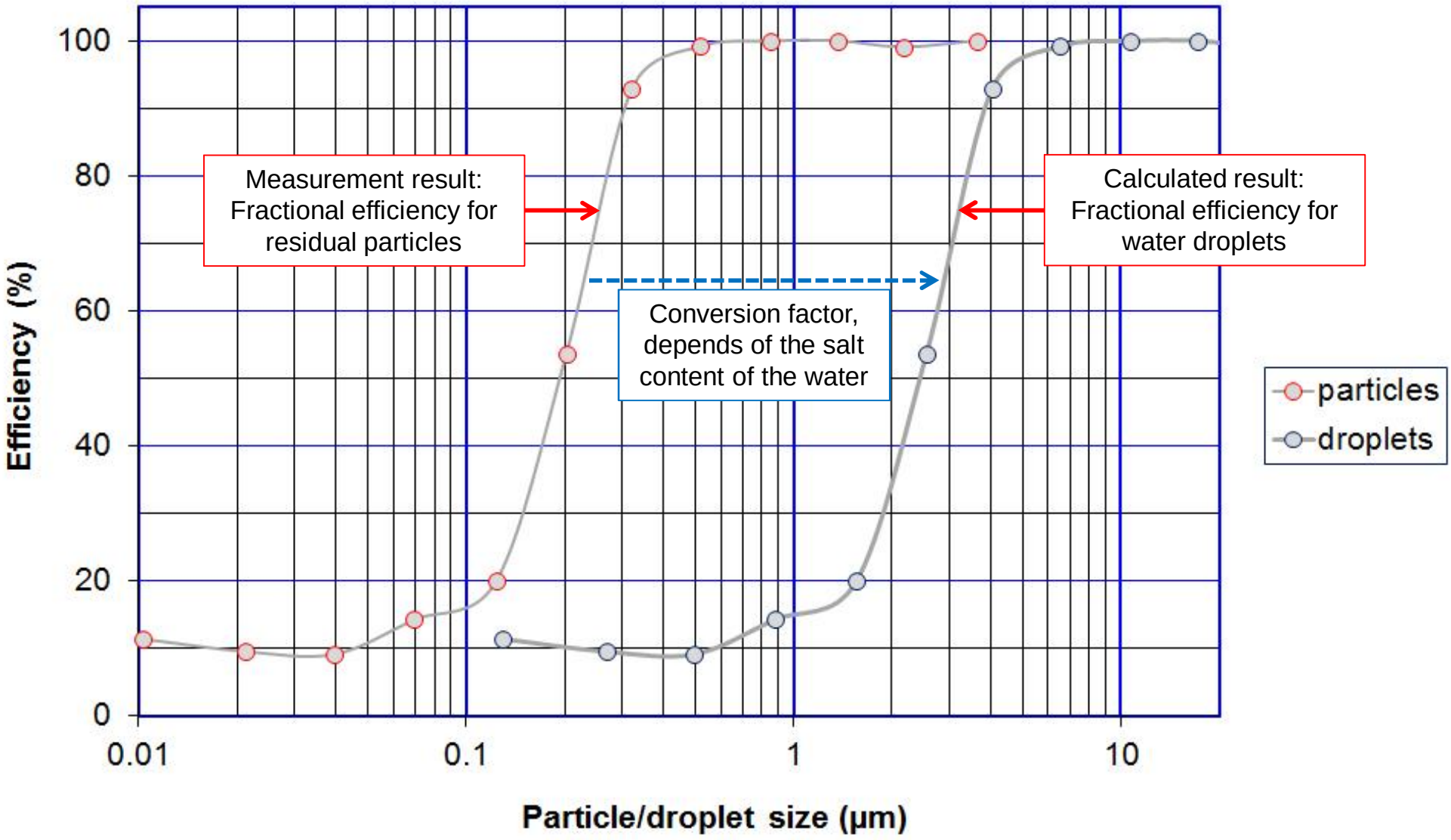
Theory of the residual particle method

Basics of the residual-particle technique

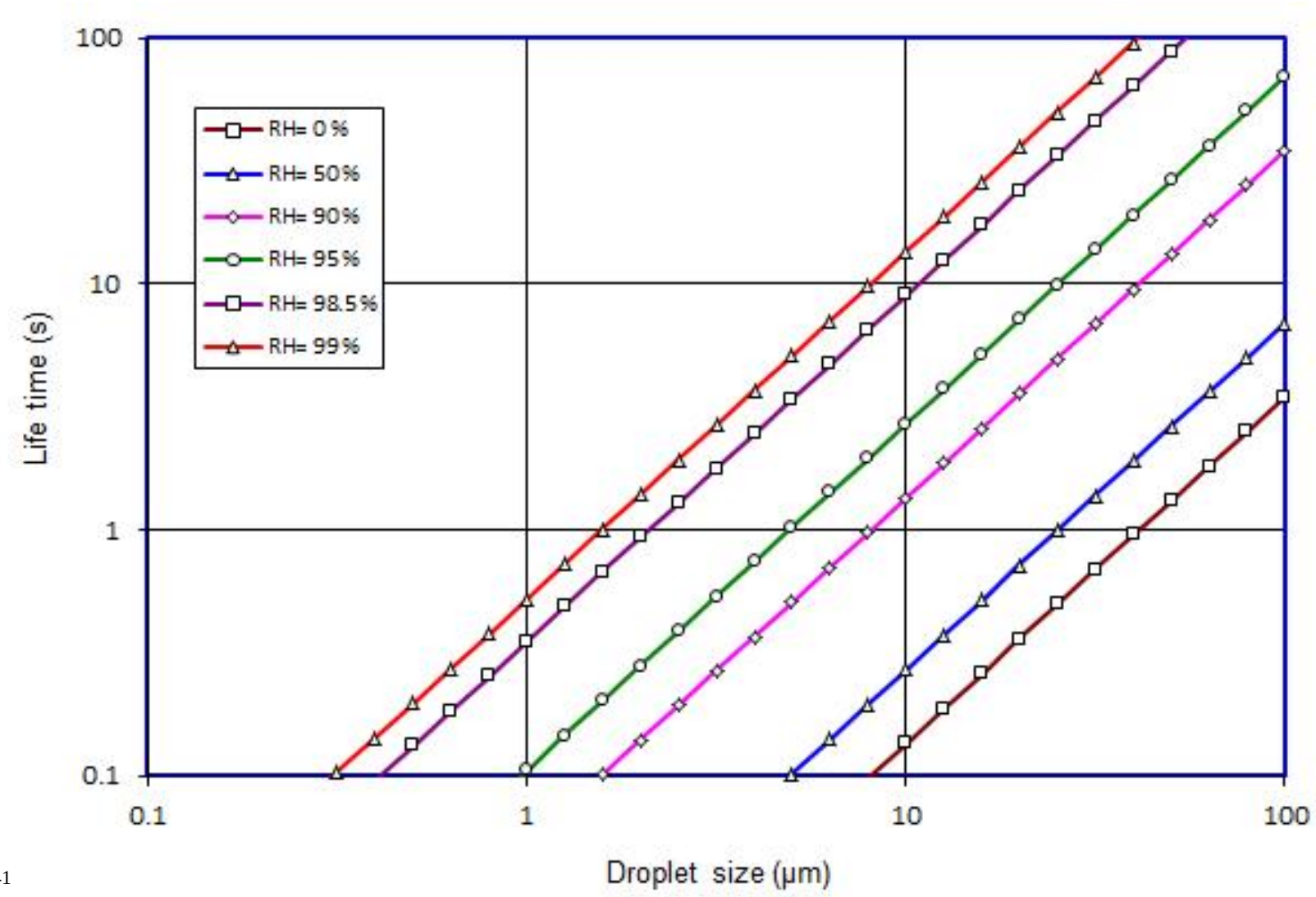


- salt concentration c_0
- droplet diameter D_0
- density of the salt particle ρ_p
- particle size d_p

Basic principle of the residual technique



Life time of a water droplet



$$t = \frac{A\left(\frac{d}{d_0}\right)^{1.41}}{1 - RH} \qquad d_0 = 1\mu m, A = 5.27 \cdot 10^{-3} s$$

Equilibrium droplet size in humid air