DEKATI

Excellence in Particle Measurements

Dekati®
Oxidation Flow Reactor DOFR™

Compact and portable oxidation flow reactor for secondary aerosol formation studies

Suitable for wide range of applications including transient emission sources

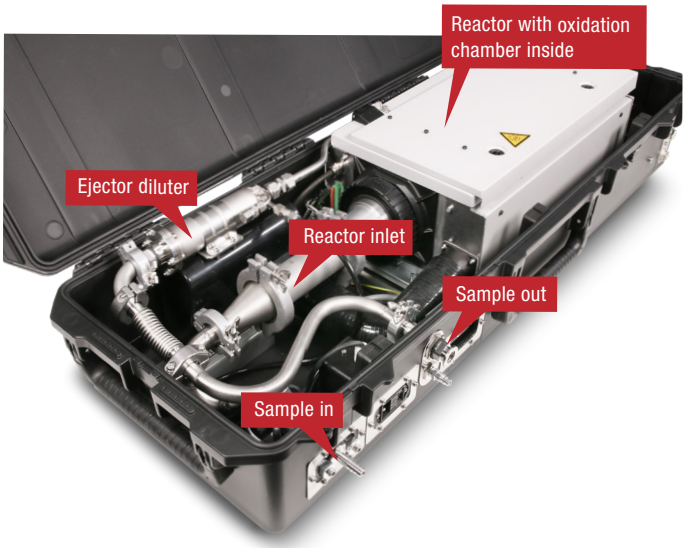
Complete setup with full and automatic control of oxidation parameters for PAM studies

Constant reactor residence time and high outlet sample flow for multiple instruments

Dekati®
Oxidation Flow Reactor DOFR™

Description

Dekati® Oxidation Flow Reactor, DOFR™, is a unique, all-in-one solution combining sample conditioning and an oxidation flow reactor for secondary aerosol (SA) formation studies. The formation of secondary aerosols can take several days in the atmosphere and the purpose of the oxidation flow reactor is to speed up these processes. In the Dekati® DOFR™, UVC radiation together with water molecules and ozone in the sample create highly oxidative conditions inside the reactor and the time- scale is reduced from days to less than one minute.



DOFR™ system is built into a portable casing.

In the Dekati® DOFR™, all parameters - humidity, ozone, UVC-intensity, dilution and reactor flow - are controlled and monitored with a user-friendly PC software. The flow through the oxidation chamber is kept constant and laminar, resulting in minimal particle losses. Together with wide oxidation range, these features make the DOFR™ an ideal tool for any secondary aerosol studies from stationary lab tests to transient emission sources.

When combined with Dekati sampling solutions such as the eDiluter™ Pro, DOFR™ can take the sample even from the harshest conditions. After the photochemical aging in the Dekati® DOFR™, the size, concentration and mass of the aerosol can be monitored with particle measurement instruments. For example, the Dekati® ELPI®+ (Electrical Low Pressure Impactor) is well suited for monitoring the particle size distribution and concentration in real time.

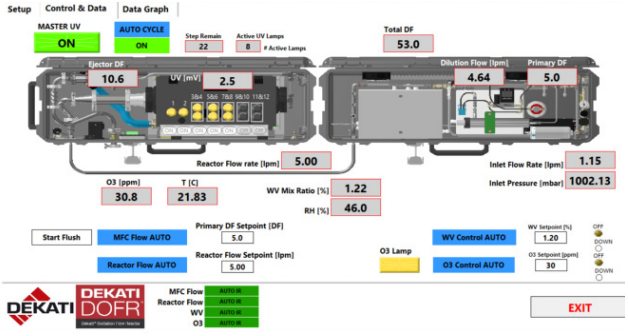
** Simonen, P., Saukko, E., Karjalainen, P., Timonen, H., Bloss, M., Aakko-Saksa, P., Rönkkö T., Keskinen J. & Dal Maso, M. 2017. A new oxidation flow reactor for measuring secondary aerosol formation of rapidly changing emission sources. Atmospheric Measurement Techniques, 10, 1519-1537, doi:10.5194/atm-10-1519-2017

Operating principle

First the sample is drawn into conditioning unit where the sample is treated to reach the desired ozone and humidity levels. After this the sample enters the DOFR™ reactor unit.

The Dekati® DOFR™ reactor unit design and operation is based on the TSAR system** (Tampere Secondary Aerosol Reactor) designed in the Tampere University of Technology (nowadays Tampere University) in 2015. Dekati® DOFR™ reactor unit consists of a sample inlet, a reactor chamber with 12 UVC-lamps, and an ejector diluter. The reactor inlet ensures laminar flow through the reactor, where the secondary aerosol formation occurs under the influence of UVC light. UVC intensity is controlled by selecting the number of activated UVC lamps. Control software includes option for automatic UVC intensity cycles to use in potential aerosol mass studies.

An ejector diluter placed right after the oxidation chamber acts as a pump and generates a constant flow through the inlet and the reactor chamber. The ejector diluter additionally dilutes the sample that is then lead to particle measurement instruments such as the ELPI®+.
The complete DOFR™ system is built into portable and robust casing that can easily be transported between measurement locations.
The system has a modular design making it easy to detach different components of the unit for maintenance and cleaning.



DOFR™ PC user interface

Applications

- Secondary aerosol precursor and formation research
- PAM measurements
- Transient emission source measurements
- Engine tailpipe emission research
- Marine engine studies
- Aircraft emission research
- Stationary source emission studies
- Toxicology studies

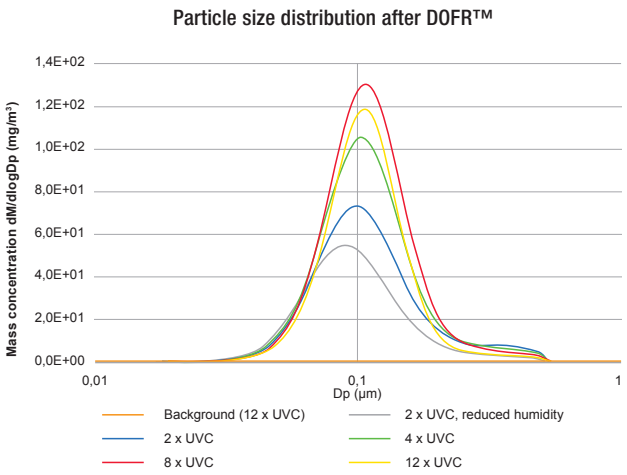
What is secondary aerosol?

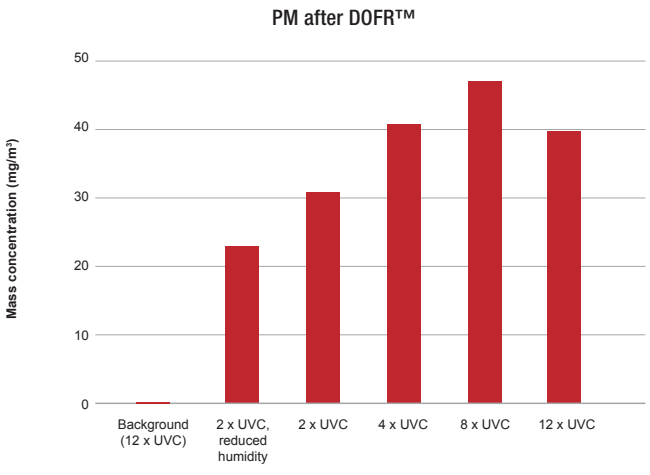
Term secondary aerosol is used to refer to the particulate matter that is formed through chemical reactions in the atmosphere, long after the primary emission from the source is released into the air. Secondary aerosol is formed when volatile compounds originated from the source react in the atmosphere with highly reactive oxidative species and form new compounds. The volatile compounds that have potential to form new compounds are called precursors, and they can be either organic or inorganic molecules.

When the precursor compounds and the oxidative species react, they form new compounds that can have lower volatility than the original precursor molecules emitted from the source. These newly formed low volatility compounds can then form new particles via nucleation or grow existing particles via condensation. This process is called aging of the aerosol and the potentially formed aerosol mass is commonly referred to as PAM (Potential Aerosol Mass), and the DOFR™ is designed to determine the maximum PAM for the source aerosol in a matter of minutes by adjusting different oxidation parameters.

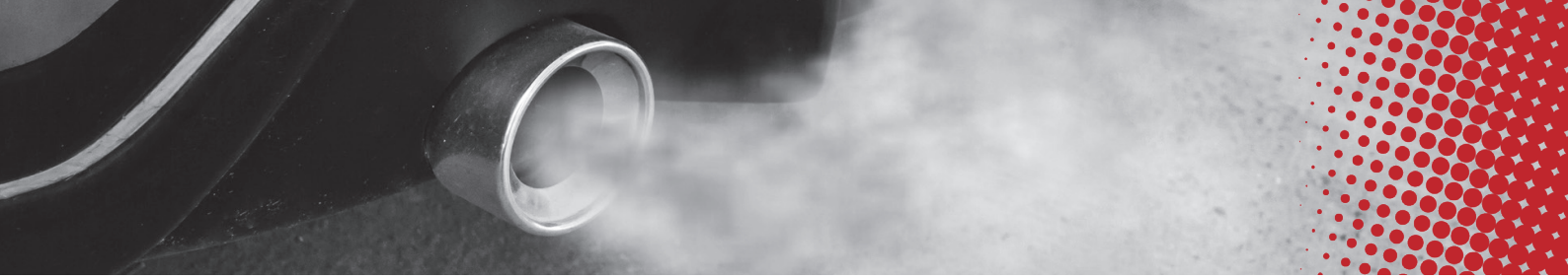
Features

- Fast oxidation flow reactor for secondary aerosol formation studies
- Constant and laminar reactor flow with short residence time and negligible fine particle losses
- Up to 1 month photochemical age for aerosol
- Ozone generation and measurement
- Humidity control and measurement
- Flow control and measurement
- Adjustable UV intensity with 12 UVC lamps operating at 254 nm
- Integrated UV sensor for light intensity measurement
- Integrated cooling for UV lamps
- Integrated ejector diluter to maintain reactor sample flow and for diluting the sample for measurement instruments
- Compact and portable design
- PC software for easy and automated control and data logging





Example of vehicle exhaust measurements: particle size distributions and PAM measured with HR-ELPI®+ after DOFR™ with different UVC intensity settings.



Dekati® Oxidation Flow Reactor DOFR™

Specifications

Sample temperature	0 - 60 °C
Sample pressure	Ambient
Reactor residence time	~ 40 s
Photochemical aging time	Adjustable, up to 1 month
Inlet/sample reactor	3-7 lpm, recommended default flow rate 5 lpm
Outlet flow rate	~ 50 lpm
Primary dilution factor	1.2 - 10
Ejector diluter dilution factor	~10
Dilution air	Clean and dry dilution air, 5 bar abs., max 60 slpm
Dilution air connection	G1/4" female, quick connector included
UV source wavelength	254 nm
Ozone concentration range	0 - 100 ppm
Power requirements	250 W at 230 V, 300 W at 110 V
Weight	36 kg reactor unit, 35 kg sample conditioning unit
Dimensions	W120 x L42 x H24 cm, 2 pcs (reactor and sample conditioning unit)

DOFR™ oxidation chamber is made of clear glass and surrounded with 12 UVC lamps operating at 254 nm.

DOFR™ complete setup

- Sample conditioning unit
- Laminar flow OFR
- PC user interface

Instruments for full secondary aerosol measurement system

- Particle measurement instrument, for example Dekati® ELPI®+
- Option to measure with mass spectrometer and gas analyzers
- Primary dilution system (e.g. Dekati® eDiluter™ Pro)

Acknowledgements

The DOFR™ instrument originated through work carried out at the Aerosol Research Group at Tampere University, Tampere, Finland.

For more information, please contact:
sales@dekati.com

DEKATI Since 1993

Dekati Ltd. is a world leader in designing and manufacturing innovative fine particle measurement solutions. We have 30 years of experience in providing measurement instruments and complete measurement solutions to a wide variety of environments and sample conditions. All Dekati® Products are developed and manufactured in Finland and are available with up to five-year warranty.

ISO 9001 BUREAU VERITAS Certification

05/2023