ELECTRICAL AEROSOL SPECTROMETER

Electrical Aerosol Spectrometer (EAS) is a device for the real-time measurement of aerosol particle size distribution (size spectrum): distribution of the number, diameter, surface or volume of the particles according to their size (equivalent diameter quite near to Stokes diameter). EAS is especially suitable for the monitoring of atmospheric aerosols. EAS is a unique instrument among aerosol spectrometers by

- wide measurement range according to particle diameter (3 nm - 10 m),
- high time resolution (down to 1 sec per spectrum),
- ability to work by highly fluctuating particle concentration.

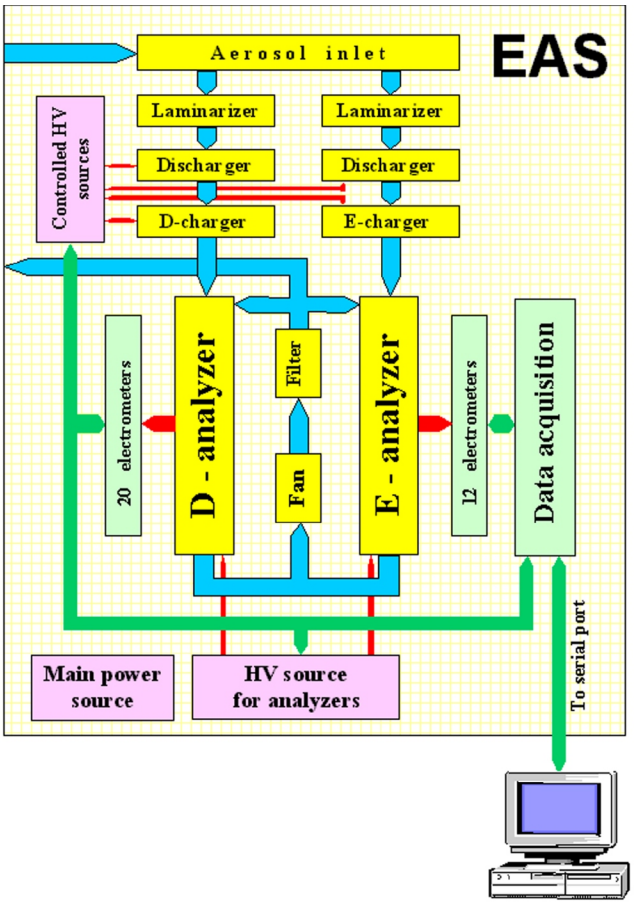
EAS needs no consumables and can continuously monitor aerosol spectrum for months without servicing. EAS can be switched into the Internet, which allows long-distance monitoring and long-distance diagnostics of the repair of the apparatus;

All the mechanical and electronic parts of EAS are mounted in one box; no other external units but a computer and two cables (power cord and signal cable between EAS and computer) are needed. By means of an interactive user interface, the computer controls the measuring process, performs the diagnostics of the regime parameters of EAS, and processes the data in real time. Results of data processing can be stored on the hard disc of the computer. Raw data and results of the diagnostics can be stored as well, to enable further analysis and checking of the quality of measurements.

Operation principle

EAS operates on the electrical principle of aerosol size spectrum measurement. Two differential mobility analysers provided with two different unipolar chargers (weak electric field or diffusion, and strong electric field chargers) enable to measure the particles in an extremely wide size range. Electrical detection of the charged particles enables to use the multichannel (parallel) measurement method in EAS. All the particles are simultaneously collected by the multielectrode collecting system, each electrode of which is provided with its own electrometer. The method has several advantages:

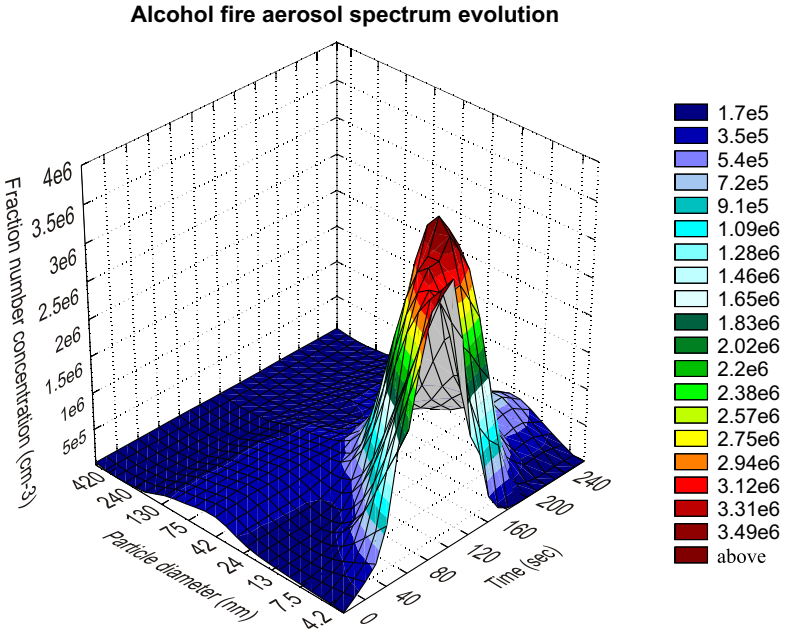
- A representative average spectrum is obtained over the measurement period even for spatially inhomogeneous and fluctuating aerosols. Dynamic measurement errors are avoided and the statistical characteristics of rapid aerosol variations are correctly provided.
- A high time resolution is achieved, and quick changes in the shape of aerosol spectrum and particle concentration can easily be followed.



Sheath air for differential mobility analysers is obtained when the input aerosol is cleaned, using the mobility analysers as filters, and by a complementary electric filter. Therefore, all gaseous phase parameters of the aerosol and sheath air are approximately the same, and EAS measures particles almost in situ conditions. A built-in fan-type air pump is used.

The charging conditions in chargers are stabilised by the controlling of charging currents. To exclude the impact of parasitic currents generated by the insulators, and the zero drift of the electrometers, the input signals are modulated by modulating the process of charging. The offset level and noise of the electrometers are recorded using the opposite polarity of the particle charge, from these records the random measurement errors are calculated. The number of measurement channels is redundant when compared with the number of calculated fraction concentrations. Thus the estimation of channel errors is used to balance the weights of channel signals, enabling to suppress the effect of noise in any single channel.

A special calibration procedure based on the mathematical model of the spectrometer and the experimental determination of some free parameters of such model make it possible to convert the response of the apparatus, determined by mobility distribution, directly into size distribution.



Applications

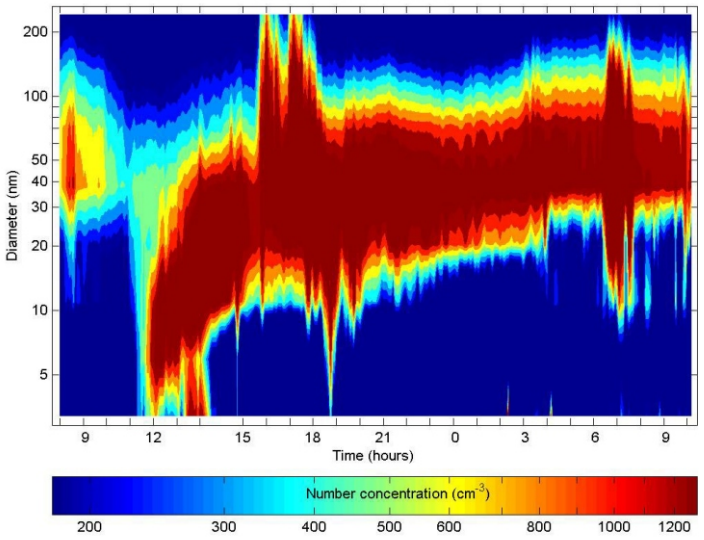
Wide particle size range, high reliability and capability for long-run work without any servicing makes EAS ideal for long-term continuous monitoring of atmospheric aerosols in environmental research. High time resolution enables to analyse quick particle concentration changes and the evolution of a size spectrum. Field of application includes:

- Monitoring of atmospheric aerosols
- Monitoring of indoor air pollution
- Combustion aerosol studies
- Particle size distribution measurement in automobile exhaust
- Air filter testing
- Technology of pulverised materials
- Laboratory aerosol research

Specifications

- The instrument's measuring range according to the particle diameter is from 3.2 nm to 10 m. Maximum achievable size resolution is 8 fractions per decade of diameter; standard software enables resolution of 4 fractions per decade. Fraction boundaries are distributed uniformly on the logarithmic scale of diameter.
- The measuring range according to the particle concentration is limited by the sensitivity and the dynamic range of electrometers and the quality of chargers. It is also dependent on the particle size. For the fractions (3.2 - 5.6) nm, (10-18) nm, (100 - 180) nm, (1.0 - 1.8) m, and (5.6 - 10) m, the measuring ranges are, accordingly: ($1X10^{2}$ - $1X10^{6}$), ($1X10^{2}$ - $1X10^{6}$), ($1X10^{1}$ - $2X10^{4}$), ($3X10^{-1}$ - $1X10^{3}$) and ($2X10^{-2}$ - $5X10^{1}$) particles per cm^{3}.
- Inlet aerosol flow rate is 800 cm^{3} sec^{-1}.
- The duration of one measurement cycle is controlled by software and can be set from 1 s to several tens of minutes. Maximum time resolution is achievable for high-concentration aerosols. Sensitivity and signal-to-noise ratio can be improved by lengthening the measuring time.
- Computer requirements: 486 DX, 8 MB RAM, DOS (as a minimum).
- Dimensions: H 820 W 580 D 310 mm.
- Mass: 60 kg.

Evolution of the atmospheric aerosol size spectrum
4.- 5. September, 1998, Tahkuse, Estonia



EAS was developed in the Institute of Environmental Physics of the University of Tartu as a result of the 20-year research and developing work. The latest version of EAS has been built by AIREL Ltd.

Airel Ltd. offers EAS which can be designed and built according to special requirements of the customer. Airel Ltd. offers the service of measurements with EAS in compliance with the customer's needs.

The air ion mobility spectrometer is in the development phase.

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