



NGN-3 PM_{2.5} Size-Cut and Heated Nephelometer

Introduction

The Optec NGN-3 size-cut and heated integrating nephelometer measures dry PM_{2.5} aerosol scattering and can be used as a surrogate for PM_{2.5} mass sampling. The NGN-3 combines the optical design of the NGN-2 ambient nephelometer with an external 2.5 μm size-cut device, an inline sample heater, and well-regulated flow control. The NGN-3 features low power consumption, a rugged compact design, and quick and easy installation and operation.

Air Resource Specialists, Inc. (ARS), has successfully deployed the NGN-3 to monitor dry particle scattering and PM_{2.5} mass in urban and rural areas. ARS is experienced in all aspects of successful monitoring, including installation, training, calibration, servicing, data reduction, analysis, and reporting.

Concept

Continuous measurement of fine particulates is critical to an understanding of air quality dynamics. In the past, aerosol mass measurements have primarily been performed with filter-based sampling devices that require laboratory analyses of

collected filters. Filter measurements generally have sample integration times of hours to a day and filter analyses can take days to months. The Optec NGN-3 PM_{2.5} size-cut and heated nephelometer provides a scattering-based surrogate for real-time continuous PM_{2.5} mass measurements at two-minute intervals.

The NGN-3 estimates the dry PM_{2.5} aerosol scattering coefficient (b_{sp}) by directly measuring the light scattered by size-cut and heated airborne aerosols in a sampled air volume. Scattered radiation from an illumination source is integrated over a large range of scattering angles, in a defined band of visible wavelengths.

The NGN-3 (as well as the NGN-2 ambient nephelometer) overcomes some of the severe limitations associated with older nephelometer designs, namely a poorly-defined optical response, a large scattering angle truncation error, and unstable electronics. The NGN-3 features well-tested, high-quality optics, a 5° - 175° integration angle, and stable solid-state electronics. The instrument also includes an external well-characterized size-cut inlet, a thermostatically controlled sample heater, and a flow control system based on a critical orifice, a long-life pump, and inline pressure transducers.

Primary Features Optec NGN-3 Size-Cut Integrating Nephelometer

Size-Cut and Heated Design

- Continuous accurate measurement of dry PM_{2.5} aerosol scattering
- Scattering measurement is used as a surrogate for PM_{2.5} mass
- Well-defined optical response characteristics
- Compact, low-maintenance size-cut device
- Monitoring of ambient and chamber temperature to ensure drying of aerosols
- Sample flow controlled via a variable pump, critical orifice, and pressure transducers

Flexible Input/Output

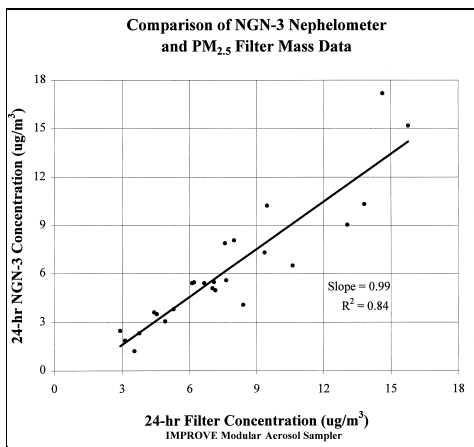
- Large liquid crystal display (LCD) interface with associated keypad
- LCD interface displays current scattering and mass value
- Initiation of calibration checks from instrument keypad
- RS232 and analog outputs for data collection via datalogger or computer
- Easy access to parameter settings via instrument keypad or external computer (RS232 input)

Solid-State Electronics

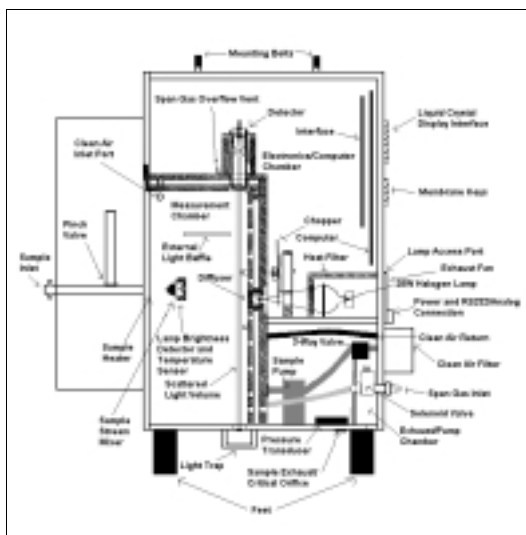
- Stable and repeatable clean air and span gas calibrations
- Automatic clean air calibrations at user-selected intervals
- User-selectable sampling modes
- Internal computer monitors and controls operation, performs and outputs diagnostics

Support Requirements

- Designed to operate indoors with an outdoor sampling inlet
- Operates off of a small 13.8 VDC, 10 amp power supply
- Minimal on-site servicing required; annual maintenance recommended
- Analog or serial datalogger or computer required to collect data



Plot Comparing NGN-3 Data With IMPROVE Modular Aerosol Sampler Data



NGN-3 Size-Cut Nephelometer Schematic

The freestanding NGN-3 nephelometer features an external liquid crystal display interface and connection for power and RS232 and analog outputs. An internal CMOS computer controls all operating functions of the NGN-3 which include:

- Dry PM_{2.5} aerosol scattering and mass measurement
- Automatic clean air calibrations
- Manually initiated clean air and span calibration checks
- Sample flow control
- Ambient and optical chamber temperature measurements (the chamber temperature is kept approximately 10°C above ambient temperature)
- System diagnostic tests

Data collection is normally performed with an on-site datalogger. By using a modem, data collection and communication with the instrument can also be done remotely.

Instrument Specifications

The NGN-3 size-cut and heated integrating nephelometer is manufactured by Optec, Inc. This new nephelometer is based on the same high-quality optics, stable solid-state electronics, and rugged design as the popular NGN-2 ambient nephelometer, which was developed to meet the needs of the Interagency Monitoring of Protected Visual Environments (IMPROVE), National Park Service, and other visibility monitoring programs. The NGN-3 is specifically designed to continuously monitor dry PM_{2.5} aerosol scattering and PM_{2.5} mass. Instrument specifications include:

- Effective Center Wavelength: 550 nm, with wide visible band pass
- Scattering Angle Integration: 5° to 175°
- Measurement Range: 0 Mm⁻¹ to over 30,000 Mm⁻¹
0 μg/m³ to over 10,000 μg/m³
- Resolution: Approx. ± 1 Mm⁻¹ or ± 0.3 μg/m³
- Size-cut Spiral Inlet: Size-cuts aerosols to 2.5 μm at 7 LPM sample flow
Recommended monthly cleaning (weekly in dirty environments)
- Clean Air Calibrations: Automatic at user-specified intervals
- Calibration Checks: Manual clean air and span calibration checks recommended monthly
- Span Gas: SUVA 134a refrigerant
- Data Input/Output: LCD interface with keypad for current data and parameter setting
RS232 and analog outputs for data collection
- Power Requirements: 13.8 VDC, 10 amp power supply
- Operating Temperature: -20°C to 45°C
- Operating Humidity: 0% to 100% RH
- Ambient and Sample Chamber Temperatures: Chamber kept approximately 10°C above ambient

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