Model 714 $NO_2/NO/O_3$ Calibration Source

Calibrate 3 Gases Using One Convenient Instrument

The Model 714 $NO_2/NO/O_3$ Calibration Source™ combines our Model 408 Nitric Oxide Calibration Source™ with our Model 306 Ozone Calibration Source™ to provide a highly portable transfer standard for three pollutant gases without the need for a compressed cylinder of nitric oxide. Calibrated concentrations of O_3 are produced by photolysis of oxygen in scrubbed ambient air, and calibrated concentrations of NO are produced by photolysis of nitrous oxide, N_2O, via a patent-pending process,

$$N_2O + h\nu \rightarrow N_2 + O^*$$

$$O^* + N_2O \rightarrow 2\,NO$$

where O* is electronically excited oxygen atoms, $O(^1D_2)$. In addition, calibrated concentrations of NO_2 are produced by gas phase titration (GPT) of NO with O_3 using the same method as conventional GPT NO/NO_2 calibrators. The concentrations of all three pollutant gases are directly traceable to the NIST photometric standard for ozone – eliminating uncertainties associated with the stability of nitric oxide standards.

Nitrous oxide is provided by disposable 8 or 16 oz cartridges typically used for making whipped cream, eliminating the requirement for a compressed gas cylinder and thereby enhancing safety and portability. The Model 714 is designed to accompany sales of our new FEM Model 405 nm $NO_2/NO/NO_x$ Monitor and replace current calibration systems for all ozone, NO and NO_2 monitors. The Model 714, which has an intuitive touch screen user interface, is provided in a rack mount-sized instrument case matching that of the Model 405 nm.

Small and inexpensive N_2O cartridges for your calibrations!

2B Technologies, 2100 Central Ave., Suite 105, Boulder, Colorado 80301, USA
Phone: +1(303)273-0559, Fax: +1(303)-277-1812, www.twobtech.com

Specifications: Model 714 NO_2/NO/O_3 Calibration Source

Method of NO Production	UV photolysis of Nitrous Oxide (N_2O) at 185 nm
Method of O_3 Production	UV photolysis of Oxygen (O_2) at 185 nm
Method of NO_2 Production	Reaction of O_3 with excess NO (gas-phase titration, GPT)
NO_2 Concentration Range	0-500 parts per billion by volume (ppb)
O_3 Concentration Range	0-500 ppb
NO Concentration Range	0-1000 ppb
Output Flow Rate	~2.0 to 3.5 L/min volumetric (2.5-3.0 typical)
Precision and Accuracy	Greater of 2.0 ppb or 2.0% of NO or O_3 concentration
Response Time for Change in Calibrant Gas Output Concentration	< 30 s to reach 95% of selected concentration
Input and Output	Touch Screen LCD Display
Dimensions	Rackmount: 17" w × 14.5" d × 5.5" h (43 × 37 × 14 cm)
Weight	15.5 lb (7.0 kg)
Power Requirements	120/240 V AC with 5-amp power pack, or 12V DC; 1.5 A at 12V,18 watt (operation) Max: 3.5 A at 12V, 42 watt (warmup)
Programmable Calibrated Gas Output	Yes, up to 99 different repeatable sequences may be specified by the user for NO, NO_2 or O_3 output, with up to 15 steps for each sequence from 0 to 500 ppb for O_3 and NO_2 (1000 ppb for NO); stored in internal memory
Transportation and Temperature Storage Ranges	−20°C to 60°C
Relative Humidity Range	0-80%, non-condensing
Altitude Range	0-2000 meters

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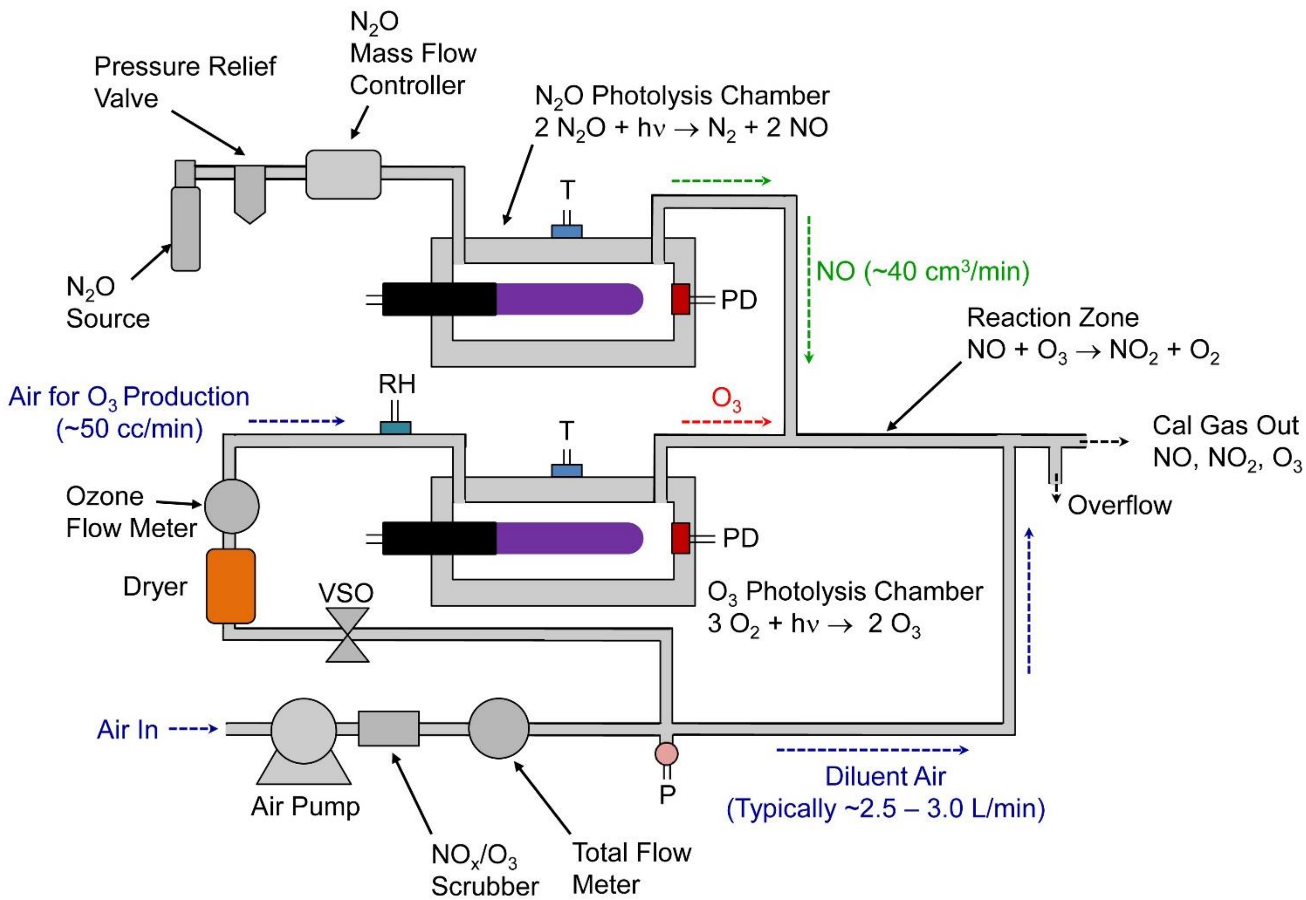
Theory of Operation

The Model 714 NO_2/NO/O_3 Calibration Source combines the 2B Technologies Model 306 Ozone Calibration Source™ and the Model 408 Nitric Oxide Calibration Source™ to produce calibrated sources of O_3, NO and NO_2. The Model 714 makes use of two low-pressure mercury lamps, one to photolyze oxygen to produce O_3, and a second lamp to photolyze nitrous oxide (N_2O) to produce NO. Nitrogen dioxide is produced in the stoichiometric reaction of O_3 with excess NO to convert NO to NO_2. A schematic of the Model 714 is shown below:



For the production of ozone, a small flow of scrubbed and dried ambient air is directed into the O_3 photolysis chamber (lower part of the diagram). The vacuum UV emission lines of a low-pressure mercury lamp near 185 nm are absorbed by O_2 to produce oxygen atoms, and the oxygen atoms rapidly attach to O_2 via a collisionally stabilized reaction to form O_3. The well-known mechanism, which also is responsible for the presence of Earth's protective ozone layer, is as follows:

$$O_2 + h\nu \rightarrow O + O \quad (1)$$

$$2\,[O + O_2 + M \rightarrow O_3 + M] \quad (2)$$

$$\text{Net: } 3\,O_2 + h\nu \rightarrow 2\,O_3 \quad (3)$$

where hν symbolizes a photon of light and M is any molecule (e.g., N_2, O_2, H_2O, Ar) that removes the energy released in reaction (2). The concentration of O_3 produced in a flowing stream of air depends on the intensity of the photolysis lamp, the concentration of oxygen (determined by pressure and temperature), and the residence time in the photolysis cell (determined by volumetric flow rate and cell volume). By holding these parameters constant, it is possible to produce a flow of air containing a constant concentration of O_3, and the concentration of O_3 produced can be varied most conveniently by varying the lamp intensity. An in-line dryer reduces the humidity of the air stream and enables more precise control of ozone produced in the photolysis chamber.

For the production of NO, a mass flow controller (MFC) directs a ~40 cc/min flow of nitrous oxide from an N_2O cartridge or gas cylinder into the N_2O photolysis chamber (upper part of diagram). The vacuum UV emission lines of a low-pressure mercury lamp near 185 nm are absorbed by N_2O to produce electronically excited oxygen atoms, $O(^1D_2)$. A large fraction (~59%) of these highly energetic oxygen atoms react with N_2O to form NO:

$$N_2O + h\nu \rightarrow N_2 + O(^1D_2) \tag{4}$$

$$O(^1D_2) + N_2O \rightarrow 2\ NO \tag{5}$$

$$\text{Net: } 2\ N_2O + h\nu \rightarrow N_2 + 2\ NO \tag{6}$$

where the term hν represents a photon of light. As for ozone, and the concentration of NO produced can be varied most conveniently by varying the lamp intensity. The nitrous oxide can be supplied by a 16-g or 8-g disposable cartridge (e.g., Whip-It or other whipped cream charger) in the Model 714's Portable N_2O Source, thereby eliminating the need for a compressed gas cylinder.

For the production of nitrogen dioxide, a known concentration of O_3 is reacted with a large excess of NO according to the reaction:

$$NO + O_3 \rightarrow NO_2 + O_2 \tag{7}$$

The NO stream combines with the O_3 stream in the Reaction Zone. In order to avoid complications from secondary reactions, nitric oxide is always generated in excess to completely consume all of the O_3. The concentration of NO_2 produced is equal to the initial ozone concentration. This method of producing known amounts NO_2 equal to the amount of ozone added has long been referred to as the "gas phase titration" (GPT) method. The calibrated NO_2 stream will therefore also contain the excess NO.

By powering the appropriate lamp, one can choose to produce only a calibrated amount of NO, only a calibrated amount of O_3, or one can power both lamps simultaneously to produce a calibrated amount of NO_2.

Features

- Calibrate for NO, NO_2, or O_3 using one instrument
- Low power consumption (~18 watt on average)
- Lightweight (~15.5 lb, 7.0 kg), standard rack-mount size
- Convenient touch screen user interface
- Program up to 99 different sequences, stored in internal memory
- A sequence can have up to 15 steps and can be repeated up to 99 times
- Portable N_2O Source eliminates the need for compressed gas cylinders
- Economical, replacing the use of multiple other commercially available instruments

System Includes

- Model 714 NO_2/NO/O_3 Calibration Source
- Power Adapter (5 amp, 100-240 VAC to 12 VDC) with select power cord
- Portable N_2O Source
- Model 714 Dryer
- Operation Manual on USB Stick
- Calibration Data and NIST-Traceable Calibration Certificate
- Instrument Birth Certificate
- One-Year Warranty