Aircraft NO_2 Converter

Manual

Air Quality Design, Inc.
11919 W. I-70 Frontage Rd.
Unit # 105
Wheatridge, CO 80033
T:303-225-0287
F:303-225-0286
www.airqualitydesign.com

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1. INTRODUCTION

1.1 THEORY

The AQD photolytic NO_2 converter uses an array of ultraviolet light emitting diodes (UV-LED's) to photolyzed NO_2 to NO and ozone per Reaction 1, which may be subsequently measured by chemiluminescence or another suitable method.

Reaction 1: $NO_2 + h\nu \rightarrow NO + O_3$ (for $h\nu$ = 350-400 nm)

Reaction 2: $NO + O_3 \rightarrow NO_2$

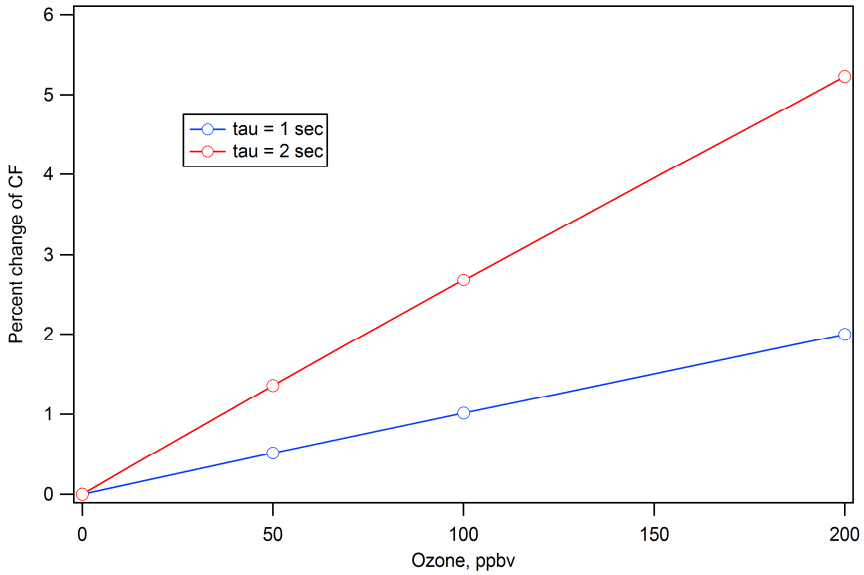
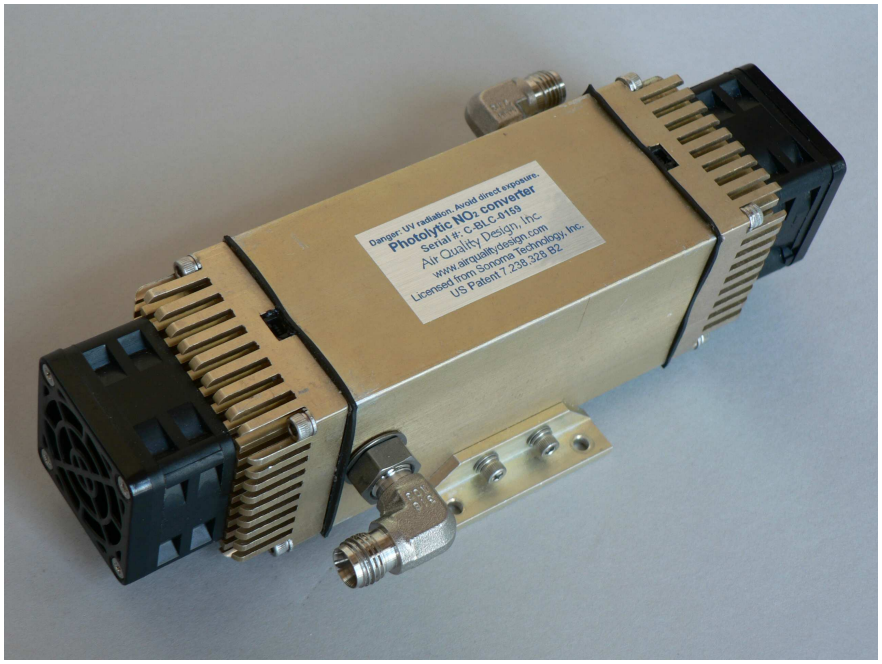


Figure 1-1. Percent change of the NO_2 conversion efficiency as a function of the ambient and produced ozone in the sample. For a residence time of 1 second the error introduced is less than 2%.

Since the reverse reaction (Reaction 2) occurs fairly quickly it is important that reaction 1 takes place in 1-2 seconds, followed shortly by measurement of the resulting product. Figure 1-1 shows the effect of the back titration of the produced NO on conversion efficiency as a function of the concentration of ambient and produced ozone.

1.2 CONVERTER OVERVIEW



The physical and performance characteristics of the AQD NO_2 converter include:

- High efficiency ($\geq$50% NO_2 conversion/second)
- Highly specific for NO_2
- Negligible radiant heating of the sample gas
- 1 second residence time for 1 SLPM at low pressure (200 Torr)
- Long light-source life (estimated >5,000 hours)
- Integrated lamp control circuit and remote on/off
- Power consumption: 30 W, 24 VDC; optional AC/DC or DC/DC power supply available
- Converter weight: 0.8 kg
- Converter size: 75 mm (w) x 55 mm (h) x 215 mm (l)
- Patented technology

Danger: UV radiation. Avoid direct exposure.
Photolytic NO_2 converter

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US Patent 7,238,328 B2

2. INSTALLATION AND USE

2.1 ELECTRICAL CONNECTIONS

The AQD NO_2 converter is shipped with two three-wire cables for connecting each of the two lamps to a user supplied power supply (optional 24 VDC power supply is available from AQD in either AC-DC or DC-DC configuration). Power for each lamp requires 24-28 VDC at 30 W. The cables may be wired in parallel and should be connected per Table 2-1.

Table 2-1. Electrical connections

Wire	Color	Connection
1	Red	+24 VDC
2	black	Power common
3	white	Remote on/off

The remote on/off turns the UV-LED's on by connecting the white wire to 5-30 VDC (typically a TTL digital output from a data system may be used). The converter cooling fans operate whenever power is applied.

2.2 PLUMBING CONNECTIONS

The plumbing connections for the converter are simply in and out with the two sides equivalent. To minimize post-photolysis back titration the converter should be either:

1. located in close proximity to the detector, or

2. for chemiluminescence detectors the flow control element (critical orifice or mass flow controller) should be located closely downstream of the converter.

Note that the converter is designed to operate at reduced pressure (nominally 250 torr) so the converter should be installed downstream of a pressure controller. A flow control element should be installed downstream of the converter.

3. CONVERSION EFFICIENCY CALCULATIONS

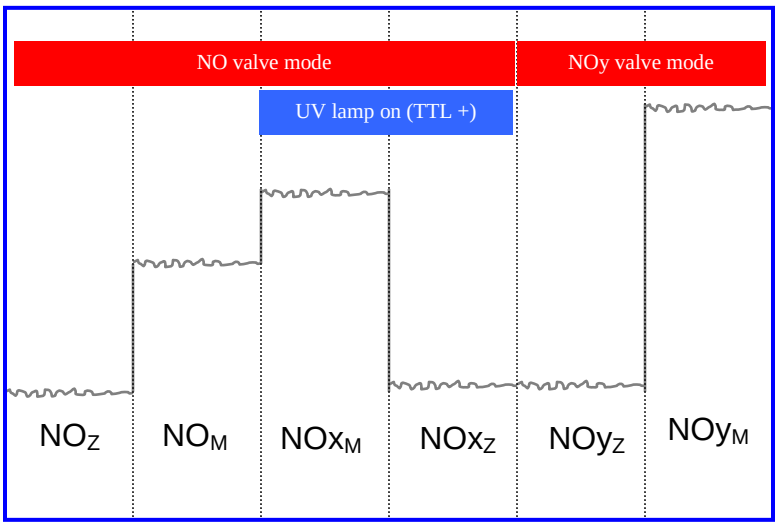

Figure 3-1. Example diagram of the sampling modes for a NO-NO_2-NO_y system.

1. $[NO] = (NO_M - NO_Z) / NO_{SENS}$

   Where: NO_M = NO concentration in measure mode
   NO_Z = NO concentration in zero mode
   NO_{SENS} = NO response factor

2. $[NO_2] = ((NOx_M - NOx_Z) - (NO_M - NO_Z)) / NO_{2SENS}$

   Where: NOx_M = NOx concentration in measure mode
   NOx_Z = NOx concentration in zero mode
   NO_{2SENS} = NO_2 response factor

3. $[NOy] = (NOy_M - NOy_Z) / NOy_{SENS}$

   Where: NOy_M = NOy concentration in measure mode
   NOy_Z = NOy concentration in zero mode
   NOy_{SENS} = NOy response factor

[1] For systems using photon counting the response factors are calculated in units of counts per second per ppb (cps/ppb) in the form:

NO_{SENS} = (cal_counts – measure_counts) / cal_concentration.

In the TEI way of calibrating NO_{SENS} would be 1.0 +/- and would be multiplied instead of divided.

[1] Similar to the NO_{sens} calculation, the NO2SENS calc is presented in terms of cps/ppb as:

$NO2_{SENS} = NO_{SENS} * NO_2CE$

Where: $NO_2CE = ((NOx_T\text{-}NOx_{TZ})\text{-}(NO_T\text{-}NO_{TZ})) / ((NOx_C - NOx_{CZ}) - (NO_T\text{-}NO_{TZ}))$

[1] For systems using photon counting the response factors are calculated in units of cps/ppb of NOx) in the form:

NOy_{SENS} = (cal_counts – measure_counts) / cal_concentration.

4. PHYSICAL DIMENSIONS