User Instruction
& Maintenance Manual

Manual No. Y-17750A

Nitrogen Analyzer

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Vacu•Med

4538 Westinghouse Street

Ventura CA 93003

Tel: (805) 644-7461

FAX: (805) 654-8759

www.vacumed.com

17750Amnl.vp

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Specifications

Gas Sampling Rate:	3 – 10 ml/min
Vacuum Inlet:	2 mmH_g typical, provided by vacuum pump
Operating Range:	0 – 80% Nitrogen
Display Resolution:	0.1%
Accuracy:	±0.5% from 0 – 80% dry N_2 in O_2
Rise Time:	10% to 90% < 30 ms
Fall Time:	90% to 10% < 30 ms
Delay Time:	< 75 ms
Rear Panel Analog Output:	1 volt ± 0.01 volt for a 10% N_2 reading
Controls:	Front panel Zero and Span. Adjustable needle valve.
Readout Rate of Display:	2.5 readings per second
Power Rating:	100-240 volts ac 50/60Hz, approximately 15VA, CSA approved class 2G for hospital use
Fuse:	1A 250V MDL
Weight (less pump):	2 Kg
Dimensions:	8.25” (21 cm) W x 1.75” (4.45 cm) H x 10” (25.4 cm) D
Vacuum tubing:	Tygon R-3603
Sample inlet tubing:	Clippard 3814-5

Specifications subject to change without notice

References

1) A Simple Method for Measuring Functional Residual Capacity by N2 Washout in Small Animals and Newborn Infants. Tilo Gerhardt, et al. Pediatric Research, vol 19, No 11, 1985.

2) H-P Vertek Series 3500VR Nitrogen Analyzer operating guide, part number 47302-91998

3) CRC Handbook of Chemistry and Physics

1. General Information

Introduction

The Model 17750A Nitrogen Analyzer detects the nitrogen concentration in a gas sample by measuring the light produced from a high voltage ionization tube. It is frequently used for medical research applications and when combined with a data acquisition system and a pneumotach, may be used to perform single and multiple breath nitrogen washout and closing volume studies.

Description

The instrument is shipped as two components; the analyzer itself, and a separate vacuum pump to be placed under the table or on the bottom of an instrument cart. In operation, the vacuum pump draws the gas sample through a needle valve and into an ionization chamber. Within this chamber, the gas sample is ionized by a high voltage field and the light emitted by the ionized gas (which is proportional to the percentage of nitrogen in the sample) is filtered by a narrow band optical filter and measured by a photodiode. The small electrical signal variations are then further amplified, filtered and linearized to produce a 0 – 8 volt full scale signal which is presented on a 3-1/2 digit display on the front panel and to a BNC connector on the rear panel for recording.

The device is considerably smaller than previous designs and does not require a separate head-stage. The only operating controls are the needle valve and front panel zero and span dials.

Unpacking

Before opening the crate, check for obvious damage. Try to do this at the time you receive it from the transportation company, or within three days thereafter. Any delay and the transportation company will say you caused the damage. If any damage is visible, take photographs and immediately call the transportation company that delivered the system to you and report the damage. Ask how to file a claim for damages, and write down the name of the person you talked to. Save all shipping boxes, the transportation company will want to inspect them.

Check List

The shipment will be accompanied by a System Final Test Check List verifying final test results and listing accessories shipped with your system. Check off each item on this check list. As you unpack go through the packing material carefully to avoid discarding small parts.

2. Installation

The instrument location should be free from excessive vibration, dust, and humidity. For cabinet-mounted installations, provide sufficient room at the front and rear for operating and servicing the instrument with the cabinet doors open, and at the top and bottom to permit natural air convection to cool the unit. For open mounting, the vacuum pump should be placed in an out-of-the way location to minimize noise. The maximum recommended distance that the vacuum pump can be located from the analyzer is about 20 feet (6 meter).

Attach the ½" (1.27 cm) ID heavy wall vacuum pump tubing (Tygon R-3603) to the pump fitting and tighten snugly. Attach the other end to the rear panel of the analyzer, to the quick-disconnect fitting labeled "Vacuum Pump".

Attach one end of the 1/16" (1.59 mm) ID sample tubing to the sample inlet on the front of the analyzer. The other end of this tubing connects to a fixed orifice of .041" (1 mm) (purple color) and then to the needle valve's side port. The maximum recommended length of the sample tubing is 10' (3 meter).

The actual nitrogen gas sampling site is the end port of the needle valve and it is recommended that you do not attach any length of tubing to this port as it will severely limit the system's response time. For maximum speed, the needle valve can be cemented into a plastic coupler that is then inserted into the breathing circuit.

4. Operation

SPECIAL NOTE

THE EFFECTS OF INTERFERING GASES

Sulfurhexafluoride (SF_6). The presence of sulfurhexafluoride, even in small concentrations, has a great effect on the accuracy of the nitrogen analyzer. Concentrations as little as 0.1% can cause a noticeable increase in the nitrogen reading when present in room air. At SF_6 concentrations above 10%, the $\%N_2$ reading will begin to decrease, going to zero somewhere between 18% and 30% in ambient air.

Helium/Oxygen Mixtures. The relative nitrogen concentration in a helium/oxygen mixture may require special modifications: Contact VacuMed.

5. Set-Up Procedure

Each day the analyzer is used, the needle valve should be adjusted as follows for a peak reading, and the analyzer's circuits set to compensate for ambient nitrogen concentration, which will vary from day to day with temperature and humidity.

Needle Valve Adjustment

Figure 1: The needle valve and fixed orifice

Turn on the analyzer power switch, located on the rear panel of the instrument. The display should read ± 00.1.

a. Turn the vacuum pump valve to the "closed" position, apply power to the vacuum pump and then turn the valve to the "open" position. Run the pump for at least 10 minutes to warm up the oil.

b. The digital display should show a reading of between 60% and 80%.

Note: *If the display still reads ±00.1, adjust the needle valve slowly in the clockwise direction until a reading is obtained. Do not turn past the point where a resistance is first felt. If a reading is still not obtained, make sure the vacuum pump valve is set to the "open" position, and that all connections are secure. Also check that the air-bleed valve on the vacuum pump is turned tightly clockwise.*

c. Turn the needle valve clockwise until a slight resistance to further rotation is felt. (Do not over-tighten) and the digital display begins to decrease in value.

d. Turn the needle valve slowly counter-clockwise in order to obtain a peak reading on the digital display. Make a note of this reading.

e. Keep turning the needle valve counter-clockwise until the reading begins to fall again.

f. Turn the needle valve clockwise again, little by little, until the same peak reading as before is obtained.

Zero Adjustment

Direct a stream of pure oxygen onto the sample inlet port of the needle valve and wait until the output stabilizes. Adjust the zero control until the digital display reads 00.0 and lock the control.

Span Adjustment

Once the nitrogen detector has been set to peak sensitivity with the needle valve and the zero has been set, the front panel span control can be used to adjust the analyzer to the room air %N_2 (wet). The %N_2 (wet) can be found by the following formula:

$$\%N2\ (wet) = 78\% \times \frac{Patm - PH_2O}{Patm}$$

where:

PH_2O = partial pressure of water vapour at 100% relative humidity (from table 1)

Patm = barometric pressure in mmHg

78% = the percentage of nitrogen in a dry atmosphere

T °C	PH_2O (mmH_g)
20	17.5
21	18.7
22	19.8
23	21.1
24	22.4
25	23.8
26	25.2
27	26.7
28	28.3
29	30.0
30	31.8
31	33.7
32	35.7
33	37.7
34	39.9
35	42.2
36	44.6
37	47.0

← Table 1

Partial Pressure of Water Vapour at 100% Relative Humidity for Various Temperatures.

For example, assume a room temperature of 25°C, a 60% relative humidity and an atmospheric pressure of 760mmH_g.

From the table, the 100% PH_2O for 25°C is equal to 23.8 mmH_g.

Since the humidity is 60%, the actual PH_2O is 23.8 x .6 = 14.3 mmH_g.

Substitute values into the equation:

$$78\% \times \frac{760-14.3}{760}$$

= 76.5% N_2(wet).

Turn the span control on the front panel until a reading of 76.5% is obtained, then lock the control.

Vacuum Pump Connections

Figure 2, the vacuum pump (typical model shown).

The vacuum pump is shipped dry and must be filled prior to first use. With the power off, remove the black plastic fill plug on the top of the vacuum pump. Using a funnel, pour in just sufficient oil to bring the level up to the indicated line on the sight glass (approx. 400ml). Do not overfill. If too much oil is added, drain some by opening the drain plug on the bottom of the pump. Run the pump for a few minutes, turn off and recheck the level.

The oil should be replaced if pumping efficiency is low, for example if it takes longer for the analyzer to achieve a stable nitrogen reading upon start up, and at least annually.

The supplied oil is standard high-vacuum pump oil. A material safety sheet is included at the end of this manual.

Shut Down Procedure

It is recommended that the vacuum pump valve be turned to the “closed” position prior to shutting off as this will prevent oil from backing up into the analyzer in case of failure of the automatic check valve.

It is also suggested that the analyzer power be turned off whenever the vacuum pump is off.

Analyzer Maintentance Procedure

The analyzer has no user-serviceable components. Dangerous voltages are present in several exposed locations inside the analyzer and it is recommended that all servicing be provided by the authorized distributor or by VacuMed. Refer to Appendix III for the recommended preventive maintenance schedule and list of spare parts.

Appendix I

Effects of Extended Sample Tubing Lengths on Analyzer Performance

Since the 17750A can be situated remotely from the measuring site, it is useful to consider what effect a long length of sample tubing will have on the delay and response time to a step signal. We ran tests using two lengths of sample tubing, one 8” (200mm) and the other 89” (2.25m) long. These were connected from the inlet port of the 17750A to the fixed orifice/needle valve combination.

Note: *It is important to always use the shortest possible tubing to connect the fixed orifice to the needle valve. Also, whenever possible, insert the sampling port of the needle valve directly into the gas mixture to be measured without any attached tubing. Any length of tubing at this point will have a significant effect on the response time.*

The test gas was switched from 100% oxygen to a 20% oxygen 80% nitrogen mixture using a 3-way solenoid valve having an actuation time of less than 10 ms.

Short Tubing (8" - 20 cm)

Risetime:	28 ms
Falltime:	26 ms
Delay time from 0% to 80% nitrogen:	74 ms
Delay time from 80% to 0% nitrogen:	72 ms

Long Tubing (89” - 2.25 m)

Risetime:	36 ms
Falltime:	52 ms
Delay time from 0% to 80% nitrogen:	660 ms
Delay time from 80% to 0% nitrogen:	670 ms

The rise and fall time was measured as the time required for the output signal to change from 10% to 90% of its final value. The delay time was measured from the instant the solenoid valve was switched, to the time when the output signal reached 50% of its final value.

Discussion

The response time of the 17750A is only minimally affected by long lengths of sample tubing and should not be a factor in respiratory measurements with lengths up to 10 feet or more. The signal delay time is in direct proportion to the length of the sample tubing and can become significant with longer runs. The fact that the signal delay is easily measured and is constant for any given setup however, allows for easy compensation in the data analysis.

Appendix II

Effects of Tubing Type of Analyzer Performance

In the course of measuring the preceding response time data, it was noticed that long lengths of certain types of tubing produced an unstable nitrogen reading. This was especially true when the tubing was flexed or otherwise manipulated during the course of a measurement. This is thought to be the result of outgassing of the material in the partial vacuum of the sample inlet circuit. Our tests have not been exhaustive, but it was found that tubing made of polyurethane performed the worst, while clear PVC tubing made by the Clippard Instrument Company, part number 3814-5, performed the best. We are currently supplying this brand of inlet tubing with all analyzer shipments. Other tubing types should be individually evaluated before their use is considered.

Appendix III

Model 17750A Nitrogen Analyzer Maintenance Schedule and Spare Parts

Preventive Maintenance:

Every 90 days of operation:	change vacuum pump oil
Every 12 months of operation:	change needle valve and fixed orifice
Every 24 months of operation:	check vacuum lines and replace if necessary clean sample cell and adjust linearity*

Spare Parts:

Vacuum pump oil:	P/N Y215-001
Needle valve and orifice kit:	P/N Y215-002
Vacuum tubing and sample tubing kit:	P/N Y215-003

*This procedure requires special equipment. It is recommended that the 17750A unit be returned to the factory for re-certification

Revision History

22 March 2001: Initial release