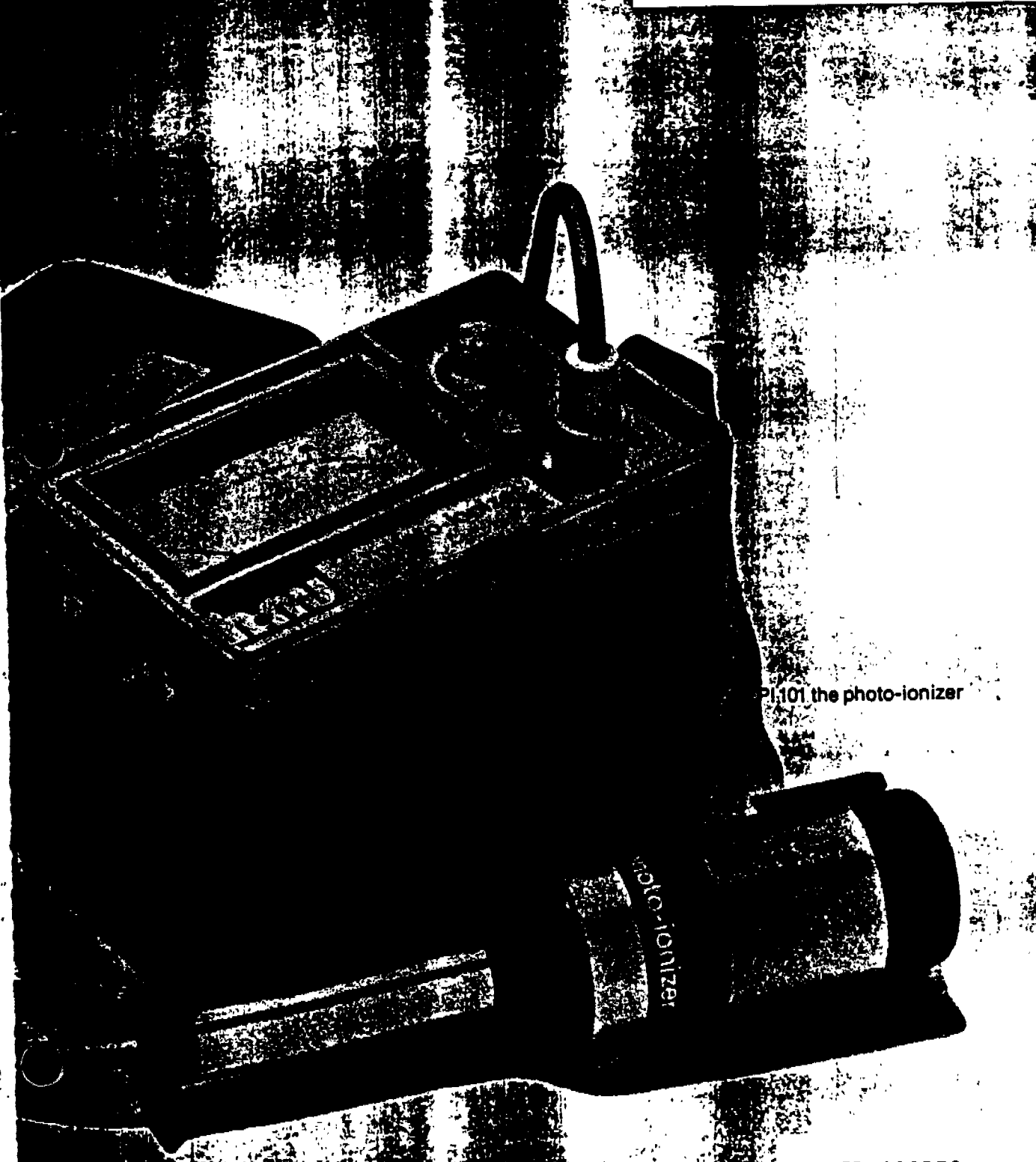


HNU Systems, Inc. 30 Ossipee Road Newton Upper Falls, Massachusetts 02164 **UNIVERSITY MICROFILMS**

Trace gas analysis by photoionization



PI-101 the photo-ionizer

SL 090358

APPROVED FOR CLASS 1 DIV. 2 GROUPS A B C & D HAZARDOUS LOCATIONS

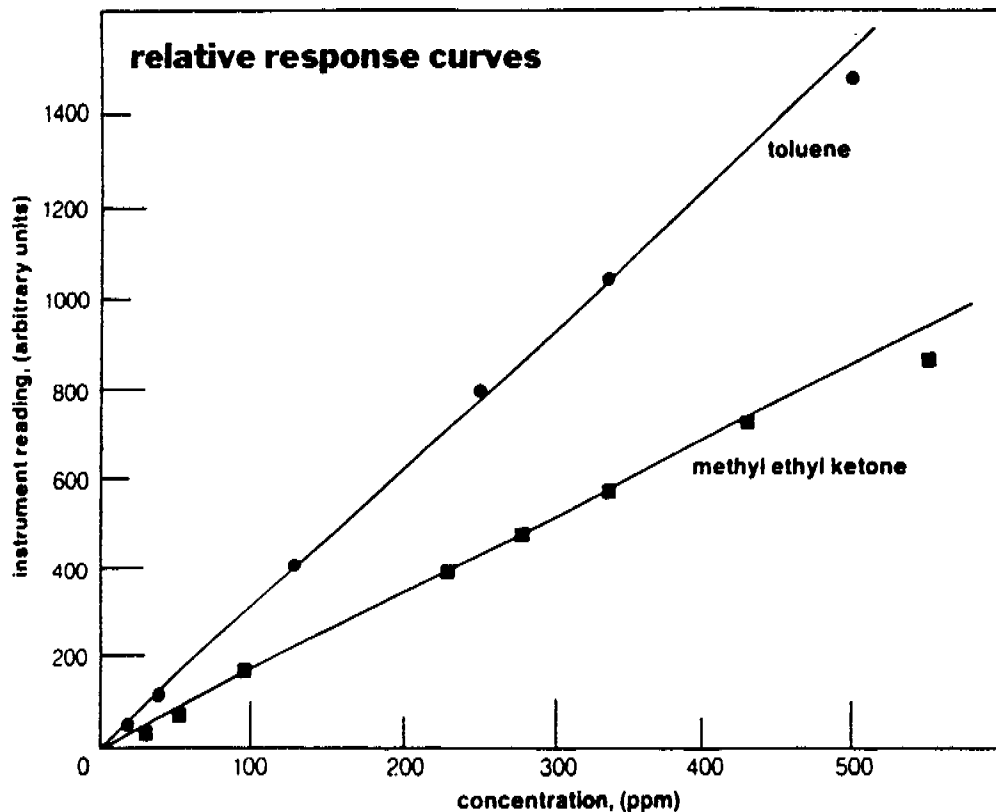
principle of operation

The photo-ionizer is a trace gas analyzer used to measure the concentration of a wide variety of species in industrial atmospheres. The analyzer employs the principle of photoionization for detection. The process is termed photoionization since the absorption of ultraviolet light by a molecule leads to ionization via: $R + h\nu \rightarrow R^+ + e^-$ where R^+ is the ionized species and $h\nu$ represents a photon which has an energy $\geq$ the ionization potential of the species.

The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not

ionize the major components of air such as O_2 , N_2 , CO , CO_2 , or H_2O . A chamber adjacent to the ultraviolet source contains a pair of electrodes. When a positive potential is applied to one electrode the field created drives any ions formed by the absorption of UV light to the collector electrode where the current (proportional to the concentration) is measured. Typical calibration curves showing the relative response of toluene and methyl ethyl ketone (at the same gain setting) are shown below.

Information on the relative response factors for other species is available upon request.



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30 ossipee rd.
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th photo-ioniz r.
accurate measurements,
easily obtained

sensitivity A maximum sensitivity of 0-2 ppm, full scale, can be obtained for many species. This scale is readable to 1% (100 division scale).

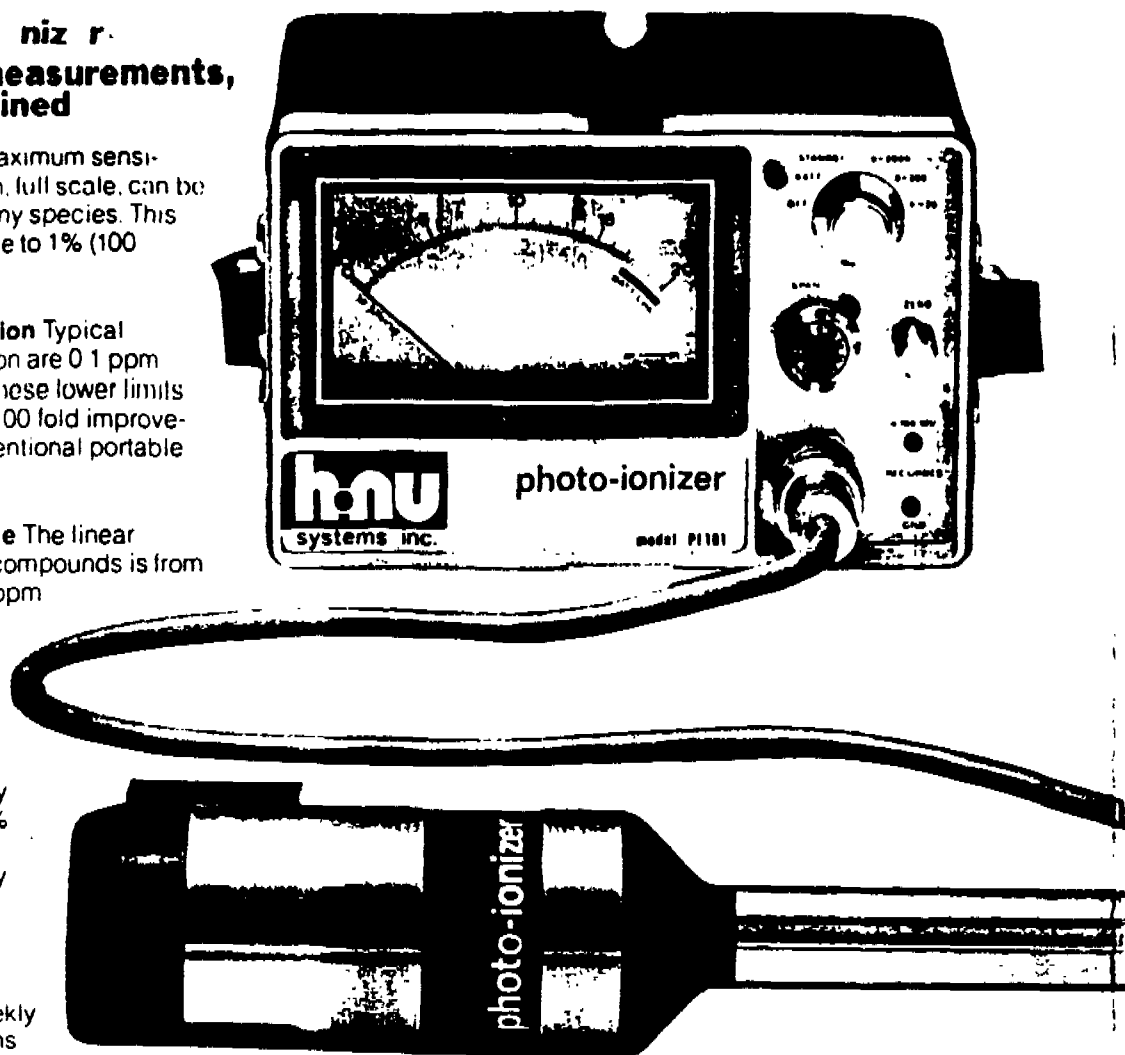
limits of detection Typical limits of detection are 0.1 ppm. In many cases these lower limits represent a 10-100 fold improvement over conventional portable analyzers.

operating range The linear range for most compounds is from 0.1 ppm to 600 ppm while the useful range typically extends to 2000 ppm.

stability Zero drift is extremely low, normally 1% or less over 10 hours, on battery operation. On AC operation, zero drift is less than 1% over 24 hours. Semiweekly span calibrations (100 ppm toluene) over a one month period give a relative standard deviation of $\pm 4.5\%$. This long term stability of both zero and span is due to the solid state electronics and stable ultraviolet light source.

specificity Specificity in photoionization analysis depends on the sensitivity of the detector to the species being measured, the number of interfering species present, and the concentration of the species being measured relative to interferences. The optimum specificity can be obtained by choosing the light source (9.5 eV, 10.2 eV, 11.7 eV) to suit the application, maximizing sensitivity to the species being analyzed and minimizing any possible interference. Return the postcard for details on your application.

rapid response Response to changes in concentration is extremely rapid. A 90% of full scale change (0-2000 ppm) takes less than five seconds. In addition, the sensor is located at the sampling point rather than inside the instrument. This eliminates the problems of hydrocarbon adsorption and transit time through a sampling tube, all of which can delay the real time response by 30-45 seconds or more.



AC/DC operation—The instrument power is supplied from a 12 VDC rechargeable battery which gives a *minimum* of 10 operating hours before recharging is necessary. The AC recharger provides the option of operating the unit continuously from 110V AC so that the instrument can be used either as a portable unit for industrial hygiene surveys and leak detection work or as a continuous stationary monitor. An optional HNU Recorder can also be operated with the 101 battery.

The instrument is equipped with an automatic solid state battery protection circuit to prolong battery life by preventing deep discharging. Both the analyzer and the recorder can be operated during the recharge cycle.

portability The instrument is truly portable, with a total weight of less than 9 pounds (4.1 Kg) complete. No additional bulky power packs, sample pumps or cylinders of fuel gas or zero gas are needed. When not in use, the hand-held sensor is stored in the instrument cover and the total package measures 21 cm wide x 13 cm deep x 24 cm high.

select dlist sp ci s d tec. d

NR: no response
H: high response
L: low response

direct reading Concentration (ppm) is read out directly on an easy to read 4.5" (11.3 cm) linear scale

three simple operating controls

Function and Range Switch This switch puts the instrument into the STANDBY, BATTERY CHECK, MEASUREMENT modes or OFF position. The MEASUREMENT position allows the choice of a 0-2 ppm, 0-20 ppm, 0-200 ppm or 0-2000 ppm full scale range. The STANDBY mode reduces power consumption between measurements. The BATTERY CHECK allows a manual power check before use while an LED (red indicator light) adjacent to the function switch provides an automatic battery check indicator during operation.

Zero Adjust The zero control allows electronic calibration of the instrument at the zero concentration point without requiring the use of a zero gas.

Span To calibrate the instrument for a particular gas, this control is adjusted to the gain setting which will match the value of a calibration gas to that same reading on the instrument scale. This control also provides the 10 fold increase in gain that allows the 0-2 ppm full scale range.

recorder outputs A signal output of 0-5V full scale is provided on the front panel for the attachment of a strip chart recorder.

electronic zero Zero calibration is done completely electronically. The instrument is switched to the STANDBY mode where the UV light source is turned off but the other electronics remain on. The zero control is adjusted until the meter indication is zero. No zero gas or regulators are needed; no further adjustments are required. Verification tests for this technique against hydrocarbon-free zero gas show perfect agreement.

safety The photo-ionizer is extremely safe to use, requiring no flames, igniters, or hydrogen fuel. It is approved by FM to meet the safety requirements of Class 1, Division 2 of the National Electrical Code.

instant warmup Solid state electronics produce stable readings within 20 seconds after turning the instrument on.

class species	photoionization response		
	9.5 eV lamp	10.2 eV lamp	11.7 eV lamp
paraffins and unsaturated hydrocarbons			
methane	NR	NR	NR
ethylene	NR	L	H
acetylene	NR	NR	H
1-butene	H	H	H
hexane	NR	L	H
chlorinated hydrocarbons			
methyl chloride	NR	NR	H
carbon tetrachloride	NR	NR	H
chloroform	NR	NR	H
dichloroethane	NR	NR	H
vinylidene chloride	L	H	H
vinyl chloride	L	H	H
trichloroethylene	H	H	H
heterocyclics & aromatics			
phenol	H	H	H
pyridine	H	H	H
benzene	H	H	H
toluene	H	H	H
xylene	H	H	H
styrene	H	H	H
aniline	H	H	H
chlorobenzene	H	H	H
nitrobenzene	NR	L	H
nitrogen compounds			
formamide	NR	H	H
ammonia	NR	L	H
hydrazine	H	H	H
methyl amine	H	H	H
acetonitrile	NR	NR	NR
acrylonitrile	NR	NR	H
sulfur compounds			
sulfur dioxide	NR	NR	NR
hydrogen sulfide	NR	H	H
carbonyl sulfide	NR	NR	H
carbon disulfide	H	H	H
methyl mercaptan	H	H	H
dimethyl sulfide	H	H	H
dimethyl disulfide	H	H	H
aldehydes, ketones, alcohols, acids, esters			
formaldehyde	NR	NR	H
acetaldehyde	NR	H	H
propionaldehyde	L	H	H
acrolein	L	H	H
crotonaldehyde	L	H	H
acetone	L	H	H
methanol	NR	NR	H
ethanol	NR	L	H
formic acid	NR	NR	H
acetic acid	NR	L	H
methyl methacrylate	L	H	H
others			
ethylene dibromide	NR	H	H
ethylene oxide	NR	L	H
tetraethyl lead	H	H	H
phosphine	NR	H	H
arsine	NR	H	H
iodine	H	H	H

specifications

performance (benzene referred)

range 0.1 to 2000 ppm
detection limit 0.1 ppm
sensitivity (max) 0-2 ppm FSD over 100 division meter scale
repeatability $\pm 1\%$ of FSD
linear range 0.1 to 600 ppm
useful range 0.1 to 2000 ppm
response time < 5 sec to 90% of full scale

physical

size: probe 6.3 DIA x 28.5L (cm) $(2\frac{1}{2} \times 11\frac{1}{4})$
readout 21W x 13D x 16.5H (cm) $(8\frac{1}{4} \times 5\frac{1}{4} \times 6\frac{1}{2})$
stowed 21W x 13D x 24H (cm) $(8\frac{1}{4} \times 5\frac{1}{4} \times 9\frac{1}{4})$
cable 80 cm long (32")
weight probe .55kg (20 ounces)
readout 3.2kg (7 pounds)
total (shipping) 5.4 kg (12 pounds)

controls and functions

mode switch Off, Battery check, Standby, Zero, 0-2000,
0-200, 0-20 ppm
low battery indicator light
zero (10 turn $\pm 300\%$ FSD max)
span (10 turn counting dial 1.0 to 10 times nominal sensitivity)
readout 4 1/2" (11.3 cm) meter Taut Band movement
graduated 0-5-10-15-20, divisions
outputs recorder 0-100 MV FSD

power requirements of operating times

continuous use with battery > 10 hours
with HNU Recorder > 6 hours
recharge time, max < 14 hours, 3 hours to 90% of full charge
recharge current, max 4 amps @ 15 VAC

construction

Designed to withstand the shock and abuse to which portable instruments are often subjected.

The readout is housed in a two piece aluminum case, and finished with a solvent resistant baked acrylic textured paint.

The probe is fabricated from extruded aluminum sections and machined plastic.

serviceability

The probe and readout are of modular design allowing rapid servicing and/or replacement of mechanical and electrical components. Full module interwiring includes quick disconnect.

maintenance

The instrument contains only one moving part, and consumes no gases or reagents. The only routine maintenance procedure is cleaning the light source window every several weeks.

represented by

LOCAL REPRESENTATIVE
HNU SYSTEMS, INC.
(713) 525-7999 in Houston

applications

Industrial hygiene surveys of toxic gases for OSHA (TLV) compliance can be rapidly accomplished with this portable, direct reading instrument. Hood ventilation rates can also be measured accurately because of the sensitivity and wide operating range of the unit.

leak detection is facilitated by the rapid instrument response and extreme sensitivity. This enables the user to locate even small leaks very rapidly.

residual solvent vapors such as trichloroethylene in decaffeinated coffee or degreasing operations, hexane from soybean extraction and other vapors from food chemical processing, paint spraying or coating can be easily and rapidly measured.

benzene concentrations as low as 1 ppm can be selectively measured using a 9.5 eV lamp. This eliminates most common interferences.

non methane hydrocarbons in the atmosphere can be measured directly since the photo-ionizer does not respond to methane.

vinyl chloride measurements in monomer plants can be made without interference from major starting materials or by-products such as ethylene and ethylene dichloride (dichloroethane). Low level vinyl chloride measurements in PVC fabrication processes do not have the 1-2 ppm methane background interference seen in other portable instruments.

For additional information on specific applications please fill out the attached postage paid reply card.

hnu

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VCM EMISSION CONTROL LEAK REPORT

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