

Sample Collection and Analysis of Carbonyls

Improve Detection of Trace
Level Contaminants in Air

The life science business of
Merck KGaA, Darmstadt,
Germany operates as
MilliporeSigma in the
U.S. and Canada.

Supelco®
Analytical Products

Improve Sampling and Detection of Carbonyls in Air

Leverage a Wide Range of Samplers and Accessories

Achieve sensitive and reliable results with air sampling media for a wide range of applications in various configurations for solvent desorption, thermal desorption, passive and whole air sampling from Supelco. Ensure low background for carbonyl sampling with products that are produced to the highest quality standards in a carbonyl controlled manufacturing environment that is complemented by high-purity solvents and calibration standards.

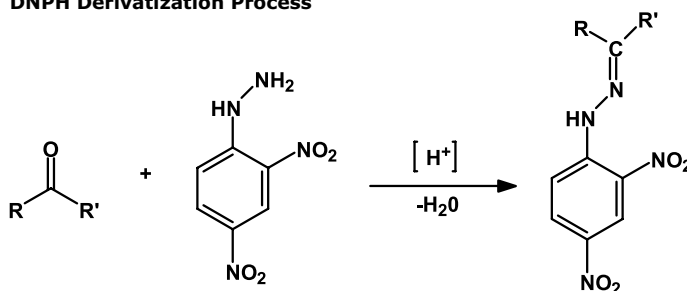
The sampling of aldehydes and ketones requires an on-site derivatization on a coated adsorbent e.g. with 2,4-dinitrophenylhydrazine (2,4-DNPH). Supelco's product range includes the low back pressure DNPH (LpDNPH) cartridges (available in 6 different configurations and 16 products) for active sampling, which ensure longer pump operation, glass tubes (ORBO™) and DNPH coated filters as well as devices with otherwise coated adsorbents for sampling carbonyls.

Our product range is suitable for OSHA, NIOSH, ASTM, EPA and CARB methods. For a complete overview on air monitoring from Sigma-Aldrich, visit SigmaAldrich.com/air-monitoring.

LpDNPH Products

LpDNPH cartridges are air sampling devices designated for sampling carbonyls (e.g. formaldehyde) in ambient, indoor and industrial atmospheres. Carbonyls are trapped on a high-purity adsorbent coated with 2,4-dinitrophenylhydrazine where they are converted to hydrazone derivatives. The derivatives are eluted from the cartridge with acetonitrile and analyzed by HPLC, in most cases. Select LpDNPH products are vacuum packaged in our low-background storage bag to ensure purity.

DNPH Derivatization Process



Method Applications

US EPA IP-6A – *Determination of Formaldehyde & Other Aldehydes*

US EPA TO-11A – *Method for Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by HPLC*

US EPA 100 – *Sampling for Formaldehyde & Other Carbonyl Compounds*

ASTM Method D5197 – *Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds*

NIOSH 2016 – *Formaldehyde*

NIOSH 2532 – *Glutaraldehyde*

NIOSH 2539 – *Aldehydes, Screening*

NIOSH 2541 – *Formaldehyde by GC*

NIOSH 3500 – *Formaldehyde by VIS; Impinger Method*

OSHA 52 – *Acrolein and/or Formaldehyde*

OSHA 64 – *Glutaraldehyde*

OSHA 81 – *Crotonaldehyde*

OSHA 85 – *Valeraldehyde*

Air Monitoring Applications



Vapor Intrusion



Agricultural Contaminants



Petrochemical Industry



Paints & Coatings



Chinese Drywall Contamination



Welding Processes



Anesthetic Gases in Healthcare



Scan code for detailed information on air sampling techniques and products for specific industries.
SigmaAldrich.com/airsampling

Carbonyl Sample Collection Devices

Active Sampling

Industrial Hygiene - NIOSH 2016 Appendix B

The NIOSH Method 2016, Appendix B glass sampling tubes contain 300 mg of LpDNPH in the front section and 150 mg in the back section. Both tubes are suitable for the NIOSH Method with the ORBO™-558 allowing higher flow rates. The back section functions as a control bed to indicate breakthrough that can occur with single bed DNPH cartridges in higher concentration environments or when you are not certain of the concentration.



| Cat. No. | Description | Qty. |
|----------|-----------------------------------|------|
| 54020-U | ORBO™-555 DNPH Tube, 6 mm x 110 L | 20 |
| 54081-U | ORBO™-558, 8 mm x 115 mm L | 20 |

S10 Cartridge

Easy-to-use in the field and in the laboratory. Reusable adapters are available for connecting the cartridge to the sampling pump. Built-in reservoir eliminates the need to attach to a syringe for sample extraction/elution. All S10 cartridges are 3 mL and composed of a low extractable polypropylene syringe barrel packed with 350 mg of LpDNPH coated sorbent. A starter kit with cartridges, adapter and fittings needed is available.



| Cat. No. | Description | Qty. |
|------------------------------|--------------------------------------|------|
| Vacuum Foil Packaging | | |
| 21024-U | LpDNPH S10 Starter Kit* | 10 |
| 21026-U | LpDNPH S10, 350 mg/3 mL | 10 |
| 21014 | LpDNPH S10, 350 mg/3 mL | 50 |
| Nylon Bag Packaging | | |
| 23124-U | LpDNPH S10, Bulk | 50 |
| 54072-U | LpDNPH S10 (1 tube/polyethylene bag) | 50 |

* Includes one tube adapter and ten 1/8" male luer fittings.



Above: LpDNPH S10 Starter Kit (21024-U)

S10L Cartridge

Offers a reversible design for analysts who prefer shorter dimensions and do not need an adaptor for sampling. The cartridge is eluted by connecting to a syringe barrel that acts as a reservoir for gravity-fed elution solvent. Meets EPA TO-11A requirements.



| Cat. No. | Description | Qty. |
|----------|---------------------|------|
| 505361-U | LpDNPH S10L, 350 mg | 10 |
| 505358 | LpDNPH S10L, 350 mg | 50 |

S10x Cartridge

Shorter than the S10 cartridge and designed to fit automated systems.



| Cat. No. | Description | Qty. |
|----------|---------------------|------|
| 505293 | LpDNPH S10x, 350 mg | 10 |

Rezorian™ DNPH Cartridge

Made of low extractable polypropylene with polyethylene frits. The end-fittings are luer lock syringe connections that can be used individually or connected in a series (piggybacked) to monitor breakthrough or to increase capacity.



| Cat. No. | Description | Qty. |
|----------|------------------------|------|
| 54074-U | Rezorian™ DNPH, 350 mg | 10 |
| 54075-U | Rezorian™ DNPH, 350 mg | 50 |

BPE-DNPH Cartridge

The BPE-DNPH cartridge is dual-layered and is comprised of silica gels impregnated with trans-1,2-bis (2-pyridyl) ethylene (BPE) as the top layer and DNPH for the bottom layer. The BPE converts the ozone into pyridien-2-aldehyde which is then converted to the DNPH derivative for either analysis or simply scrubbing ozone from your sample, depending on your choice of extraction method. The DNPH layer collects carbonyls for analysis. This product is not affected by high humidity.



| Cat. No. | Description | Qty. |
|---|---|----------|
| Cartridges | | |
| 54278-U | BPE-DNPH 130 mg/270 mg | 10 |
| 54279-U | BPE-DNPH 130 mg/270 mg | 50 |
| Analytical Standard (for ozone analysis) | | |
| 40117-U | Pyridine-2-Aldehyde DNPH (in acetonitrile, aldehyde equivalent) | 3 x 2 mL |

H Series Cartridges

The H series of LpDNPH cartridges contains higher loadings of 2,4-DNPH on the support material and larger bed weights compared to the S10 cartridges. This provides a significantly higher capacity for carbonyls making the H series cartridges the preferred choice for use in high concentration environments. The H series is available in H10 (350 mg), H30 (1 g) and H300 (10 g) cartridges.



| Cat. No. | Description | Qty. |
|----------|--------------------------|------|
| 505315 | LpDNPH H10, 350 mg/3 mL | 10 |
| 505320-U | LpDNPH H10, 350 mg/3 mL | 50 |
| 505323 | LpDNPH H30, 1 g/6 mL | 10 |
| 505331 | LpDNPH H300, 10 g/ 20 mL | 10 |

ORBO™-DNPH Tube

The ORBO™-DNPH tube contains 120 mg of 2,4-DNPH packed into a glass tube with a 'frangible' break seal ensuring purity until use. Each tube measures 6 mm O.D. x 90 mm long.



| Cat. No. | Description | Qty. |
|----------|--------------------|------|
| 20081-U | ORBO™-DNPH, 120 mg | 10 |

DNPH Coated Glass Fiber Filters

Suitable for OSHA 64, 81 and 85 test methods for sampling select carbonyls, such as glutaraldehyde, crotonaldehyde and valeraldehyde.



| Cat. No. | Description | Qty. |
|----------|------------------------------------|------|
| 20069 | ORBO™-827 LpDNPH Coated GFF, 37 mm | 25 |

Ozone Scrubber

Available in Rezorian™ and reversible tube styles. Each tube style contains 1.5 g of high purity potassium iodide. KI traps the ozone, which causes a negative formaldehyde interference in DNPH-coated devices. Luer end-fittings enable you to connect this cartridge directly to the inlet of any DNPH cartridge with a luer tip. Testing (200 ppb ozone, 50% RH, 25 °C) has shown the scrubber to have an ozone capacity of 100,000 ppb/hr.



| Cat. No. | Description | Qty. |
|----------|----------------------|------|
| 54078-U | Rezorian™, 1.5 g KI | 10 |
| 505285 | Reversible, 1.5 g KI | 10 |

2-HMP on Amberlite® XAD®-2 for Formaldehyde

Commonly used for Industrial Hygiene (IH) sampling, OSHA 52 specifies use of a glass tube packed with 2-(Hydroxymethyl)piperidine on Amberlite® XAD®-2. The 2-HMP on XAD®-2 reacts with formaldehyde to form an oxazolidine derivative. Suitable for NIOSH 2541 and OSHA 52 methods.



| Cat. No. | Tube | Bed Wt. A/B | Dimensions | Qty. |
|----------|----------|---------------|----------------------|------|
| 20257-U | ORBO™-23 | 120 mg/60 mg | 6 mm O.D. x 85 mm L | 25 |
| 20231 | ORBO™-24 | 150 mg/75 mg | 6 mm O.D. x 105 mm L | 25 |
| 20357 | ORBO™-25 | 450 mg/225 mg | 8 mm O.D. x 115 mm L | 25 |

Passive Sampling

The Radiello® and DSD-DNPH diffusive sampler employ a radial passive sampling design while other samplers commonly available in the market employ an axial design. The benefits of the radial design over the axial design are faster sampling rates, higher capacity and better robustness to wind, temperature and humidity. They also are versatile and can be used for indoor and outdoor air as well as personal sampling.

Radiello®

The Radiello® passive sampler has sampling rates equivalent to pumped (active) sampling. For example, the sampling rate for formaldehyde is 99 mL/min and 84 mL/min for acetaldehyde.



| Cat. No. | Description | Qty. |
|----------|--|------|
| RAD165 | Aldehyde Cartridge Adsorbents | 20 |
| RAD1201 | Blue Diffusive Body | 20 |
| RAD121 | Triangular Support Plate | 20 |
| RAD122 | Vertical Adapter (for personal sampling) | 20 |

For more information about Radiello® passive sampling products, visit SigmaAldrich.com/radiello

DSD-DNPH

Another type of radial diffusive sampler is the DSD-DNPH sampling device. It is comprised of a porous polyethylene tube, which acts as the diffusive membrane, which is attached to a small syringe barrel for elution of analytes from the adsorbent. A 2,4-DNPH coated support acts as the adsorbent and is moved from the diffusive end during sample collection to the syringe end for sample extraction by inverting the device. DSD-DNPH is an all-in-one sample collection and elution device. Specified in OSHA 1007 Method for Determination of Aldehydes.



| Cat. No. | Description | Qty. |
|----------|---|------|
| 28221-U | DSD-DNPH Sampling Device | 10 |
| 28222-U | Perforated Holder (for personal sampling) | 10 |
| 000J004 | DSD-DNPH Color Cap Insert (string not included) | 100 |

Solution Sampling

Borosilicate Standard Glass Impingers and Bubblers

Glass impingers (for particles) and bubblers (for gases and vapors) are ideal for NIOSH & OSHA methods that require collection of airborne contaminants by drawing them into solution; available with ground glass joints or threaded PTFE micro-connectors.

| | |
|---------------------|---------------------|
| Length: | 186 mm (7.3 in) |
| Reservoir Length: | 152 mm (6 in) |
| Reservoir Capacity: | 25 mL |
| Graduations: | 5 mL |
| Glass Joint: | 24/40 taper |
| Impinger: | Standard Glass Stem |
| Bubbler: | Fritted Glass Stem |



| Cat. No. | Description | Qty. |
|----------|---------------------|------|
| 20270-U | Std Midget Impinger | 1 |
| 64835-U | Std Midget Bubbler | 1 |

Plastic Clips/PTFE Sleeves

Plastic clips fit over the connection on our 24/40 taper ground glass joints to ensure secure connections. Use full-length PTFE sleeves in ground glass joints for inert, tight seals without the possibility of frozen joints; for use with standard impingers and bubblers.



| Cat. No. | Description | Qty. |
|----------|---------------------------------------|------|
| 64764 | Plastic Clip for use with 24/40 taper | 1 |
| 64761 | PTFE Sleeve for use with 24/40 taper | 1 |

Borosilicate Threaded Midget Impingers and Bubblers

Make your sampling process more convenient. The vial can be capped after sampling, thus reducing sample handling in the field – no transferring of samples from the reservoir to a separate vial. The reservoir may be easily replaced with a standard or graduated screw-top vial.



Threaded Midget Impinger

Length (without vial): 143 mm (5 5/8 in)
 Vial Capacity (mL): 22
 Thread (mm): 20
 Pack Size (ea): 2
 Cat. No.: 64712-U

Threaded Midget Bubbler

Length (without vial): 143 mm (5 5/8 in)
 Vial Capacity (mL): 22
 Thread (mm): 20
 Graduation Mark (mL): 15
 Pack Size (ea): 1
 Cat. No.: 64834-U

Spill Resistant Midget Bubbler

Length (without vial): 143 mm (5 5/8 in)
 Vial Capacity (mL): 40
 Thread (mm): 24
 Graduation Mark (mL): 15
 Pack Size (ea): 1
 Cat. No.: 64832

Screw Top Replacement Vials (cap not included)

| Cat. No. | Description | Qty. |
|--|--|------|
| Clear Vials | | |
| 27173 | 22 mL 23 mm x 85 mm, thread 24-400 | 100 |
| 27184 | 40 mL 29 mm x 82 mm, thread 24-400 | 100 |
| 27379 | 40 mL 28 mm x 95 mm, thread 24-400 | 100 |
| Amber Vials | | |
| 27073-U | 22 mL, 23 mm x 85 mm, thread 20-400 | 100 |
| 27185-U | 40 mL, 29 mm x 82 mm, thread 24-400 | 100 |
| 27382 | 40 mL, 28 mm x 95 mm, thread 24-400 | 100 |
| Caps for 22 mL Vials (Size: 20-400) | | |
| 27174-U | Green Melamine Resin, Solid Cap, PTFE Liner | 100 |
| 27175-U | Black Phenolic Solid Cap, Aluminum Liner | 100 |
| Caps for 40 mL Vials (Size: 24-400) | | |
| 27186 | Green Melamine Resin, Solid Cap, PTFE Liner | 100 |
| SU860006 | White Polypropylene Solid Cap, PTFE/Silicone | 100 |

Accessories for Solution Sampling

In-Line Impinger Trap

Bottom cap allows easy emptying. Has a 15 mL capacity for absorbing solution. Can be packed with charcoal or other adsorbent (sold separately). Cap and PTFE liner included. Length 152 mm (6 in): 20 mm threads



Impinger Holder

Insert your impinger, bubbler or in-line trap in this holder, and attach to your lapel, shirt pocket or belt.



| Cat. No. | Description | Qty. |
|----------|--------------------------------------|------|
| 64833 | In-line Impinger Trap w/20 mm Thread | 1 |
| 20271 | Impinger Holder | 1 |

NIOSH 3500 for Formaldehyde Impinger Method

This method has been replaced by solid sorbent sampling methods, however it is still used in reference sampling situations. This method utilizes impingers and filters, employing a solution of chromotropic acid. The formaldehyde is measured by spectrophotometry.

| Cat. No. | Description | Qty. |
|----------|-----------------------------------|------|
| 23383 | PTFE Filter w/Pads, 37 mm, 1.0 µm | 100 |
| 23369 | 37 mm Filter Cassette, 2 pc | 100 |

Reagents & Solutions

| Cat. No. | Description | Qty. |
|--------------|--|--------|
| 252549-25ML | Formaldehyde, ACS Reagent 37% in Water | 25 mL |
| 27150-10G-F | Chromotropic Acid Disodium Salt, Dihydrate | 10 g |
| 13438-1L-R | Sodium Bisulfite Solution (40%) | 1 L |
| 320501-500ML | Sulfuric Acid, Concentrated, ACS Reagent | 500 mL |

Air Sampling Accessories

Adapters, Fittings and Connectors

We offer a selection of reusable adapters and fittings for connecting our cartridges to a sampling pump and other devices.



| Cat. No. | Description | Qty. |
|----------|--------------------------------------|------|
| 21018-U | Cartridge Adapters for S10, H10, H30 | 10 |
| 57267 | Cartridge Adapters for H300 | 6 |
| 21016 | Male Luer Fittings for 1/8" Tubing | 20 |
| 23364 | Male Luer Fittings for 3/16" Tubing | 20 |
| 24856 | Male Luer Fittings for 1/4" Tubing | 10 |
| 21017 | Fittings for 1/8" Tubing | 20 |
| 21015 | Female Luer Couplers | 20 |
| 25064-U | Male Luer Couplers | 20 |
| 504351 | Male Luer Plugs | 12 |
| 57098 | Visidry™ Female Luer Plug | 12 |
| 21019-U | Lapel Clips | 6 |
| 21012 | Bar Code Labels | 100 |
| 57241 | Syringe Barrels, 3 mL | 54 |
| 57242 | Syringe Barrels, 6 mL | 30 |
| 20015-U | Glass Reservoirs, 5 mL | 5 |

Universal Elution Rack

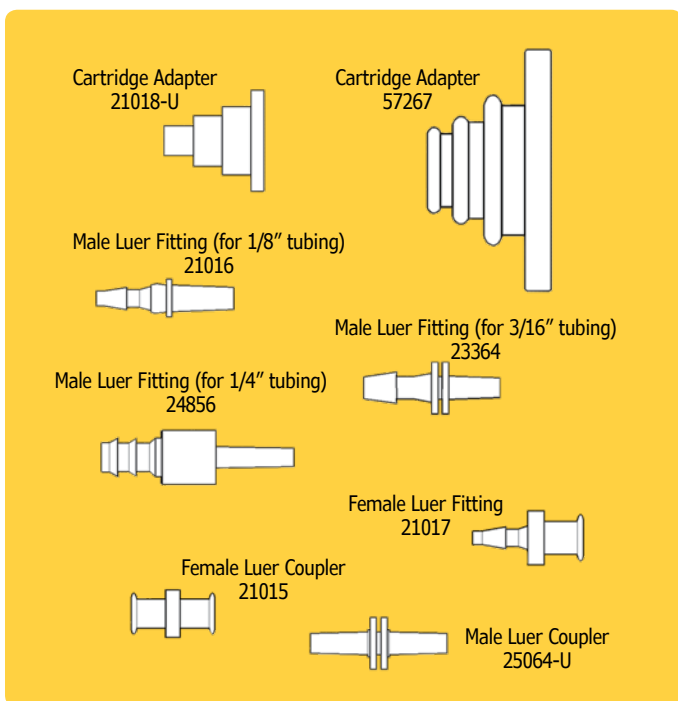
Developed for fast and convenient sample preparation without the use of a vacuum. Our versatile elution rack can be used with a variety of air monitoring tubes and receiving vessels, including our LpDNP cartridges, for simultaneous gravity feed extraction up to 12 samples. By using the assembly plates in various combinations, you can configure the unit to accept:

- 1, 3 or 6 mL syringe style cartridges (S10)
- Closed cartridges (S10L)
- 5 or 10 mL volumetric flasks
- 2 or 4 mL vials
- Test tubes up to 15 mm ID x 10 cm

With cartridge adapters (for S10 or H300), you can attach an empty syringe barrel (see table to the left) to the cartridge to serve as a solvent reservoir. The rack allows room for syringe filters.



| Cat. No. | Description | Qty. |
|----------|------------------------|------|
| 21043-U | Universal Elution Rack | 1 |



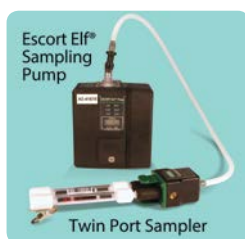
Sampling Pumps

Escort Elf® Sampling Pump

An electronic laminar flow sensor in this easy-to-operate, state-of-the-art sampling pump provides constant flow control, unaffected by changes in battery voltage, temperature, sample load or altitude. An internal secondary standard calibrates the pump continuously, requiring only monthly calibration with a primary standard. The volumetric flow rate held within $\pm 2.5\%$ of set-point over the 1 to 3 L/min operating range ($\pm 5\%$ to 0.5 L/min). A built-in counter monitors total operating time and reminds you when a primary calibration is required. The pump also features a low battery function with an indicator light and blocked flow detection. LED readout alternately displays flow rate and elapsed sampling time. The pump is UL approved as intrinsically safe for use in hazardous locations, Class I, Groups A, B, C, D; Class II, Groups E, F and G; Class III, Division I locations. Order charger separately.

Twin Port Sampler

This pump attachment is designed for low flow industrial hygiene sampling, such as gas and vapor monitoring, using sorbent tubes. Two needle valves provide independent flow control for simultaneous collection on two tubes, but can also be used for a single tube by closing the flow through one valve. The sampler is compatible with any personal sampling pump capable of 1.5 L/min flow rate and a load of 25 in of water. Total flow cannot exceed 500 mL/min. Each sampler comes with two tube protectors, one for small tubes (2 in./ 5 cm long) and one for large tubes, (<4.5 in. / 12.5 cm long) and the tubing required to connect the sampler to the sampling pump.



| Cat. No. | Description | Qty. |
|--------------------|-------------------------------------|------|
| 28160-U | Escort Elf® Sampling Pump | 1 |
| 28118-U | Twin Port Sampler | 1 |
| Accessories | | |
| 28155-U | Omega Battery Charger 12 Volt | 1 |
| 28157-U | 110 Volt, units charged: 1 | 1 |
| 28158-U | 240 Volt, units charged: 1 | 1 |
| 28159-U | 120 Volt/240 Volt, units charged: 5 | 1 |

Model 1067 Ambient Air Sampler

The Model 1067 sampler (dual channel) allows to simultaneously take 2 samples with independent flow rates at 5-500 mL/min per channel. The built-in timer allows for an automatic shutoff.



| Cat. No. | Description | Qty. |
|----------|---|------|
| 507113 | Model 1067 Tube Sampler* (Dual Channel) | 1 |
| 24697-U | Universal Charger, 110 V/240 V | 1 |

*Includes universal charger

PAS-500 Micro Air Sampler

This low flow pump is lightweight (4 oz./114 g) and compact (7 in./17.8 cm), fitting easily into your shirt pocket. The adsorbent tube connects directly to the inlet of the pump. This sampler is versatile, adapts to fit both 6 and 8 mm O.D. tubes, and the flow range is 40-200 mL/min. The low flow adapter enables you to sample at 20 mL/min.



This unit is powered by a convenient and easily replaceable 9-volt battery. The full flow regulation feature provides constant voltage to the pump, even as battery voltage drops. It is intrinsically safe – a built in resistor limits the power current, preventing any short circuit.

| Cat. No. | Description | Qty. |
|--|---|------|
| PAS-500 Micro Air Sampler with Low Flow Orifice | | |
| 24865 | Includes sampler, 6 mm O.D. tube holder, screwdriver and two 9-Volt batteries | 1 |
| Tube Holder for PAS-500 Pump | | |
| 24867 | For use with 6 mm O.D. adsorbent tube | 1 |
| 24868 | For use with detector tube | 1 |
| 24869 | For use with 8 mm O.D. adsorbent tube | 1 |
| Carrying Case for PAS-500 | | |
| 24871 | Single pump case | 1 |

Flow Calibration Devices for Air Sampling Pumps



| Cat. No. | Description | Qty. |
|----------------------------------|---|------|
| Mini-Buck Flow Calibrator | | |
| 24843 | Model M-5, Flow Rate 1-6000 mL/min | 1 |
| 24845 | Model M-30, Flow Rate 1-30 mL/min | 1 |
| 24844 | Battery Charger for M-5/M-30, 110 Volt* | 1 |
| 24846 | Battery Charger for M-5/M-30, 220 Volt* | 1 |

*Battery charger not included with 24843 and 24845, order separately

Optiflow Digital Bubble Flow Meter



| Cat. No. | Description | Qty. |
|----------|---------------------------------------|------|
| 28679-U | Model 520, Flow Range: 0.5-500 mL/min | 1 |

Analytical Columns for Analysis of Carbonyl Samples

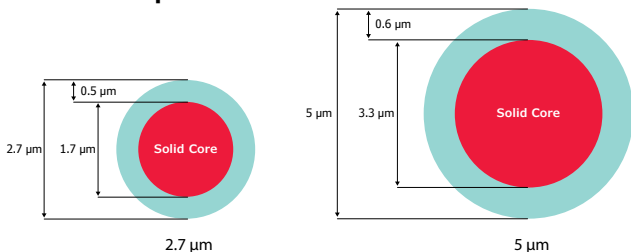
After sample collection of carbonyls by the wide range of sample collection devices, the analytes are typically analyzed by HPLC with a UV detector; an exception to this is the OSHA 52 method whose modified method employs capillary GC analysis. In addition to carbonyl sample collection devices, we provide the complete solution of analytical standards, reagents, solutions and analytical HPLC and GC columns.

Analytical Columns for HPLC Analysis

Ascentis® Express C18 and RP-Amide

Ascentis® Express HPLC columns, through the use of Fused-Core® particle technology, can provide you with both the high speed and high efficiencies of sub-2 µm particles while maintaining lower backpressures. The combination of high efficiency and low backpressure in conjunction with robustness benefits UHPLC users as well as conventional HPLC users.

Ascentis® Express Particles



| Cat. No. | Description | Qty. |
|---|-----------------------------|------|
| Ascentis® Express C18 HPLC Column | | |
| 53829-U | 15 cm x 4.6 mm I.D., 2.7 µm | 1 |
| Ascentis® Express RP-Amide HPLC Column | | |
| 53931-U | 15 cm x 4.6 mm I.D., 2.7 µm | 1 |

For more information, visit SigmaAldrich.com/express

Analytical Columns for GC Analysis

SUPELLOWAX® 10

Application: This column is based on one of the most widely used polar phases and is suitable for analyses of carbonyls, solvents, fatty acid methyl esters (FAMES), food, flavor and fragrance compounds, alcohols and aromatics.

Additionally, this column is a great choice when a polar general purpose column is required.

Suitable for OSHA 52

USP Code: This column meets USP G16 requirements.

Phase: Bonded; poly(ethylene glycol)

Temp. Limits: ≤0.53 mm I.D., df <2 µm: 35 °C to 280 °C (isothermal or programmed)



| Cat. No. | Description | Qty. |
|--|-----------------------------|------|
| SUPELLOWAX® 10 Capillary Column | | |
| 25325 | 30 m x 0.53 mm I.D., 0.5 µm | 1 |

For more information, visit SigmaAldrich.com/gc

Analysis of Carbonyl Samples

Analysis of 21 Aldehyde/Ketone DNPH Derivatives Using Ascentis® RP-Amide

This application demonstrates the suitability of the Ascentis® RP-Amide for the analysis of 21 aldehyde ketone derivatives.

column: Ascentis® RP-Amide, 15 cm x 4.6 mm I.D., 3 µm particles (565322-U)

mobile phase A: 60:40, water:acetonitrile

mobile phase B: 25:75, water:acetonitrile

flow rate: 1.5 mL/min.

temp.: 30 °C

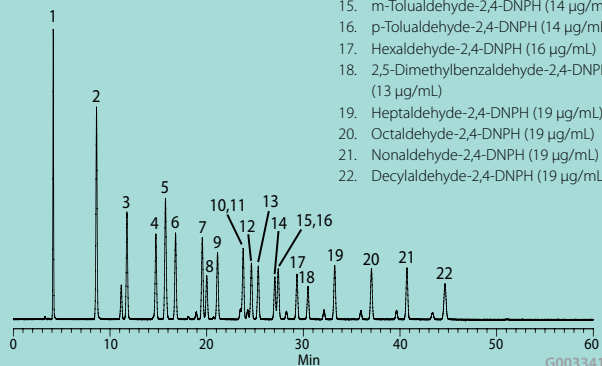
det.: UV at 360 nm

injection: 10 µL

sample: as listed in mobile phase

| gradient: | Min | %A | %B |
|-----------|-----|-----|-----|
| | 0 | 100 | 0 |
| | 5 | 100 | 0 |
| | 25 | 40 | 60 |
| | 40 | 0 | 100 |
| | 60 | 0 | 100 |

- Dinitrophenylhydrazine (100 µg/mL)
- Formaldehyde-2,4-DNPH (40 µg/mL)
- Acetaldehyde-2,4-DNPH (29 µg/mL)
- Acetone-2,4-DNPH (23 µg/mL)
- Acrolein-2,4-DNPH (24 µg/mL)
- Propionaldehyde-2,4-DNPH (23 µg/mL)
- Crotonaldehyde-2,4-DNPH (20 µg/mL)
- 2-Butanone-2,4-DNPH (10 µg/mL)
- Butyraldehyde-2,4-DNPH (20 µg/mL)
- Benzaldehyde-2,4-DNPH (15 µg/mL)
- Cyclohexanone-2,4-DNPH (10 µg/mL)
- Isovaleraldehyde-2,4-DNPH (18 µg/mL)
- Valeraldehyde-2,4-DNPH (18 µg/mL)
- o-Tolualdehyde-2,4-DNPH (14 µg/mL)
- m-Tolualdehyde-2,4-DNPH (14 µg/mL)
- p-Tolualdehyde-2,4-DNPH (14 µg/mL)
- Hexaldehyde-2,4-DNPH (16 µg/mL)
- 2,5-Dimethylbenzaldehyde-2,4-DNPH (13 µg/mL)
- Heptaldehyde-2,4-DNPH (19 µg/mL)
- Octaldehyde-2,4-DNPH (19 µg/mL)
- Nonaldehyde-2,4-DNPH (19 µg/mL)
- Decylaldehyde-2,4-DNPH (19 µg/mL)



G003341

BPE-DNPH – Acetonitrile (3 mL) Extraction

column: Ascentis® Express C18, 15 cm x 4.6 mm I.D., 2.7 µm particle

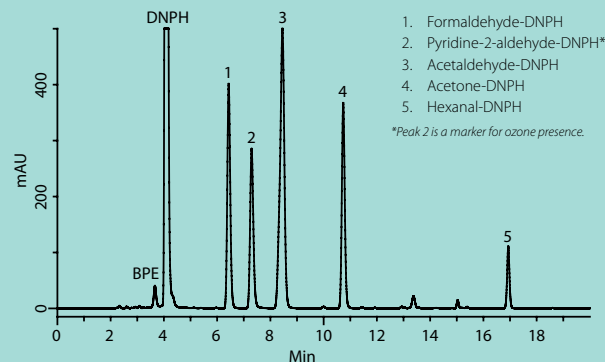
mobile phase: 55:45 acetonitrile:water (4 min), gradient to 90% acetonitrile at 13 min (5 min hold)

flow rate: 0.5 mL/min

det.: UV 360 nm

injection: 10 µL

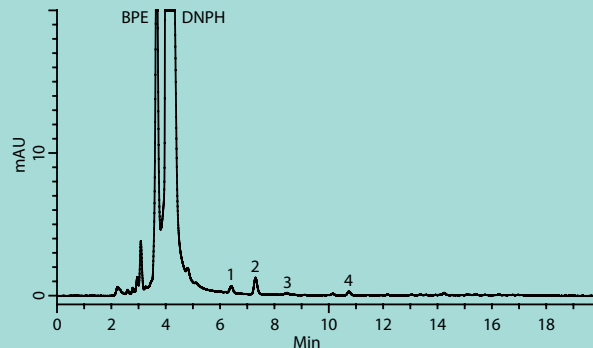
Air Sample



- Formaldehyde-DNPH
- Pyridine-2-aldehyde-DNPH*
- Acetaldehyde-DNPH
- Acetone-DNPH
- Hexanal-DNPH

*Peak 2 is a marker for ozone presence.

Cartridge Blank



G005758-G005759

Isocratic Analysis of Aldehydes/Ketone DNPH on Ascentis® Express C18

column: Ascentis® Express C18, 10 cm x 4.6 mm I.D., 2.7 µm (53827-U)

mobile phase: 60:40, water:acetonitrile

flow rate: 2 mL/min.

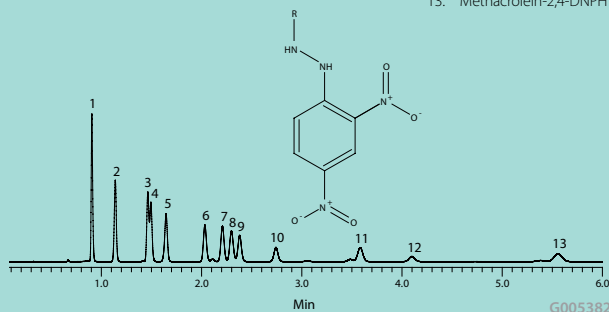
temp.: 30 °C

det.: UV at 360 nm

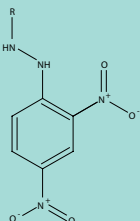
injection: 5 µL

sample: water

- Formaldehyde-2,4-DNPH
- Acetaldehyde-2,4-DNPH
- Acetone-2,4-DNPH
- Acrolein-2,4-DNPH
- Propionaldehyde-2,4-DNPH
- Crotonaldehyde-2,4-DNPH
- 2-Butanone-2,4-DNPH
- Butyraldehyde-2,4-DNPH
- Benzaldehyde-2,4-DNPH
- Valeraldehyde-2,4-DNPH
- m-Tolualdehyde-2,4-DNPH
- Hexaldehyde-2,4-DNPH
- Methacrolein-2,4-DNPH



G005382

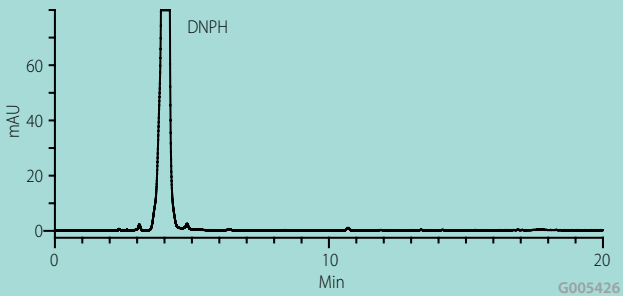


Fast Separation on Fused-Core Ascentis® Express Column

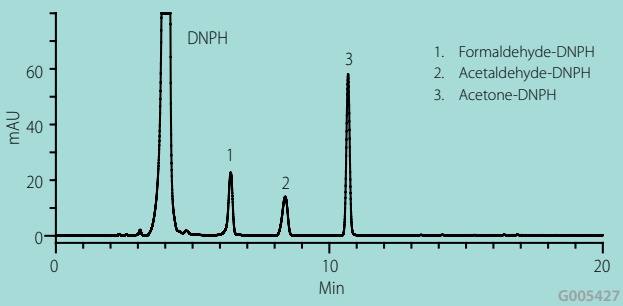
column: Ascentis® Express C18, 15 cm x 4.6 mm I.D., 2.7 µm (53829-U)
 mobile phase A: water
 mobile phase B: acetonitrile
 flow rate: 0.5 mL/min
 temp.: ambient
 det.: UV at 360 nm
 injection: 10 µL
 gradient:

| Time (min) | %A | %B |
|------------|----|----|
| 0 | 45 | 55 |
| 4 | 45 | 55 |
| 13 | 10 | 90 |
| 20 | 10 | 90 |

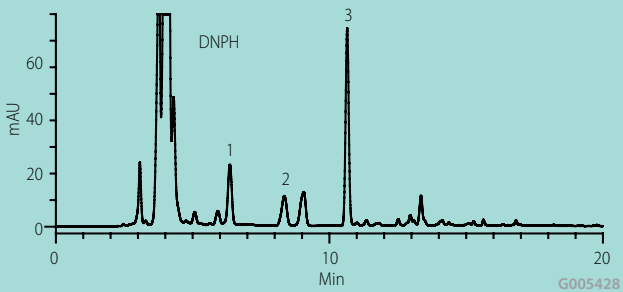
LpDNPH S10 Cartridge Blank



LpDNPH S10 Cartridge Blank Spiked with DNPH Standards



LpDNPH S10 Cartridge – Laboratory Air Sample

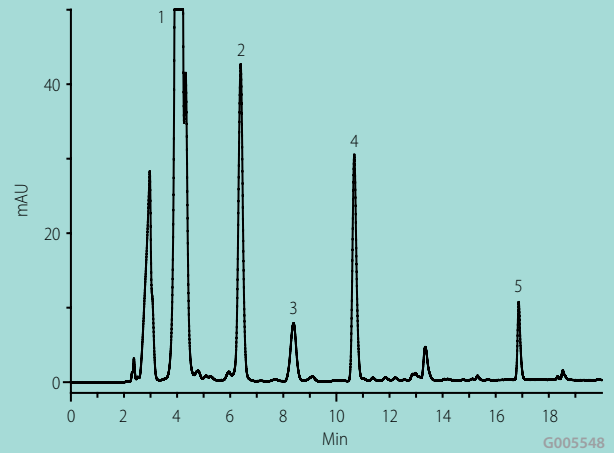


Acetonitrile Extract of ORBO™-555 Tube (Primary Bed)

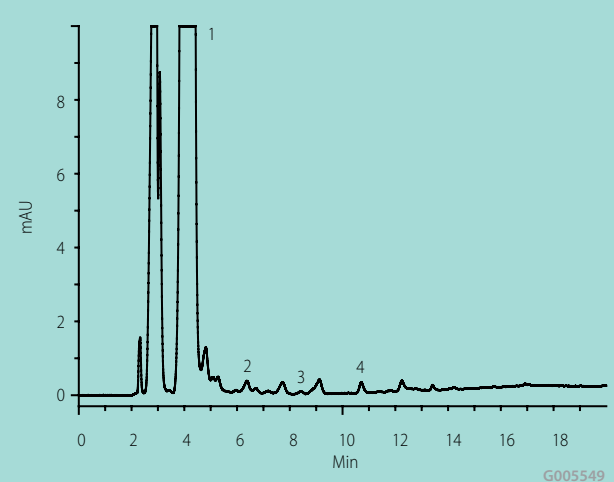
column: Ascentis® Express C18, 15cm x 4.6mm I.D.,
 2.7 µm particles (53829-U)
 mobile phase A: water
 mobile phase B: acetonitrile
 flow rate: 0.5 mL/min.
 temp.: ambient
 det.: UV, 360 nm
 injection: 10 µL
 sample cartridge: ORBO™-555 DNPH Cartridge (54020-U)
 gradient:

| Min | %A | %B |
|-----|----|----|
| 0 | 45 | 55 |
| 4 | 45 | 55 |
| 13 | 10 | 90 |
| 20 | 10 | 90 |

1. 2,4-Dinitrophenylhydrazine (DNPH)
2. Formaldehyde-DNPH
3. Acetaldehyde-DNPH
4. Acetone-DNPH
5. Hexanal-DNPH



Blank Tube (Primary Bed)



Standards & Certified Reference Materials (CRMs) for Analysis of Carbonyl Samples

American Society for Testing and Materials (ASTM) Methods

The following standards are for use with methods developed under ASTM Committee D-22, described in the Annual Book of ASTM Methods, Volume 11.03, Atmospheric Analysis, Occupational Health and Safety. The standards are quantitative formulations for use as chromatographic calibration or spiking solutions. Products include a Certificate of Analysis describing lot-specific production and analytical information. Free data packets are available for most of these products. Data packets contain data on raw materials and final production. Request the data packet when ordering the standard; the order number is the same as that for the standard, preceded by the letters DP.

ASTM D5197 Method: Determination of Formaldehyde and Other Carbonyl Compounds in Air

| Cat. No. | Description | Concentration | Qty. |
|----------|---|---|------|
| CRM47285 | TO11/IP-6A Aldehyde/Ketone-DNPH Mix, certified reference material | 15 µg/mL in acetonitrile, as aldehyde and ketone equivalent | 1 mL |
| | Acetaldehyde-2,4-dinitrophenylhydrazone | | |
| | Acetone-2,4-dinitrophenylhydrazone | | |
| | Acrolein-2,4-dinitrophenylhydrazone | | |
| | Benzaldehyde-2,4-dinitrophenylhydrazone | | |
| | Butyraldehyde-2,4-dinitrophenylhydrazone | | |
| | Crotonaldehyde-2,4-dinitrophenylhydrazone | | |
| | 2,5-Dimethylbenzaldehyde-2,4-dinitrophenylhydrazone | | |
| | Formaldehyde-2,4-dinitrophenylhydrazone | | |
| | Hexaldehyde-2,4-dinitrophenylhydrazone | | |
| | Isovaleraldehyde-2,4-dinitrophenylhydrazone | | |
| | Propionaldehyde-2,4-dinitrophenylhydrazone | | |
| | <i>o</i> -Tolualdehyde-2,4-dinitrophenylhydrazone | | |
| | <i>m</i> -Tolualdehyde-2,4-dinitrophenylhydrazone | | |
| | <i>p</i> -Tolualdehyde-2,4-dinitrophenylhydrazone | | |
| | Valeraldehyde-2,4-dinitrophenylhydrazone | | |

California Air Resources Board (CARB) Methods - Analysis of Carbonyls in Ambient Air

California Air Resources Board (CARB) – The following quantitative formulations were developed to support the analysis of aldehydes in ambient air by CARB Method 1004. Analysis is of the dinitrophenylhydrazine (DNPH) derivatives by HPLC-UV. Concentrations stated are of the equivalent carbonyl before derivatization, except where noted. The Certificate of Analysis accompanying these products states both DNPH derivatized and non-derivatized concentrations.

| Cat. No. | Description | Concentration | Qty. |
|----------|--|---|------|
| CRM47649 | CARB Carbonyl-DNPH Mix 1, certified reference material | in acetonitrile, varied, derivative concentration | 1 mL |
| | Acetaldehyde-2,4-dinitrophenylhydrazone, 1000 µg/mL | | |
| | Acetone-2,4-dinitrophenylhydrazone, 500 µg/mL | | |
| | Acrolein-2,4-dinitrophenylhydrazone, 500 µg/mL | | |
| | Benzaldehyde-2,4-dinitrophenylhydrazone, 500 µg/mL | | |
| | Butyraldehyde-2,4-dinitrophenylhydrazone, 500 µg/mL | | |
| | Formaldehyde-2,4-dinitrophenylhydrazone, 1500 µg/mL | | |

| Cat. No. | Description | Concentration | Qty. |
|----------|---|--|------|
| 47650-U | CARB Method 1004 DNPH Mix 1 | 3 µg/mL in acetonitrile, as aldehyde and ketone equivalent | 1 mL |
| CRM47651 | CARB Method 1004 DNPH Mix 2 | 3 µg/mL in acetonitrile, as aldehyde and ketone equivalent | 1 mL |
| | Acetaldehyde-2,4-dinitrophenylhydrazone | | |
| | Acetone-2,4-dinitrophenylhydrazone | | |
| | Acrolein-2,4-dinitrophenylhydrazone | | |
| | Benzaldehyde-2,4-dinitrophenylhydrazone | | |
| | 2-Butanone-2,4-dinitrophenylhydrazone | | |
| | Butyraldehyde-2,4-dinitrophenylhydrazone | | |
| | Crotonaldehyde-2,4-dinitrophenylhydrazone | | |
| | Formaldehyde-2,4-dinitrophenylhydrazone | | |
| | Hexaldehyde-2,4-dinitrophenylhydrazone | | |
| | Methacrolein-2,4-dinitrophenylhydrazone | | |
| | Propionaldehyde-2,4-dinitrophenylhydrazone | | |
| | <i>m</i> -Tolualdehyde-2,4-dinitrophenylhydrazone | | |
| | Valeraldehyde-2,4-dinitrophenylhydrazone | | |

European Mixes

DNPH Mixes

The following dinitrophenylhydrazine (DNPH) standards were developed in response to European requests for working and calibration check standards for the ambient air analysis of carbonyl emissions from automobile exhaust. Methods for this analysis are equivalent to California Air Resources Board 1004 (Sacramento, CA, USA). Concentrations are of the equivalent carbonyl quantity before derivatization. The Certificate of Analysis accompanying each of these products states both DNPH-derivatized and non-derivatized concentrations.

| Cat. No. | Description | Concentration | Qty. |
|----------|---|--|------|
| CRM47672 | Carbonyl-DNPH Mix 1, certified reference material | 20 µg/mL in acetonitrile, except where indicated (as aldehyde and ketone equivalent) | 1 mL |

Acetaldehyde-2,4-dinitrophenylhydrazine
 Acetone-2,4-dinitrophenylhydrazine
 Acrolein-2,4-dinitrophenylhydrazine
 Benzaldehyde-2,4-dinitrophenylhydrazine
 2-Butanone-2,4-dinitrophenylhydrazine
 Butyraldehyde-2,4-dinitrophenylhydrazine
 Crotonaldehyde-2,4-dinitrophenylhydrazine
 Formaldehyde-2,4-dinitrophenylhydrazine, 40 µg/mL
 Hexaldehyde-2,4-dinitrophenylhydrazine
 Methacrolein-2,4-dinitrophenylhydrazine
 Propionaldehyde-2,4-dinitrophenylhydrazine
p-Tolualdehyde-2,4-dinitrophenylhydrazine
 Valeraldehyde-2,4-dinitrophenylhydrazine

| Cat. No. | Description | Concentration | Qty. |
|----------|---|---|------|
| CRM47671 | Carbonyl-DNPH Mix 2, certified reference material | 2 µg/mL in acetonitrile, except where indicated (as aldehyde and ketone equivalent) | 1 mL |

Acetaldehyde-2,4-dinitrophenylhydrazine
 Cyclohexanone-2,4-dinitrophenylhydrazine, 5 µg/mL
 Acetone-2,4-dinitrophenylhydrazine
 Formaldehyde-2,4-dinitrophenylhydrazine, 4 µg/mL
 Acrolein-2,4-dinitrophenylhydrazine
 Hexaldehyde-2,4-dinitrophenylhydrazine
 Benzaldehyde-2,4-dinitrophenylhydrazine
 Methacrolein-2,4-dinitrophenylhydrazine
 2-Butanone-2,4-dinitrophenylhydrazine
 Propionaldehyde-2,4-dinitrophenylhydrazine
 Butyraldehyde-2,4-dinitrophenylhydrazine
p-Tolualdehyde-2,4-dinitrophenylhydrazine
 Crotonaldehyde-2,4-dinitrophenylhydrazine
 Valeraldehyde-2,4-dinitrophenylhydrazine

DNPH Single-Component Solution

| Cat. No. | Description | Concentration | Qty. |
|----------|---------------------------------|---------------------------|------|
| CRM47673 | Cyclohexanone-2,4-DNPH solution | 500 µg/mL in acetonitrile | 1 mL |

US EPA TO Methods

Toxic Organic Compounds in Air (TO)

TO-5/TO-11: Aldehydes and Ketones by HPLC/UV

| Cat. No. | Description | Concentration | Qty. |
|--|--|-------------------------------------|----------|
| Standard type calibration | | | |
| CRM47285 | TO11/IP-6A | 15 µg/mL in acetonitrile | 1 mL |
| CRM4M7285 | Aldehyde/Ketone-DNPH Mix, certified reference material | (as aldehyde and ketone equivalent) | 3 x 1 mL |
| Acetaldehyde-2,4-dinitrophenylhydrazine | | | |
| Acetone-2,4-dinitrophenylhydrazine | | | |
| Acrolein-2,4-dinitrophenylhydrazine | | | |
| Benzaldehyde-2,4-dinitrophenylhydrazine | | | |
| Butyraldehyde-2,4-dinitrophenylhydrazine | | | |
| Crotonaldehyde-2,4-dinitrophenylhydrazine | | | |
| 2,5-Dimethylbenzaldehyde-2,4-dinitro-phenylhydrazine | | | |
| Formaldehyde-2,4-dinitrophenylhydrazine | | | |

TO-11A Formaldehyde by HPLC

| Cat. No. | Description | Concentration | Qty. |
|----------|--|--|--------|
| CRM48149 | TO-11A Six Component Carbonyl-DNPH Mix, certified reference material | 15 µg/mL in acetonitrile (as aldehyde and ketone equivalent) | 1.5 mL |

Acetaldehyde-2,4-dinitrophenylhydrazine
 Acrolein-2,4-dinitrophenylhydrazine
 Formaldehyde-2,4-dinitrophenylhydrazine
 Acetone-2,4-dinitrophenylhydrazine
 Crotonaldehyde-2,4-dinitrophenylhydrazine
 Propionaldehyde-2,4-dinitrophenylhydrazine

Radiello® Aldehyde Calibration Standard

The aldehyde calibration standard consists of nine 2,4-dinitrophenylhydrazones (2,4-DNPH) diluted in acetonitrile. Actual concentrations for each component are certified for each lot. The standard stock solution is shipped in a pierceable-septum crimped cap. Cartridges are stable for at least four months when stored at 4 °C.

| Cat. No. | Description | Concentration | Qty. |
|----------|--------------------------|--|-------|
| RAD302 | Aldehyde Calibration Std | 50 µg/mL in acetonitrile, except where indicated (as aldehyde and ketone equivalent) | 10 mL |

Acetaldehyde-2,4-DNPH
 Acrolein-2,4-DNPH, 10 µg/mL
 Benzaldehyde-2,4-DNPH
 Butanal-2,4-DNPH
 Formaldehyde-2,4-DNPH
 Hexanal-2,4-DNPH
 Isopentanal-2,4-DNPH
 Pentanal-2,4-DNPH
 Propanal-2,4-DNPH

Aldehyde and Ketone DNPH Derivatives, Neats & Solutions

These solutions of DNPH derivatives are designed as quantitative calibration mixtures where a multi-component solution is not suitable. At concentration indicated as aldehyde or ketone equivalent in 1 mL (actual filling 1.1 - 1.2 mL) acetonitrile in amber glass ampule. Cat. Nos. starting with CRM indicate a certified reference material.

| Cat. No. | Description | Concentration | Qty. |
|-----------|--|----------------------------|----------|
| 442339 | 2-Butanone-2,4-DNPH | | 100 mg |
| CRM47344 | 2-Butanone-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM47340 | Acetaldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| CRM4M7340 | Acetaldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 5 x 1 mL |
| 442434 | Acetaldehyde-2,4-DNPH | | 100 mg |
| 442436 | Acetone-2,4-DNPH | | 50 mg |
| CRM47342 | Acrolein-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| 442441 | Acrolein-2,4-DNPH | | 25 mg |
| CRM47343 | Benzaldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM47345 | Butyraldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| 442504 | Butyraldehyde-2,4-DNPH | | 100 mg |
| CRM47175 | Crotonaldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| 442529 | Crotonaldehyde-2,4-DNPH | | 100 mg |
| CRM47673 | Cyclohexanone DNPH solution | 500 µg/mL in acetonitrile | 1 mL |
| 33852 | Decanal 2,4-dinitrophenylhydrazone | | 100 mg |
| CRM47177 | Formaldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM4M7177 | Formaldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 5 x 1 mL |
| 442597 | Formaldehyde-2,4-DNPH | | 100 mg |
| CRM47564 | Glutaraldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| 33848 | Heptanal 2,4-dinitrophenylhydrazone | | 100 mg |
| CRM47178 | Hexaldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| CRM47179 | Isovaleraldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| CRM47180 | Methacrolein-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| 33851 | Nonanal 2,4-dinitrophenylhydrazone | | 100 mg |
| 33849 | Octanal 2,4-dinitrophenylhydrazone | | 100 mg |
| CRM47183 | m-Tolualdehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM47182 | o-Tolualdehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM47184 | p-Tolualdehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| CRM47181 | Propionaldehyde-2,4-DNPH solution | 1000 µg/mL in acetonitrile | 1 mL |
| 442768 | Propionaldehyde-2,4-DNPH | | 100 mg |
| CRM47185 | Valeraldehyde-2,4-DNPH solution | 100 µg/mL in acetonitrile | 1 mL |
| 442834 | Valeraldehyde-2,4-DNPH | | 100 mg |

Alternative Aldehyde and Ketone Derivatives

NIOSH and OSHA Methods for Workplace Atmospheres

The following standards are for use with methods listed in OSHA and NIOSH manuals of methods for analysis of workplace contaminants. The standards are quantitative formulations for use as chromatographic calibration or spiking solutions. Products include a Certificate of Analysis describing lot-specific production and analytical information.

Free data packets containing data on raw materials and final production are available for most products. Request the data packet when ordering the standard; the order number is the same as that for the standard, preceded by the letters DP.

NIOSH 2541/OSHA 52: Analysis of Formaldehyde in Indoor Air

| Cat. No. | Description | Concentration | Qty. |
|----------|--------------------------------------|-----------------------|------|
| 48414 | Formaldehyde Oxazolidine solution | 2000 µg/mL in toluene | 1 mL |

Oximes

PFBHA (O-(2,3,4,5,6-pentafluorobenzyl)hydroxylamine) derivatives do not decompose at an elevated temperature. For this reason, PFBHA derivatives are a good alternative to 2,4-DNPH derivatives when using GC. Material purity ≥ 98% by GC except where noted.

| Cat. No. | Description | Qty. |
|----------|--|-------|
| 41558 | Formaldehyde-O-pentafluorophenylmethyl-oxime purum | 10 mg |

Get started

Additional resources are available for helping you implement air sampling products and devices.



Web

Visit SigmaAldrich.com for videos, product information, ordering and real-time availability information.



Email

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