

# GAS SAMPLING BAG PROPERTIES

New Gas Bags to Replace Tedlar®



## Tedlar® No Longer Available

Tedlar® poly(vinyl fluoride) film has been a standard material for gas sampling bags for many years because of its inertness, durability, high temperature resistance, and low permeability. However, the sole manufacturer of Tedlar® (DuPont) has decided to use all of its supply stream for the solar panel industry and thus no longer make it available for gas bags. Therefore, all gas bag manufacturers will soon run out of their stores of Tedlar® and are looking for alternatives.

## ALTEF® Formulated PVDF

Factory Direct Safety supplies gas bags made of ALTEF®, a specially formulated film based on poly(vinylidene fluoride), or PVDF. This material is chemically similar to Tedlar®, as shown in Table 1.

Table 1. ALTEF Film Properties.

Property	ALTEF®	Tedlar®
Thickness	0.003"	0.002"
Specific Gravity	1.78	1.70
Tensile Strength	6100 psi	8100 psi
Max. Operating Temp.	300°F	400°F
H <sub>2</sub> O Vapor Permeability	12-15 cc/cm <sup>3</sup> .d	9-57 cc/cm <sup>3</sup> .d
CO <sub>2</sub> Permeability	172 cc/cm <sup>3</sup> .d	172 cc/cm <sup>3</sup> .d
O <sub>2</sub> Permeability	58 cc/cm <sup>3</sup> .d	50 cc/cm <sup>3</sup> .d

ALTEF® has about the same permeability to oxygen and CO<sub>2</sub> as does Tedlar®, but its permeability to water vapor can be significantly lower.

## Advantages of ALTEF® Gas Bags

- Inert to most compounds including acids, alcohols, chlorinated solvents and aromatics.
- Very stable for sampled compounds including CO, CO<sub>2</sub>, methane, and most VOCs.
- Longer storage times for most VOCs than Tedlar®.
- Inherently pure material with no additives, fillers, or pigments.
- Does not release DMAC or phenols into the gas sample, as Tedlar® does, and has lower VOC and sulfur compound background than Tedlar®.
- Abrasion resistant
- Available in 9 different fitting types
- Available in sizes ranging from 1 to 10 liters (0.6 to 100 liters on special request)

## Limitations of ALTEF®

- Not compatible with high concentrations (>30%) of esters or ketones.
- Gradual losses of H<sub>2</sub>S and COS are observed. Similar losses are observed in Tedlar® and even more in alternatives such as "Flex-film". For these compounds we recommend Multi-layer foil bags.

## Multi-layer Foil Gas Bags

These bags exhibit extremely low permeability and are ideal for low molecular weight gases including H<sub>2</sub>, CO, and CO<sub>2</sub>. This film is the only type that holds H<sub>2</sub>S for >5 days, unlike Tedlar® or other bags. These bags also provide a strong moisture barrier and protect photo-sensitive compounds from light. Table 2 lists the five layers that give the low permeability and high inertness. Multi-layer foil bags have strong, even



seals, making them ideal for mailing or shipping to a laboratory for analysis. The multi-layer material is tough, yet flexible. Multi-layer foil bags are not suitable for collecting low ppm and ppb level VOC's due to background from the bag materials.

Table 2. Multi-Layer Foil Film Layer Material

<b>Barrier Layers</b> (Listed from outer to inner layers)	<ol style="list-style-type: none"> <li>1. 60 gauge Nylon</li> <li>2. Aluminum (Metallized)</li> <li>3. Polyethylene</li> <li>4. 0.0003" Aluminum Foil</li> <li>5. 0.002" Polyethylene</li> </ol>
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### Multi-layer Foil Bag Applications

- Biogas and landfill gas sampling:
  - Sewage treatment plants and landfills
  - Emission control
  - Fruit warehouses
  - Fermentation cellars
- Site sampling
- Mobile surveys
- Transfer of calibration gases to instrument from lab
- Assessing exposure from leaks and spills
- Indoor air studies
- Testing of workplace air quality
  - OSHA ID-172 (Carbon Dioxide)
  - OSHA ID-210 (Carbon Monoxide)

### Summary of Gas Bag Features and Benefits

Film	Unique Properties	Advantages	Limitations
<b>ALTEF</b>	<ul style="list-style-type: none"> <li>• Developed specifically for gas sampling applications</li> <li>• Chemically inert to most acids, aliphatic and aromatic organic compounds, chlorinated solvents, and alcohols</li> <li>• Maximum operating temperature: 302°F</li> <li>• Made of 0.003" thick film vs. competitor's 0.002" thick film bags</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable for sampling VOC's and sulfur compounds</li> <li>• Low VOC background</li> <li>• Longer sample storage times than most other bag materials</li> <li>• Does not exhibit background levels of DMAC or phenol, as Tedlar® does</li> <li>• Economical</li> <li>• Readily available</li> </ul>	<ul style="list-style-type: none"> <li>• More permeable than Tedlar® (0.003" thickness is recommended versus 0.002" for Tedlar®)</li> <li>• Not suitable for sampling ketones and esters in high concentrations (&gt;30%)</li> <li>• Lower resistance to UV light than Tedlar®</li> </ul>
<b>Multi-Layer Foil</b>	<ul style="list-style-type: none"> <li>• Multiple layers provide low permeability and a moisture barrier</li> <li>• Opaqueness protects samples from ultraviolet light</li> </ul>	<ul style="list-style-type: none"> <li>• The only bag material that adequately holds H<sub>2</sub>S for long periods (&gt;5 to 7 days)</li> <li>• Ideal for collecting low molecular weight compounds</li> <li>• Sample stability for up to 5 days for most compounds</li> <li>• Good VOC stability</li> <li>• Readily available</li> </ul>	<ul style="list-style-type: none"> <li>• Not suitable for collecting low ppm VOC's or less</li> </ul>
<b>FEP</b>	<ul style="list-style-type: none"> <li>• One of the most chemically inert materials available for making gas sampling bags</li> </ul>	<ul style="list-style-type: none"> <li>• Works well in extreme temperatures ranging from -400°F to +400°F, allowing it to be used in all stack sampling conditions</li> <li>• Heavier gauge (0.005") film is resistant to most severe corrosives as well as tolerates applications involving rough handling or difficult service conditions</li> <li>• Less expensive than PFA</li> <li>• Readily available</li> </ul>	<ul style="list-style-type: none"> <li>• Poor storage stability for most VOC's and sulfur compounds</li> <li>• More permeable than Tedlar®, ALTEF, and Multilayer Foil bags</li> <li>• More expensive than Tedlar®, ALTEF, and Multilayer Foil bags</li> </ul>
<b>PFA</b>	<ul style="list-style-type: none"> <li>• Highest purity, most chemically inert film available for making gas sampling bags</li> <li>• Widest temperature range: from -420°F to +500°F</li> </ul>	<ul style="list-style-type: none"> <li>• Not affected by the most corrosive chemicals, such as HF, HCl, Nitric, and Sulfuric Acids</li> <li>• Readily available</li> </ul>	<ul style="list-style-type: none"> <li>• The most expensive film option</li> <li>• Much more permeable than Tedlar®</li> </ul>

## Chemical Storage Stability Charts

Sulfur Compounds @ ~100 ppb		
Test Compound	Bag Material	
	ALTEF	Multi-Layer Foil
n-Butyl mercaptan	Not Suitable	Not Suitable
tert-Butyl mercaptan	Recommended	Recommended
Carbon disulfide	Suitable if analyzed within 24 hours	Not Suitable
Carbonyl sulfide	Recommended	Recommended
Diethyl disulfide	Not Suitable	Not Suitable
Diethyl sulfide	Suitable if analyzed within 24 hours	Not Suitable
Dimethyl disulfide	Not Suitable	Not Suitable
Dimethyl sulfide	Suitable if analyzed within 24 hours	Not Suitable
2,5-Dimethylthiophene	Not Suitable	Not Suitable
Ethyl mercaptan	Suitable if analyzed within 24 hours	Recommended
Ethyl methyl sulfide	Suitable if analyzed within 24 hours	Not Suitable
2-Ethylthiophene	Not Suitable	Not Suitable
Hydrogen Sulfide	Not Suitable	Recommended
Isobutyl mercaptan	Suitable if analyzed within 24 hours	Not Suitable
Isopropyl mercaptan	Suitable if analyzed within 24 hours	Recommended
3-Methylthiophene	Not Suitable	Not Suitable
Methyl mercaptan	Suitable if analyzed within 24 hours	Recommended
n-Propyl mercaptan	Suitable if analyzed within 24 hours	Recommended
Tetrahydrothiophene	Not Suitable	Not Suitable
Thiophene	Suitable if analyzed within 24 hours	Not Suitable

**Key:**

Not Suitable
Recommended
Suitable if analyzed within 24 hours
Suitable for medium to high ppm levels*

\* Multi-Layer Foil bags can be used to sample most VOCs at moderate to high ppm levels but are not recommended for low ppm levels or less due to background from the bag materials.

ALTEF bags are recommended for most VOCs if analyzed within 48 hours and for many sulfur compounds if analyzed within 24 hours.

Multi-layer foil bags are recommended for methane (CH<sub>4</sub>), hydrogen sulfide (H<sub>2</sub>S), carbon monoxide (CO), and carbon dioxide (CO<sub>2</sub>) if analyzed within 24 hours.

VOCs @ 200-300 ppm		
Test Compound	Bag Material	
	ALTEF	Multi-Layer Foil
Acetone	Not Suitable	Suitable for medium to high ppm levels*
Acetonitrile	Not Suitable	Suitable for medium to high ppm levels*
Acrylonitrile	Not Suitable	Suitable for medium to high ppm levels*
Allyl chloride	Recommended	Suitable for medium to high ppm levels*
Benzene	Recommended	Suitable for medium to high ppm levels*
Bromoethane	Recommended	Suitable for medium to high ppm levels*
Butyl acetate	Not Suitable	Suitable for medium to high ppm levels*
Carbon tetrachloride	Recommended	Suitable for medium to high ppm levels*
Chloroform	Recommended	Suitable for medium to high ppm levels*
Carbon dioxide	Recommended	Suitable for medium to high ppm levels*
Carbon monoxide	Recommended	Suitable for medium to high ppm levels*
1,2-Dichloroethane	Recommended	Suitable for medium to high ppm levels*
Dichloropropane	Recommended	Suitable for medium to high ppm levels*
Ethyl acetate	Not Suitable	Suitable for medium to high ppm levels*
Ethylene	Recommended	Suitable for medium to high ppm levels*
Heptane	Recommended	Suitable for medium to high ppm levels*
Hexane	Recommended	Suitable for medium to high ppm levels*
Isooctane	Recommended	Suitable for medium to high ppm levels*
Isopropyl alcohol	Recommended	Suitable for medium to high ppm levels*
Methane	Recommended	Suitable for medium to high ppm levels*
Methyl ethyl ketone	Not Suitable	Suitable for medium to high ppm levels*
Methylene chloride	Recommended	Suitable for medium to high ppm levels*
Methyl tert-butyl ether	Recommended	Suitable for medium to high ppm levels*
Octane	Recommended	Suitable for medium to high ppm levels*
Perchloroethylene	Recommended	Suitable for medium to high ppm levels*
Propylene	Recommended	Suitable for medium to high ppm levels*
Propylene oxide	Recommended	Suitable for medium to high ppm levels*
Tetrahydrofuran	Recommended	Suitable for medium to high ppm levels*
Toluene	Not Suitable	Suitable for medium to high ppm levels*
1,1,1-Trichloroethane	Recommended	Suitable for medium to high ppm levels*
Trichloroethylene	Recommended	Suitable for medium to high ppm levels*
Vinylidene chloride	Recommended	Suitable for medium to high ppm levels*
p-Xylene	Not Suitable	Suitable for medium to high ppm levels*

## Gas Bag Fittings

A variety of fittings are available on the FDSE Gas Bags:



### Polypropylene Screw-Cap Combo Valve

- On/Off valve function with replaceable septum in a single unit. Side port for tubing connection.
- Uses fluoropolymer-faced, low-bleed silicone septum.
- Inexpensive
- Lightweight. Easier to carry multiple bags in the field.
- Made of inert polypropylene. Ensures sample purity.
- Quick, easy opening and closing of valve, even in harsh conditions with no tools required. Less than one half turn opens/closes valve.
- Visual confirmation that valve is open or closed prevents accidental sample loss.



### Polypropylene Locking® Combo Valve with Septum

- On/Off valve function with replaceable septum in a single unit.
- Uses fluoropolymer-faced, low-bleed silicone septum. Allows repeated punctures with syringes without leakage.
- Inexpensive
- Lightweight. Easier to carry multiple bags in the field.
- Made of inert polypropylene. Ensures sample purity.
- Push/Pull (On/Off) valve stem. Quick, easy opening and closing of valve (< 1 second). Faster than "twist-action" valves.
- Quick locking function requires no tools, and visual confirmation prevents accidental sample loss.



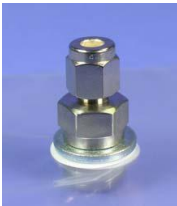
### Stainless Steel TCLP Fitting with Septum

- Stainless steel body with aluminum cap and replaceable fluoropolymer faced septum.
- Durable: withstands use in austere sampling conditions.
- Inert: Sample contacts only stainless steel & fluoropolymer.
- Lower cost than 1/4" Swagelok type fittings and nickel plated Halkey Roberts fitting.
- Designed for use with Zero Headspace Extractors.
- Validated fitting style for EPA TCLP (Toxicity Characteristic Leaching Procedure) method.



### Stainless Steel Combo Valve with Replaceable Septum

- Design combines on/off valve and septum into a single fitting to lower cost & weight.
- Stainless steel body with aluminum cap and replaceable fluoropolymer faced septum.
- Durable: withstands use in austere sampling conditions.
- Inert: Sample contacts only stainless steel & fluoropolymer.
- Lower cost than 1/4" Swagelok type fittings and nickel plated Halkey® Roberts fitting.



### Swagelok® type Stainless Steel Fitting for Tubing or Septum

- Stainless steel construction. Durability and ability to withstand use in austere sampling conditions.
- Allows attachment of tubing or syringe sample extraction by switching caps.
- Replaceable fluoropolymer-faced septum with large area allows repeated punctures with common lab syringes.



**Plastic Jaco® Fitting for Tubing or Septum**

- Compression ferrule secures tubing onto fitting with superior grip compared to metal fittings.
- Polypropylene molded construction.
- Inexpensive compared to metal fittings.
- Allows attachment of tubing or syringe sample extraction by switching caps.
- Replaceable fluoropolymer-faced septum with large area allows repeated punctures with common lab syringes.



**PFA Fitting for Tubing or Septum**

- PFA fluoropolymer construction Sample only comes into contact with high purity, inert fluoropolymer PFA, the ultimate in chemical resistance and non-contaminating material.
- Allows attachment of tubing or syringe sample extraction by switching caps.
- Compression ferrule secures tubing onto fitting with superior grip compared to metal fittings.
- Replaceable fluoropolymer-faced septum with large area allows repeated punctures with common lab syringes.



**Nickel Plated Halkey® Roberts Barbed On/Off Valve**

- Nickel Plated. Resists damage from most aggressive chemicals.
- Barbed stem for attaching tubing.
- Leak resistant seal prevents sample loss in closed position. However, when stem is not closed, sample air passes into ambient air outside valve.