

Pulmonary Function Testing



Metabolic testing has a wide range of applications, from detecting H. pylori to monitoring asthma patients. It's even being developed as a way to measure blood glucose levels.

Pulmonary Function Testing is a subset of metabolic testing and typically used when a patient is taking a stress test or an athlete is undergoing performance testing. These systems measure CO₂ and O₂ in the exhaled breath to determine the utilization of oxygen and excretion of carbon dioxide in each respiratory cycle. The results of this testing help gauge the overall efficiency of a patient's respiratory system and fitness level.

Other uses for Pulmonary Function Testing range Ambulatory systems are used by athletes during their training to provide a real-time record of their respiratory performance during peak demand. Stationary systems, which look like transparent phone booths, are used in hospitals and healthcare providers' offices during routine cardiac stress testing and also during metabolic testing to create a profile of a patient's metabolism, allowing providers to design customized exercise and weight-loss programs.

How Pulmonary Function Testing Equipment Works

A patient may walk or run on a treadmill or ride a stationary bike in the "booth" while breathing through a mouthpiece. Many Pulmonary Function Testing equipment use spirometry and pulse oximetry to measure oxygen utilization and breath volume/lung capacity. Spirometry measures the volume of each inhaled and exhaled breath as well as the speed at which the patient moves the air. This test can be used to diagnose chronic lung diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD). In pulse oximetry, a sensor is placed across the earlobe or fingertip and sends two wavelengths of light through the body part to a detector. The equipment's software interprets the difference in absorbance of each wavelength to measure the level of oxygen saturation in a patient's bloodstream.

Metabolic test rigs will also include capnography, which measures carbon dioxide in exhaled breath. By evaluating both CO₂ and O₂ levels, healthcare providers and athletic trainers can get a better idea of a patient's individual respiratory performance. Unlike pulse oximetry and spirometry equipment, capnography monitors, also known as capnographs, are very sensitive to the moisture in a patient's breath.

Capnographs used in Pulmonary Function Testing equipment is especially susceptible because the higher rates of respiration that occur during exercise translate to more exhaled moisture.

The exhaled breath travels from the mouthpiece, through a sample line, and to the capnograph. These monitors usually work on the principle that CO₂ absorbs infrared radiation. A beam of infrared light is passed across the gas sample to fall on a sensor. The presence of CO₂ in the gas leads to a reduction in the amount of light falling on the sensor, which changes the voltage in a circuit. The analysis is rapid and accurate. Capnographs display a numerical value as well a waveform, which is a graphical depiction of the CO₂ concentration in each exhaled breath. This information provides valuable insights into the CO₂ production, pulmonary perfusion, alveolar ventilation, respiratory patterns, and overall respiratory efficiency.

Challenges Associated with Pulmonary Function Testing Equipment

While Pulmonary Function Testing using a capnograph is extremely accurate, water vapor can interfere with the proper operation and results in variety of ways:

Moisture Interference in Infrared Analysis used for CO₂ Monitoring & Measurement

Water vapor appears on the scale in the same region as the CO₂ peak, making the results difficult to read and introducing inaccuracies based on the operators' interpretation of the results. Removal of the water, in vapor phase, preserves the CO₂ level while eliminating interference.

Moisture build-up in Sample Lines

Condensation from the breath gas sample stream can collect in the sample lines, a problem normally found when the fully saturated sample at body temperature is brought into contact with the lines at standard room temperature.

Moisture Collection in the Sensor Cell

Condensation in the sample will eventually reach the analyzer, and will cause irreparable harm to the sensor and render the equipment unusable. This is a problem commonly found when the fully saturated breath sample (at 37C body temperature) is brought to the analyzer at a colder room temperature.

The Perma Pure Solution: ME Series Highly –Selective Permeation Tubing

Perma Pure's ME tubing products can reduce reliance on, or even eliminate, water traps in Pulmonary Function Testing equipment where exhaled air creates condensation that can reduce accuracy of measurements, damage equipment, and create patient discomfort. Water traps can fill with liquid, leading to alarms, blocking of sample lines, and damaging expensive and sensitive medical monitoring systems. Our Nafion®-based permeation tubing solutions are simple, cleaner, and healthier – improving accuracy and reducing alarms to support a better environment for practitioners and patients.

Delivering the Perma Pure Medical Advantage for Breath Drying

- Fast response time – instantaneous and continuous moisture transfer
- Fully bio-compatible for surface contact with patient skin
- Utilizes Nafion® membrane tubing technology
- Removes up to 90% of moisture in breath samples
- Improves accuracy of IR-based EtCO₂ measurements by eliminating moisture interference
- Highly selective – removes water vapor while retaining sample analytes
- Prevents condensation to protect medical monitoring equipment
- Reduces dead volume in sample circuit when compared with a water traps

For more than forty years, Perma Pure has provided solutions for managing moisture in critical applications related to health and environmental safety. Our medical solutions include highly-selective permeation tubing products which are used by industry leading OEMs of medical diagnostic equipment and patient consumable products. We are proud to partner with our broad and diverse customer base to make the world healthier and cleaner. Our commitment to protect life starts with a focus on quality and partnership with our customers to meet the challenges of a dynamic global marketplace while making the world safer and healthier.

Perma Pure is the exclusive manufacturer of Nafion® tubing, a highly-selective permeation membrane that is uniquely suited for medical moisture management. It can be used to remove moisture from breath samples prior to analysis. Our Nafion®-based solutions take advantage of the material's unique properties that allow the removal of water vapor without the loss of any other compounds, such as CO₂ or anesthetic agents. Removal of moisture improves accuracy of IR-based CO₂ measurements by eliminating interference.

Providing the Highest Quality and Reliability

We are a proven supplier to industry-leading medical device OEMs. Our manufacturing process and quality meet the high standards required for medical applications.

- 100% leak and flow testing of dryers and sample lines
- ISO9001 and ISO13485 certified
- FDA registered
- Controlled environment for clean manufacturing
- Braided polypropylene monofilament protects Nafion® tubing
- Flexible for easier integration into the module
- Kink-resistant for bending and coiling

Offering Advanced Assembly Services

More than just tubing – we offer a full array of assembly capabilities to meet your specifications.

- Sample lines with or without dryers
- Custom labeling and packaging
- Design optimization for better flow and moisture exchange
- Standard or custom connectors
- Test capabilities
- Overmolding and solvent bonding of connectors

A Quality-Driven, Innovative Partner

Perma Pure is a trusted supplier to thousands of customers. Our Nafion®-based solutions have enabled our customers to reduce cost, improve reliability, increase accuracy, and bring new and innovative medical products to market. You can turn to Perma Pure with confidence for proven moisture management solutions, backed by decades of experience, to enable your next breakthrough.



Serving a Wide Range of Applications

Perma Pure ME Series products are an enabling technology for:

CAPNOGRAPHY • ANESTHESIA MONITORING • PULMONARY FUNCTION TESTING • INHALED GAS THERAPY

Part #	
ME Moisture Exchanger Series	ME
Nafion® Tubing Size and Typical Sample Flow Rates	
1.07mm ID x 1.35mm OD – samples up to 200cc/min	50
1.32 ID x 1.60mm OD – samples up to 400cc/min	60
1.52mm ID x 1.83mm OD – samples up to 600cc/min	70
2.18mm ID x 2.74mm OD – samples up to 1L/min	110
Standard Dryer Lengths	
6" (15 cm)	6
12" (30 cm)	12
18" (45cm)	18
24" (60 cm)	24
48" (120 cm)	48
End Fittings	
DEHP-free medical tubing attached to each end of ME Series	TT
Thermoplastic tube with nylon barb coupling	BT
Nylon barbed fitting (ME-070 and ME-110 only)	BB
1/16" molded polypropylene barb fitting (ME-050, ME-060 only)	MB
Stainless steel tube in molded polypropylene header	ST
Molded male locking luer fitting (not available on ME-110)	ML
Male locking luer with push-in barb attached with heat shrink	BML
Molded female luer fitting (not available on ME-110)	FL
Female locking luer with push-in barb attached with heat shrink	BFL
Molded male slip luer fitting (not available on ME-110)	MS
With 1/8" stainless steel compression fittings (ME-060 only)	COMP2
Molded headers for 1/4" compression fittings (ME-110 only)	COMP4



ME	050	12	BB
Series	Tubing	Length	Fittings