Perma Pure™

Breathe Easier. Be Healthier.

Solutions for Gas Drying | Solutions for Humidification | Sample Conditioning System & Coolers | Other Solutions

Environmental and Scientific Solutions

Preparing Gas Samples

Perma Pure's Environmental and Scientific portfolio offers a wide array of products used for the drying, humidification, and conditioning of gases. Controlling the amount of water vapor in the sample helps to ensure analytical accuracy, reduces the risk of damage to equipment and minimizes downtime.

Our products are used worldwide in a variety of applications including emissions monitoring, ambient air monitoring, laboratory analysis and process control.

Our commitment is to:

- Improve Analysis
- Safeguard Equipment
- Build Cleaner Processes

Nafion™ Polymer

Many of our solutions are powered by Nafion™ polymer tubing. Unlike porous membranes that depend on the physical size of a molecule, Nafion™ polymer's selectivity is based on chemical reactivity. Nafion™ polymer utilizes the partial pressure of water vapor on either side of its membrane to move water vapor from the side of higher partial pressure to the side of lower partial pressure. The process will continue as long as there is a pressure differential or until it reaches equilibrium.

This gives our products the unique ability to transfer water vapor from one side of the membrane to the other while leaving most other analytes in the gas stream untouched.

Retained in Sample	
Atmospheric Gases	Ar He H_2 **N_2 O_2** O_3
Halogens	Br_2 Cl_2 F_2 I_2
Hydrocarbons	Simple Forms (Alkanes)
Inorganic Acids	**HCl HF HNO_3 H_2SO_4**
Other Organics	Aromatics Esters Ethers
Oxides	**CO CO_2 SO_X NO_X**
Sulfur	COS H_2S Mercaptans
Toxic Gases	$COCl_2$ HCN NOCl

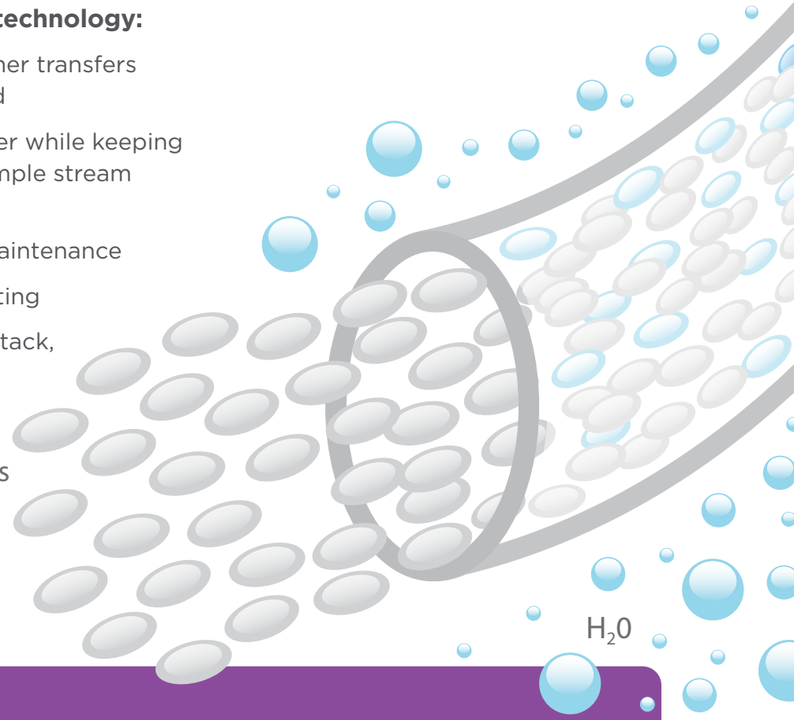
Losses	
Atmospheric Gases	H_2O
Inorganics	NH_3
Organics	Alcohols, DMSO, THF
Variable Loses	
Organics	Acids
	Aldehydes
	Amines
	Ketones
	Nitriles

Chemicals/compounds highlighted in bold represent typical combustion analytes.

Perma Pure
Breathe Easier. Be Healthier.

Benefits of Nafion™ polymer technology:

- Highly efficient, Nafion™ polymer transfers water in a fraction of a second
- Highly selective, removes water while keeping most other analytes in the sample stream regardless of particle size.
- No moving parts or routine maintenance
- Continuous and self-regenerating
- Highly resistive to chemical attack, making it ideal for use with corrosive gases



Did You Know?

Water molecules must come in contact with the Nafion™ tubing for water transfer to happen. As the number of water molecules that touch the surface area of the tubing increases so does the drying or humidifying performance.

This can be accomplished by:

- **Increasing the length of the tubing**
- **Increasing the diameter of the tubing**
- **Increasing the number of tubes used**

Tubing is available in a variety of sizes:

Part Number	Inside Diameter (in)		Outside Diameter (in)		Wall Thickness (in)
	Min	Max	Min	Max	
TT-020	0.012	0.016	0.018	0.024	0.003
TT-030	0.023	0.028	0.03	0.036	0.003
TT-050	0.038	0.046	0.048	0.058	0.005
TT-060	0.047	0.057	0.057	0.069	0.005
TT-070	0.054	0.066	0.065	0.079	0.006
TT-110	0.077	0.094	0.097	0.119	0.01

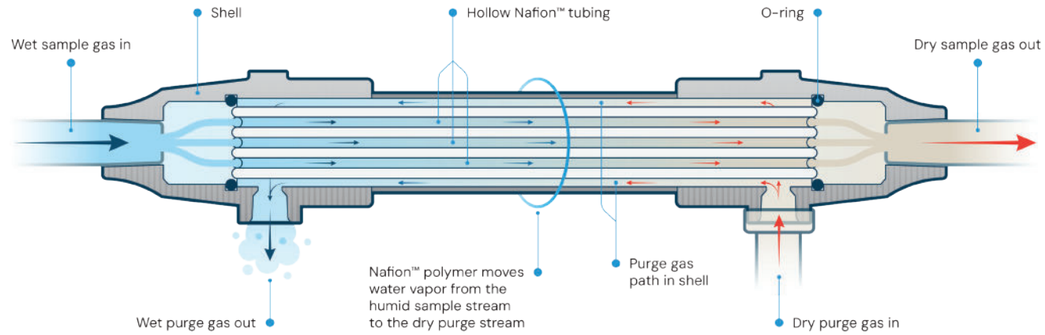
Solutions for Gas Drying

	Flow Rate			Drying Performance				Gas	
Series	< 2 lpm	2 – 4 lpm	> 4 lpm	Ambient	-10°C	-30°C	-40°C	Purge Gas Required	Gas to Gas Humidification*
MD	✓	✓		✓	✓	✓	✓	✓	✓
MRD	✓	✓		✓	✓	✓	✓	✓	✓
PD	✓	✓	✓	✓	✓	✓	✓	✓	✓
BE	✓	✓		✓		✓			✓
BE-HP	✓	✓		✓					✓
MDH	✓			✓	✓		✓	✓	
DM	✓			✓	✓	✓	✓		

*While drying is the most common application, Perma Pure Dryers can be use for gas-to-gas humidification by using a purge gas with a higher dew point than the sample gas.

For more information on available dryer sizes and lengths visit our website at **www.permapure.com**. Custom and OEM configurations are available based on quantity and application.

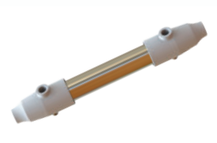
Perma Pure
Breathe Easier. Be Healthier.



MD Series

MRD Series

PD Series



	MD Series	MRD Series	PD Series
Description	Single tube in shell design	Single tube in shell design with rotating end fittings ideal for tight spaces and easier maneuverability	Multiple tubes (50, 100, 200 Tubes) in one shell design
Flow Rate	up to 4 lpm	up to 4 lpm	up to 40 lpm
Temperature	up to 100 °C	up to 100 °C	up to 100 °C
Pressure	up to 80 psig (6 barg)	up to 80 psig (6 barg)	up to 30 psig (2 barg)

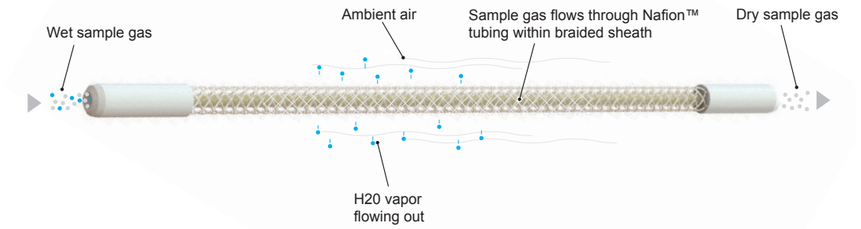
Tube in Shell Dryers

Drying to dew points as low as -40°C, our tube in shell dryers consist of a single or multiple Nafion™ tube(s) in a hollow shell. These dryers require a purge gas source, such as vacuum or instrument air, connected to the purge ports of the dryer. The purge gas will flow outside the Nafion™ tubing counter-current to the sample gas flowing inside the Nafion™ tubing. Since water vapor removal is driven by the partial pressure differential of water vapor across the membrane, the purge gas needs be drier than the sample in order to draw water out of the sample and through the Nafion™ polymer membrane.

Shell and fitting materials are available in a variety of materials to accommodate different operating conditions and parameters.

BE-Series Braided Exchangers

Ideal for applications were meeting ambient conditions is sufficient.



BE Series	BE-HP Series
No purge gas required	No purge gas required
Flow rates up to 4 lpm	Flow rates up to 4 lpm
Can remove up to 90% moisture from a wet gas stream	Can remove up to 90% moisture from a wet gas stream
Temperatures up to 80° C	Temperatures up to 80° C
Pressures up to 80 psig (6 barg)	Pressures up to 250 psig (17 barg)

BE-Series Dryers can be used in a two staged drying process along with desiccant to increase the efficiency and prolong the life of the desiccant.

MDH Series

Ideal for gas samples with dew points higher than ambient temperature.

- Does not require separate heating element or insulation
- Flow rates up to 1.5 lpm
- Operating temperatures to max. 80°C
- Operating pressures to 100 psi (absolute)
- Can dry gases with as much as 30% water by volume

DM Series

Ideal for applications that require portability.

- No purge gas or pumps are required
- Nafion™ tubing surrounded by desiccant
- Water vapor absorbed by Nafion™ tubing is transferred into surrounding desiccant
- Flow rates up to 1 lpm

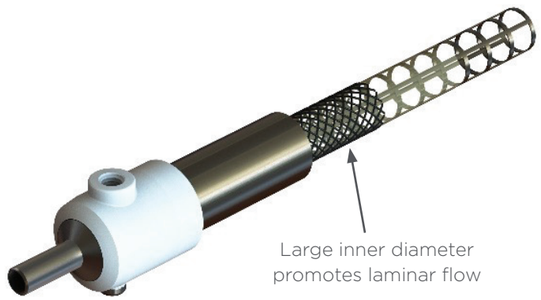
Perma Pure
Breathe Easier. Be Healthier.

Humidity Control

MD-700 Series Gas Dryer

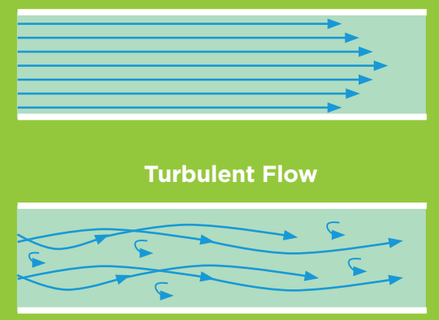
Designed specifically for humidity control in particle measurement and aerosol analysis applications.

- Maintains laminar flow throughout the sample path, significantly reducing particle loss
- Grounded stainless-steel tubing and shell construction eliminate buildup of static electricity
- Flow rates up to 17 lpm
- Available in multiple lengths to accommodate flow rate and drying requirements



Did You Know?

Laminar flow is characterized by a streamlined orderly flow while turbulent flow is more chaotic. Most of Perma Pure's dryers are designed for turbulent flow which increases the surface area contact of water molecules with the tubing wall. The MD-700 is designed to minimize particle loss. In this case reducing contact with the tubing wall is essential and therefore laminar flow is preferred.



Solutions for Humidification

Types of Humidification

Gas-to-Gas Humidification

Water vapor from a source gas flowing outide the Nafion™ tubing is transferred into the gas stream.

Applications include:

- Calibration gases
- Particle and aerosol streams
- Gases the contain water soluble components

Water-to-Gas Humidification

Liquid water flows along the outside of the Nafion™ tubing, counter current to the sample stream.

Applications include:

- Gases that do not contain water soluble analytes
- Air to be used in other processes, such as gas blending

Perma Pure
Breathe Easier. Be Healthier.

MH Series

- Efficient water-to-gas humidification with minimal temperature loss
- Wide range of flow rates, up to 20 lpm
- Humidifies to 98% RH

FC Humidity Exchangers

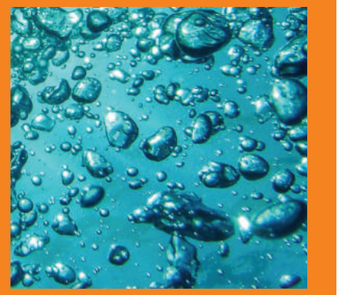
Provide consistent repeatable humidification.

- Appropriate for water-to-gas or gas-to-gas humidification
- Suitable for use with H_2
- Highly efficient, requiring no power consumption
- Multiples sizes available with flow rates ranging from:
  - Gas-to-gas to 4 - 2500 alpm
  - Water-to-gas: up to 7000 slpm

Nafion™ polymer utilizes the difference in partial pressure of water vapor on either side of its membrane to transfer water. As a result, our **MD-Series**, **PD-Series** and **BE-Series** products can also be used for gas-to-gas humidification if the water concentration on the outside of the tubing is higher than on the inside.

Did You Know?

Perma Pure humidifiers require the use of deionized water. DI water is purified water that has all its ions removed. Standard water has cation ions present that attract the negatively charged OH groups on the surface of the Nafion™ tubing. These groups functions as pathways for water transfer. The capability to transfer water declines as the pathways are blocked.



Sample Conditioning System and Coolers

The Baldwin line of sample conditioning systems and coolers consistently and reliably reduce the dew point of emissions and process gases to 4°C even when ambient temperatures fluctuate.

Complete systems include thermoelectric cooler, sample pump, drain pump, particulate filter, sensors, relays and flow meters (some components are optional). Thermoelectric coolers can be purchased as part of a complete system or separately.

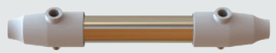
Coolers and Systems

	System	Thermoelectric Cooler	Flow Rate	Impingers	
				Passive	Active
Low Capacity	4S-9A	4C-M115D	1 lpm		1
	4S-9PA	4C-M325D	3 lpm	1	1
	4S-9AA	4C-M425D	4 lpm		2
High Capacity	4S-9PA	4C-5210D	3 – 8 lpm	1	1
	4S-9AA	4C-8210D	4 – 10 lpm		2
	4S-9PAPA	4C-20410D	10 – 20 lpm	2	2
Hazardous Area*	4SX-9PA	4E-5500XP	4-7 lpm	1	1
	4SX-9AA	4E-5800XP	7 – 10 lpm		2
	4SX-9PAPA	4E-5900XP	10 – 20 lpm	2	2

*Certified Under CSA: Class I, Division 2, Groups A, B, C and D T3B.

Did You Know?

Polishing gas is the process of removing excess water after the sample gas stream passes through the gas conditioning system. Perma Pure's PD dryers are an effective way to polish gas after a thermoelectric cooler. This helps to ensure the most accurate analysis, protects the analyzer from potential damage from condensation and acts as safety measure in case of cooler malfunction.



Perma Pure
Breathe Easier. Be Healthier.

Hybrid Sample Gas Cooler

Exclusive Product – Patent #: US 11,067,483

Perma Pure's Hybrid Sample Gas Cooler combines the superior performance of Nafion™ polymer drying technology with the functionality of a traditional thermoelectric cooler. Powered by compressed air, this non-electric cooler achieves dew points lower than 0˚C helping to prevent problems associated with condensation. The patented mechanical design is ideal for locations with limited or no access to power and is suitable for use in C1D2 hazardous area locations.*

Operates with greater efficiency than comparable non-electric coolers.**

Non-electric mechanical design:

- Reduces the costs associated with electrical installation and permits***
- Simplifies maintenance
- Increases reliability resulting in decreased downtime

Achieves dew points lower than 0˚C

- Reduces the risk of damage to the analyzer
- Helps increase analytical accuracy

System	Description	Sample Gas Pressure	
		Positive	Negative
PCD-3000-W	Drain eductor compresses incoming air to create a vacuum needed to drain condensate.		✓
PCD-3000-W-DP	Includes provision for drain pump.		✓
PCD-3000-PR	Includes bypass port to increase response time.	✓	
PCD-3000-PR-CD	Includes bypass port and drain float valve to prevent sample gas from escaping.	✓	

* Complies with ISO 80079-36 Group II, Zone T3/T4 for use in C1D2 hazardous locations

** Compared to a vortex cooler removing 40% water by volume at sample flow rate between 3 and 4 LPM

*** Grounding Lug is necessary for installation

Gas Analysis Sampling Systems (GASS)

Leveraging the unique properties of Nafion™ polymer technology, these systems are designed to replace a thermoelectric cooler and to produce a dry, clean, cool sample even under the harshest of conditions, including gas streams that have:

- High moisture content
- High levels of water-soluble analytes such as H_2S, HF, HCl, NO_x, SO_x
- Very low dew points

System	Description	Flow Rate (lpm)			Max Drying Performance	
		5	10	25	-15°C	-25°C
Indi-GASS™	Minimal electronics and controls, ideal for remote industrial locations.	✓			✓	
Mini-GASS™	Can handle sample streams with up to 30% water by volume.		✓			✓
GASS-2040™	Ideal for the harshest conditions. Can handle sample streams with up to 70% water by volume		✓	✓		✓

Specialty Drying Applications

The Micro GASS can handle higher temperatures and humidity. It is suited for ECS analyzers and is used for CEMS applications. The ACES is intended for electo-chemical sensor (ECS) type analyzers.

System	Description	Flow Rate
Micro-GASS™	Heated System: Ideal for gases that condense above ambient conditions.	Up to 1 lpm
ACES™	Non-Heated System: Ideal for gases that are non-condensing at ambient conditions.	Up to 2 lpm

Did You Know?

The combination of ammonia, SO_x and water can cause ammonia salts to form that may clog your sample line and cause damage to the analyzer. Removing as much water and ammonia as possible can prevent this from happening.

Formation of Ammonia Salts

$$NH_3 + SO_2 + H_2O \longrightarrow NH4HSO3$$

$$NH_3 + SO_3 + H_2O \longrightarrow NH4HSO4$$

Other Solutions

Heated Filter Probes

- Designed to extract a representative portion of gas sample from a stack or duct
- Heated enclosure maintains sample gas temperature above dew point
- Removes particulate before entering heated transport line

	Particulate Level	Self-Regulated Control	Blowback	Z-Purge
4P-32C	Low			
4P-34C-R	High	✓	✓	
4P-34C-R-Z*	High	✓	✓	✓

* Suitable for certification in class 1 Division 2 areas

Ammonia Scrubbers

- Highly selective, remove ammonia from gas stream to protect the analyzer
- Install prior to a condensing cooler to prevent clogging from ammonia salt formation

Acid Safety Scrubbers

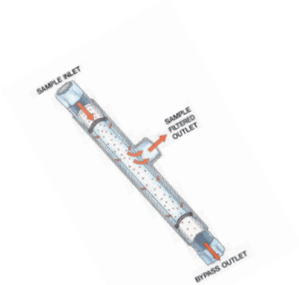
- Calcium carbonate scrubbers remove acidic gas stream components to protect analyzers from corrosion

Baldwin Flow Control Drawers

- Provide an easy and compact solution for the control of sample and calibration gases
- Control up to 6 gas analyzer channels and 8 calibration gases

FF Series Coalescing Filters

- Ideal for high temperature corrosive environments
- Remove liquid droplets and particulate down to 1 micron



FF Series Bypass Filters

- Inertial separation filters for high particulate applications

HD Series Heatless Desiccant Dryers

- Supplies continuous dry air
- Fully automatic reaching dewpoints of -50°C

SDS Supplemental Drying System

- Prevents damage to analyzers and sample conditioning equipment due to process upset conditions and from wet acids
- Ready-to-use system with minimal setup time

Zero Air Generator

- Portable generator eliminates the needs for cylinder gas
- Produces up to 18 lpm of purified air successfully removing CO, NOX, SOX, water vapor, hydrocarbons, acid vapors and bacteria

Perma Pure
Breathe Easier. Be Healthier.

Clayborn Heated Lines & Heat Tape

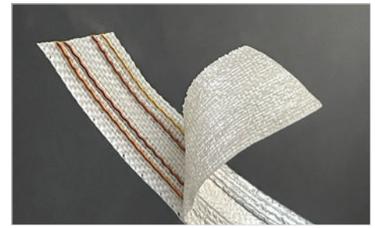
Clayborn Lab

An industry leader in adhesive heat technology, Clayborn Lab products are utilized in a multitude of applications from space programs to continuous emissions monitoring systems.

Heated Lines

Utilizes Clayborn's own proprietary heat tape as the heating element.

- Consistent heating, no zonal drop out
- Terminated ends for easier installation
- Fully customizable to achieve specific temperature, length, and voltage combinations
- Integrated strain relief loops for easier maneuverability and durability
- Application include CEMS, stack testing, process control, viscosity management



Heat Tape

Flexible tape allows for precision wrapping and consistent heating.

- Highly efficient architecture
- Rapid heat-up time
- Customizable for specific applications

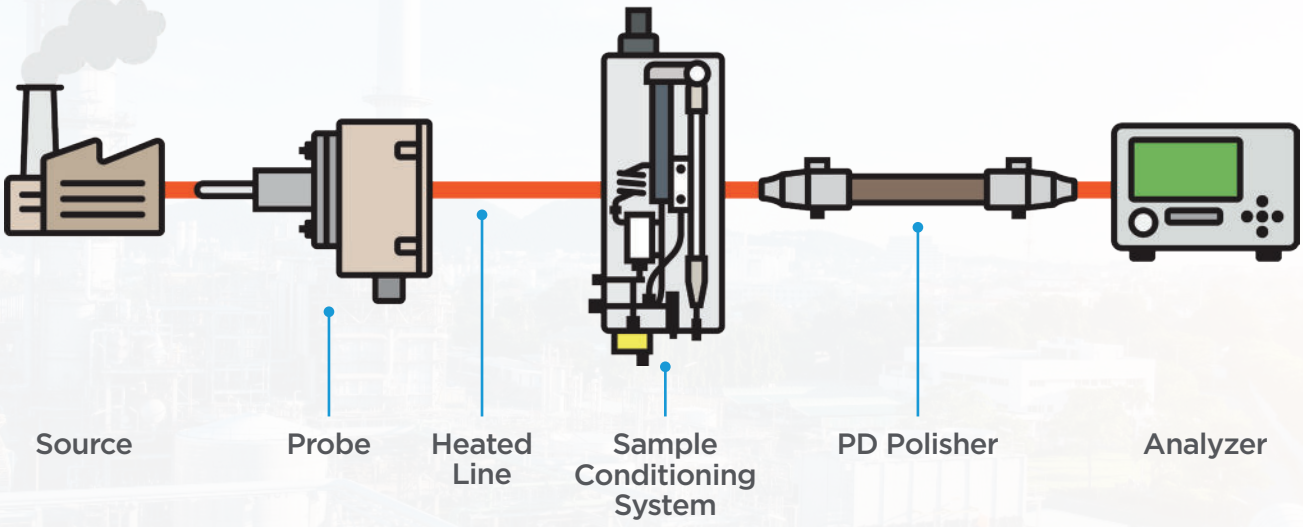
Did You Know?

Clayborn Lab Heated Lines are also used in a variety of viscosity control applications to help maintain the proper flow of materials and ensure a consistent process.

Perma Pure
Breathe Easier. Be Healthier.

Offering a full solution from sample source to analyzer, Perma Pure has everything needed to ensure cool, clean, dry sample gas is introduced to the analyzer.

Complete Solution from Sample Source to Analyzer



The result is more accurate analysis and better protection for your analytical equipment.

A Halma company

800-337-3762

permapure.com

Perma Pure LLC, a Halma company, is a leading manufacturer of gas conditioning products including dryers, humidifiers, filters, coalescers, specialty scrubbers and complete sampling systems. We market these products worldwide for use in medical, industrial and scientific applications. To learn more about Perma Pure product solutions visit **www.permapure.com**.