

## *Cartridge Filter Systems For Oil and Gas Processing*

- Reduce Filtration Costs
- Improve Process Performance
- Minimize Downtime & Labor Costs
- Control Disposal Costs



# Petro-Klean® Filters

## Petro-Klean Cartridges - Raising the standards for Oil & Gas filtration systems.

Petro-Klean\* filter cartridge systems have demonstrated an unmatched record of consistently providing the most cost effective solutions to Gas Processing and Refining filtration applications. The Petro-Klean family of depth media filter cartridges have greater service life, reduced filter cartridge change-out frequency, and provide higher quality effluent than competitive products! Petro-Klean uniquely combines absolute filtration performance with exceptionally high dirt holding capacity providing the cost effective choice in these Oil & Gas filtration applications:

- Amine sweetening systems for gas plants and refineries
- Glycol Dehydration
- Compressor lube oil systems
- Refinery catalytic process protection
- Process and equipment protection
- Waterflood and enhanced oil recovery

## Discover the Petro-Klean Competitive Advantage!

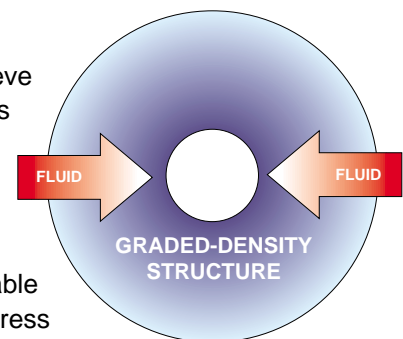
Filtration Characteristic	Petro-Klean Filters	Sock Type Filters	Melt-Blown Filters	Pleated Filters	String-Wound Filters
Absolute Rated	Yes	No	Yes	Yes	No
Rigid Structure	Yes	No	No	No	No
Graded Density	Yes	No	No	No	No
Bypass and Unloading	No	Yes	Yes	Yes	Yes
Performs at High Delta-P	Yes	No	No	No	No

The above table lists common filtration characteristics of various filter types for comparison. Petro-Klean filter construction and design provide the features that ensure performance superior to competitive product.

## Petro-Klean Filter Construction

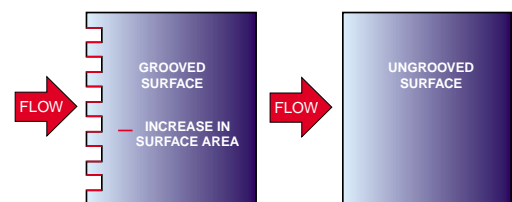
### Rigid Graded-Density Petro-Klean Structure

Petro-Klean filter cartridges are manufactured using an exclusive process to achieve a true graded-density structure. A proprietary Cuno manufacturing process results in progressively more dense center core region creating a graded-density structure. Each fiber is locked in place by a thermosetting resin binder to create a rigid depth filter matrix that traps larger particles near the outer surface and smaller particles near the cartridge's inside diameter. The overall effect is to greatly improve cartridge service life by retaining particles and deformable contaminants in decreasing particle size ranges as the contaminant particles progress through the cartridge.



### High Surface Area Petro-Klean

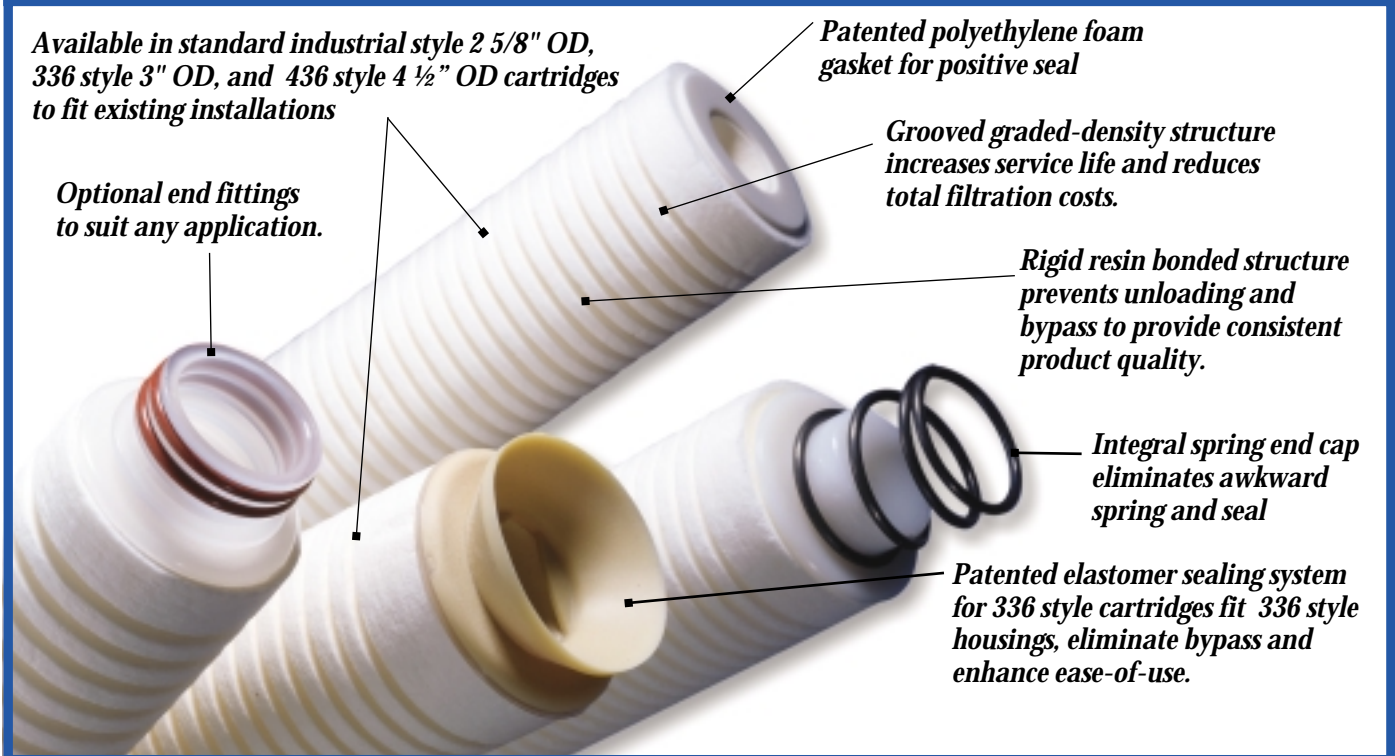
Petro-Klean cartridges also feature an optimized groove pattern to increase the surface area by over 65% when compared to ungrooved cylindrical cartridges. The grooved surface prevents premature blinding of the outer surface by large particles and allows full utilization of the depth structure. Maximum surface area with a true graded-density structure means that Petro-Klean can provide significantly greater service life than competitive filter cartridges.



\* U.S. Patent Number 5,399,264, 5,015,316, 5,028,037, and other U.S. and foreign patent rights.

# The Petro-Klean® Advantage!

Feature	Advantage	Benefit
<ul style="list-style-type: none"> <li>Absolute-rated cartridge filters from 10 - 60 microns</li> </ul>	<ul style="list-style-type: none"> <li>Distinct particle size cutoff at the specified removal rating</li> </ul>	<ul style="list-style-type: none"> <li>Reproducible effluent quality throughout the filter's life</li> </ul>
<ul style="list-style-type: none"> <li>Beta 1000 rated throughout the cartridge life</li> </ul>	<ul style="list-style-type: none"> <li>No bypass or unloading at high differential pressure</li> </ul>	<ul style="list-style-type: none"> <li>Consistent product quality throughout the filter's life</li> </ul>
<ul style="list-style-type: none"> <li>Grooved surface with true graded-density structure</li> </ul>	<ul style="list-style-type: none"> <li>Significantly longer life</li> </ul>	<ul style="list-style-type: none"> <li>Dramatic cost savings with optimized yields</li> </ul>
<ul style="list-style-type: none"> <li>Patented "336" cartridge elastomer sealing system</li> </ul>	<ul style="list-style-type: none"> <li>User-friendly, maintains integrity at high differential pressure</li> </ul>	<ul style="list-style-type: none"> <li>Fast filter change-out and consistent product quality</li> </ul>
<ul style="list-style-type: none"> <li>No metal or plastic cores</li> </ul>	<ul style="list-style-type: none"> <li>Easy disposal, suitable for incineration or shredding</li> </ul>	<ul style="list-style-type: none"> <li>Reduced disposal costs</li> </ul>
<ul style="list-style-type: none"> <li>Available in 2 5/8" OD, 336 style 3" OD, and 436 style 4 1/2" OD and lengths to 72"</li> </ul>	<ul style="list-style-type: none"> <li>Broad range of configurations for custom sizing</li> </ul>	<ul style="list-style-type: none"> <li>Retrofit existing housings and current applications</li> </ul>



# Absolute Petro-Klean® Filters

Absolute removal ratings for Petro-Klean are determined using a filter performance test developed by CUNO to comply with the general procedures outlined in ASTM 975. Cuno defines absolute rating as the particle size (x) providing an initial Beta Ratio ( $B_x$ ) = 1000. At this Beta ratio the removal efficiency is equal to 99.9%. Beta Ratio ( $B_x$ ) is defined by the following equation:

$$B_x = \frac{\text{Cumulative Number of Particles Larger than } x \text{ in the Influent Challenge}}{\text{Cumulative Number of Particles Larger than } x \text{ in the Effluent}}$$

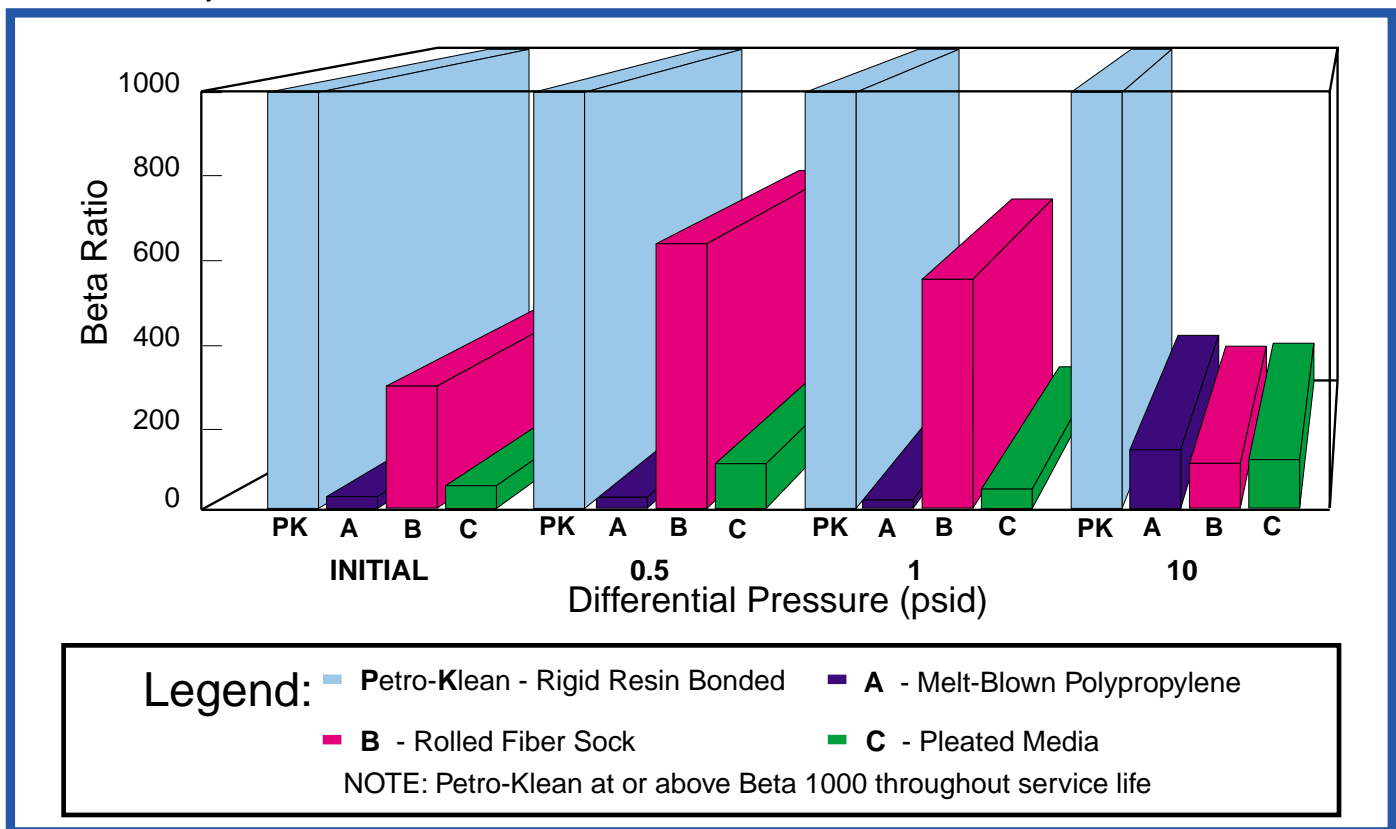
Petro-Klean filters achieve a minimum Beta ( $B_x$ ) value of 1000 at the ratings specified in Table 1.

Grade Designation	Absolute Rating ( m )
M100	10
M200	20
M300	30
M400	40
M600	60

TABLE 1 PETRO-KLEAN ABSOLUTE RATINGS

## Petro-Klean - Consistent Performance

The initial Beta-Ratio for all grades of Petro-Klean filter cartridges is equal or greater than 1000, and Petro-Klean cartridges perform at or above this initial value throughout the usable (all the way to plugging) life. This defines Petro-Klean's absolute filtration performance. The Beta Ratio vs. Differential Pressure in Graph 1 illustrates how competitive filters do not achieve the consistent performance of Petro-Klean. Filters that show a decrease in Beta Ratio as the differential pressure increases are exhibiting either unloading of previously held contaminants or a loss of filtration efficiency.



GRAPH 1. - BETA RATIO COMPARISON 10 µm CARTRIDGES

As illustrated in Graph 1, the performance of the Rolled Fiber Sock cartridges (Competitor B) exhibits contaminant unloading and a loss of filtration efficiency as differential pressure increases from 1 to 10 psid. The Melt-Blown (Competitor A) and the Pleated Cellulose/Polyolefin (Competitor C) filters exhibit minimal contaminant retention through the test duration.

# Filtration Applications

## **Petro-Klean for Natural Gas Processing**

Petro-Klean provides excellent filtration performance in many natural gas processing applications including:

- Amine Sweetening
- Glycol Dehydration
- Compressor lube oil systems

## **Petro-Klean for Refining**

Petro-Klean provides excellent filtration performance in many refinery applications including:

- Hydrotreater, Catalyst protection
- Amine plant systems
- Fuel Products

## **Petro-Klean for Oil & Gas Production**

Distinct particle size cutoff and reproducible effluent quality make absolute-rated Petro-Klean ideally suited for oil & gas production. Petro-Klean consistently provides clean fluids to maximize well production. The efficient removal of suspended solids minimizes formation damage and plugging, and reduces the need for injection well workovers. Applications include:

- Waterflooding
- Completion, workover fluids



## **The Cuno Petro-Klean Advantage**

Installation of Petro-Klean filters in ALL amine filtration systems at a major gas processing plant in New Mexico provided:

**Over \$ 250,000 Total Annual Filtration Cost Reduction through:**

- Major reduction in filter use and disposal costs
- Significant labor savings
- Reduced fouling of heat transfer surfaces
- Reduced maintenance and shutdown frequency

In another application, a major Texas refiner replaced competitive “sock” filter cartridges with Petro-Klean “472” cartridges to filter NGL, natural gas liquid, with the following results.

- Service life improved from 3 weeks to 12-14 weeks
- \$ 20,000 savings in filter, labor, and disposal costs
- \$ 200,000 increase in NGL production by reducing change-out downtime



# Petro-Klean® Product Specifications

Rating & Materials Of Construction			
Absolute Rating ( m )	Grade	Fiber	Resin
10	M100	Cellulose / Glass	Melamine
20	M200		
30	M300		
40	M400	Cellulose	
60	M600		

Operating Parameters		
Maximum Operating Temperature	Standard (Media Only)	250°F (121°C)
	With Polyethylene Foam Gasket	200°F (93°C)
	With Elastomer Seal or Polypropylene End Fittings	180°F (82°C)
Maximum Differential Pressure	70 psid (4.8 bar) @ 68°F (20°C)	
Recommended Change-out Differential Pressure	35 psid (2.4 bar)	

Dimensions			
Cartridge Style	PG Style	336 Style	Standard Industrial Style
Inside Diameter	3 1/8" (79.4 mm)	1 15/32" (37.3 mm)	1 1/16" (26.9 mm)
Outside Diameter	4 1/2" (114.3 mm)	2 25/32" (70.6 mm)	2 19/32" (65.9 mm)
Cartridge Length	24" to 72" (610 - 1829 mm)	36" to 72" (914 - 1829 mm)	9 3/4 to 40" (248 - 1016 mm)

TABLE 2. - PETRO-KLEAN PRODUCT SPECIFICATION

## Petro-Klean Flow Rates

Standard Industrial Cartridges		
Grade	Absolute Rating	Specific Δp/10" Element * (psi/gpm)
M100	10	0.35
M200	20	0.19
M300	30	0.11
M400	40	0.10
M600	60	0.09
336 Style Cartridges		
Grade	Absolute Rating	Specific Δp/36" Element (psi/gpm)
M100	10	0.06
M200	20	0.04
M300	30	0.03
M400	40	0.02
M600	60	0.015
PG Style Cartridges (4 1/2" OD)		
Grade	Absolute Rating	Specific Δp/12" Element @ 20°C (psi/gpm)
M100	10	0.12
M200	20	0.06
M300	30	0.03
M400	40	0.02
M600	60	0.01

\*Specific aqueous pressure drop (Δp) for a 10" equivalent length cartridge. For multiple length cartridges, divide total flow by the number of 10" equivalents.

TABLE 3. - PETRO-KLEAN FLOW RATES

For liquids other than water, use the following formula in conjunction with the values from column 3 of Table 3. The specific pressure drop values may be effectively used when three of the four variables (Viscosity, Flow, Differential Pressure, and Cartridge Grade) are set.

$$\text{psid clean} = \frac{\left( \frac{\text{Total system}}{\text{gpm}} \right) \left( \frac{\text{Viscosity in}}{\text{Cp}} \right) \left( \frac{\text{Value from}}{\text{table}} \right)}{\left( \frac{\text{Number of}}{\text{Equivalent Single Length Cartridges}} \right) \left( \frac{\text{in housing}}{\text{in housing}} \right)}$$

## Petro-Klean Chemical Compatibility

Petro-Klean is well suited for organic solvents including amines and glycols. Table 4 contains specific recommendations.

Fluid		RATING
Category	Example	
Organic Solvents	Amines (DEA, MDEA, MEA) 20% - 50% up to 160°F (71°C)	R
	Glycols	R
	MEK	R
	Benzene	R
	Xylene	R
	Alcohols	R
	Dimethyl Formamide (DMF)	R
Petroleum	Gasoline	R
	Kerosene	R
	Diesel Fuel	R
	Lube Oil	R
	Fuel Oil	R
	Waxes	R
Water	Process @ 212°F (100°C)	R
	Produced @ 212°F (100°C)	R
	Boiler Feed @ 212°F (100°C)	R
	Demineralizer Feed @ 212°F (100°C)	R
Organic Acids	Acetic (100%)	N
	Tannic 10%	N
Inorganic Acids	Hydrochloric (Muriatic ) Acid 5%	N
	Sulfuric 50%	N
	Sulfurous 5-10%	N
	Nitric	N
Brines and Aqueous Salt Solutions	Sodium Chloride	R
	Sodium Sulfate	R
	Sodium Nitrate	R
Weak Alkalis	Aluminum Hydroxide	N
	Ferric Hydroxide	N
	Magnesium Hydroxide	N
Fatty Acids - Oils	Detergents	R
	Mineral Oil	R
	Silicone Oils	R

R = Generally Recommended up to 250°F (121°C) unless otherwise noted.  
N = Not Recommended

TABLE 4. - CHEMICAL COMPATIBILITY

The recommendations in Table 4 are for general guidance only. Testing under specific application conditions is recommended. For various end modifications and multi-length cartridges, consult your local distributor or Cuno. Refer to Cuno publication GF.G02.788 for additional information.



## CUNO Filter Housings

The Express Series (ES) cartridge filter housings are designed and certified to ASME Code, Section VIII, Div. I to provide a broad range of high quality stainless and carbon steel vessels for the oil and gas processing industries. Available in 150 and 300 psi ASME Code, this premium 304L, 316L stainless, or carbon steel filter housing can be constructed to fit specific system requirements including inlet/outlet location, connection size and type, and corrosion allowance. For more information ask your local CUNO Distributor for literature number LITCHSES1.

### Express Series Advantages

- Durable construction for long service life
- Easy access, swing bolts and cover lifting device, for filter removal
- Flexible housing design accepts a wide range of industrial style filters
- Easy maintenance and clean-up
- ASME Code design meets plant safety requirements

Housing Model	Housing Diameter (Inches)	Number of Cartridges	Cartridge Style	Construction Material	Pressure Rating	Gasket Materials	Outlet Location
For Standard Industrial Cartridges (2.625" Maximum OD)							
ES	8	6	Double Open End	Carbon Steel, 304L Stainless Steel, or 316L Stainless Steel	150 psi or 300 psi	Nitrile, EPR, Viton, or Teflon encapsulated Viton	Bottom, Side 90°, Side 180° Side 270°
	12	12					
	14	18					
	16	24					
	20	36					
	24	52					
	30	85					
36	120						
For 336 Style Cartridges (36" long by 3" Maximum OD)							
ES	8	3	Petro-Klean 336	Carbon Steel, 304L Stainless Steel, or 316L Stainless Steel	150 psi or 300 psi	Nitrile, EPR, Viton, or Teflon encapsulated Viton	Bottom, Side 90°, Side 180° Side 270°
	12	9					
	14	12					
	16	17					
	20	27					
	24	39					
	30	63					
36	91						

## CUNO ... A World Leader in Fluid Purification

CUNO's manufacturing sites have ISO 9000 registered quality systems. Global manufacturing together with trained stocking distributors and state-of-the-art laboratory support bring quality solutions to existing and challenging gas processing filtration applications.



### Scientific Applications Support Services (SASS)

The cornerstone of CUNO's philosophy is service to customers, not only in product quality and prompt delivery, but also in problem solving, application support, and in the sharing of scientific information. CUNO's Scientific Applications Support Services (SASS) group is a market-focused group of scientists and engineers who work closely with customers in the oil & gas processing industry to provide solutions to challenging filtration applications and aid in the selection of the most efficient and economical filter systems. SASS provides a vital link between CUNO and users of CUNO filter systems. SASS specialists are skilled in performing on-site testing (pilot or lab bench scale) and are able to relate field test results to full manufacturing scale operations. SASS projects can also be performed in CUNO's extensive in-house laboratory facilities. CUNO's vast experience with gas processing operations worldwide provides the knowledge and insight to resolve problems promptly and efficiently in a cost-effective, confidential manner.

# Petro-Klean® Ordering Guide

## Standard Dimension Industrial Cartridges (2 5/8" OD)

Cartridge Type	Cartridge Length	Grade Description		Surface Type	Packaging Option	End Modification	Gasket Material
		Grade	Absolute Rating ( m )				
PT (2 5/8" OD)	09 - 9 3/4"	M100	10	G - Grooved U - Ungrooved	2 - Bulk	C - 222 O-ring & Spear	A - Silicone
	10 - 10"	M200	20			F - 222 O-ring & Flat Cap	B - Fluorocarbon
	19 - 19 1/2"	M300	30	N - None		C - EPR	
	20 - 20"	M400	40	P - Polypropylene Core Extender		D - Nitrile	
	29 - 29 1/4"	M600	60	R - Closed Cap with Stainless Spring		N - None*	
	30 - 30"			S - Stainless Steel Core Extender		G - PE Foam*	
	39 - 39"			Q - Same as "R" without Spring			
40 - 40"			Y - 222 Single O-ring & Flat Cap (40" length only)				

\* For End Modifications N, P, Q, R, & S only.

## 336 Style Cartridges (3" OD)

Cartridge Type	Cartridge Length	Grade Description		Surface Type	Packaging Option	End Modification	Gasket Material
		Grade	Absolute Rating ( m )				
PK (3" OD)	35 - 35 1/2"	M100	10	G - Grooved U - Ungrooved	2 - Bulk	V - Elastomer Compression Seal (Double Open End)	S - Elastomer Compression Seal
	36 - 36"	M200	20			W - Elastomer Compression Seal (Single Open End)	G - PE Foam*
	37 - 36 1/2"	M300	30	R - Closed Cap with Spring		N - None*	
	72 - 72" **	M400	40	Q - Same as R without spring			
		M600	60	N - None (35" & 36" lengths only)			

\* For End Modifications N, Q, & R only.

\*\* For End Modifications V & W only.

"1401" Style (PN 46467-01) internal o-ring is available in all grades in 38 7/8" length only.

## PG Style Cartridges, 436 (4 1/2" OD)

Cartridge Type	Cartridge Length	Grade Description		Surface Type	Packaging Option	End Modification	Gasket Material
		Grade	Absolute Rating ( m )				
PG (4 1/2" OD)	24 - 24"	M100	10	U - Ungrooved	2 - Bulk	N - None	G - PE Foam
	36 - 36"	M200	20				N - None
	71 - 71"	M300	30				

### WARRANTY

Seller warrants its equipment against defects in workmanship and material for a period of 12 months from date of shipment from the factory under normal use and service and otherwise when such equipment is used in accordance with instructions furnished by Seller and for purposes disclosed in writing at the time of purchase, if any. Any unauthorized alteration or modification of the equipment by Buyer will void this warranty. Seller's liability under this warranty shall be limited to the replacement or repair, F.O.B., point of manufacture, of any defective equipment or part which, having been returned to the factory, transportation charges prepaid, has been inspected and determined by Seller to be defective. THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, EITHER EXPRESSED OR

IMPLIED, AS TO DESCRIPTION, QUALITY, MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE OR USE, OR ANY OTHER MATTER. Under no circumstances shall Seller be liable to Buyer or any third party for any loss of profits or other direct or indirect costs, expenses, losses or consequential damages arising out of or as a result of any defects in or failure of its products or any part or parts thereof or arising out of or as a result of parts or components incorporated in Seller's equipment but not supplied by the Seller.

# Service Worldwide

Visit us at [www.cuno.com](http://www.cuno.com)



## Fluid Purification

CUNO Pacific Pty Ltd  
140 Sunnyholt Road  
Blacktown, NSW 2148  
Australia

CUNO Europe SA  
Chemin du Contre Halage  
62730 - Les Attaques  
France

CUNO Srl  
Via Zara, 38  
20032 Cormano (Mi)  
Italy

CUNO Filtration Asia Pte Ltd  
18 Tuas Link 1 (3<sup>rd</sup> Floor)  
Singapore 638597

## Cuno Incorporated

400 Research Parkway  
Meriden, CT 06450, U.S.A.

Tele: (800) 243-6894

(203) 237-5541

Fax: (203) 238-8977

CUNO Latina Ltda  
Rua Amf Do Brasil 251  
18120 Mairinque-SP  
Brazil

CUNO GmbH  
Wihl-Th-Römheld-Str. 32  
55130 Mainz  
Germany

CUNO K.K.  
Hodogaya Station  
Building 6F  
1-7 Iwai-cho, Hodogaya-ku  
Yokohama 240 Japan

CUNO Ltd  
21 Woking Business Park  
Albert Drive  
Woking, Surrey GU215JY  
United Kingdom