RESISTOFLEX®

brands you trust.

RESISTOFLEX® ATL PTFE

Advanced Technology Liner

CRANE

Crane ChemPharma & Energy

www.cranecpe.com

RESISTOFLEX® 75 Years of Fluoropolymer Innovation

Heritage of Innovation!

1936 Resistoflex® was founded
1953 PTFE-Lined Hose
1956 PTFE-Lined Pipe
1957 PTFE Expansion Joints
1962 Patented PTFE-Lined Pipe (Thermalok®)
1964 PP, PVDF, and Field Fabrication
1981 PTFE Clamp Valve
1982 High Integrity Flange™
1992 MULTI-AXIS® Precision Bent Plastic Lined Piping System
1998 Patented PTFE Conquest® Flangeless Piping

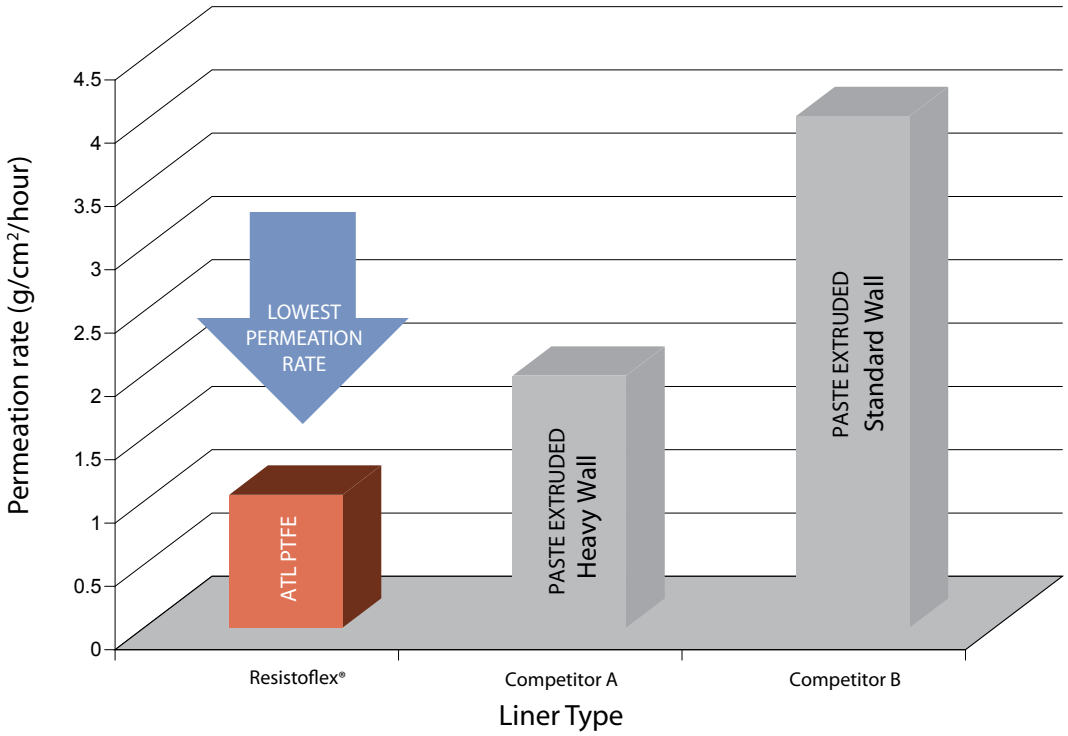
Key Features & Benefits

- Resistoflex®ATL PTFE reduces permeation rates by up to 60% when exposed to aggressive chemical elements at high temperatures
- The outer shell delivers superior corrosion resistance in temperatures reaching 450°F
- Full vacuum rating up to 450°F on sizes 1" – 12"

Newest Technology!

PTFE Lined Pipe & Fittings
with Advanced Technology Liner

36% HCl Permeation Testing at 250°F



Third Party Testing by Renowned MERL lab.

RESISTOFLEX®ATL Superior Components

Resistoflex®ATL is the most cost effective solution for resolving permeation issues in severe service applications.

- The permeation rate is 60% lower compared to other available products
- Resistoflex®ATL provides up to 75% cost savings versus exotic alloys and glass-lined piping
- It has zero corrosion rate, and is full vacuum rated

Resistoflex®ATL PTFE liners are produced from carefully formulated resins and proprietary processing and lining techniques. The result is a molded PTFE liner that provides optimal crystallinity and strength. ATL PTFE liners provide the best permeation resistance in the industry.

1 *Optimized PTFE liner*

Resistoflex®ATL PTFE pipe and fittings are designed to minimize any potential permeation attack of the housing by use of an advanced venting system that eliminates blockage and corrosion at the vent hole.

2 *Enhanced venting system*

Resistoflex®ATL PTFE pipe and fittings are double coated with a highly chemical and temperature resistant paint. This paint is rated to 450°F (232°C) and can be used under insulation.

3 *Highly chemical and temperature resistant paint system*

RESISTOFLEX®ATL
Permeation Issues and Effects

What is Permeation?

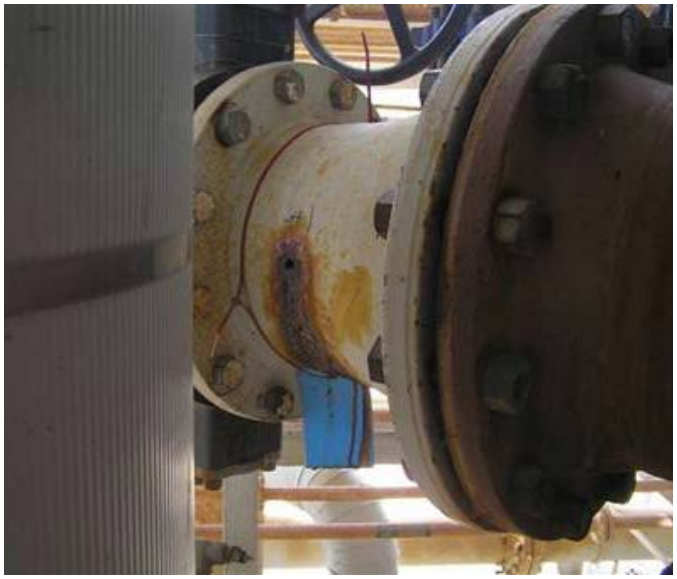
Permeation is a three stage process involving, in sequence:

- Absorption of fluid by contacting the liner
- Diffusion of the fluid through the liner
- Desorption (evaporation) of the fluid when it reaches the opposite surface of the liner

How to Control Permeation with PTFE Liners?

- Proper PTFE resin formulation
- Liner production methods that produce high molecular crystallinity and low void content
- Maximized liner thickness

All plastic will permeate; this is a natural phenomenon and does not detrimentally affect the performance of the PTFE liner. The result, however, can affect the system performance and life cycle costs. These pictures depict some of the issues caused by permeation.



Appearance of a Leak

Single Lobe Liner Collapse

RESISTOFLEX®ATL
Breakthrough Liner Processing Technology

Paste Extrusion is the most widely utilized method for producing PTFE pipe and fitting liners, the process was introduced by Resistoflex® in the 50s, and served the chemical industry's corrosion resistant needs for many years. However as the chemical industry utilized PTFE lined piping systems in more aggressive processes, such as elevated temperatures and pressures and a wider range of chemical concentrations, the performance requirements for liner properties increased and a more suitable method for making pipe and fitting liners was required.

Resistoflex® has been processing PTFE resins for over 50 years and currently utilizes various methods for producing PTFE liners including; Isostatic Molding, Ram Extrusion, and Paste Extrusion. Each process yields different mechanical properties and we match those with end-use products that meet varying customer needs.

Paste Extrusion Process

- Paste extruded PTFE liners most frequently acquire anisotropic mechanical properties, resulting in hoop strength not being equal to axial strength.
- Anisotropic properties negatively impact the liners ability to withstand vacuum and temperature cycling due to thermal expansion.
- Paste extruded PTFE liners also exhibited higher permeation rates due to inherent low molecular crystallinity which results in high void content.
- As noted, a key component in controlling the rate of permeation in PTFE is the molecular crystallinity. (High molecular crystallinity is desired for greater permeation resistance.)
- Independent testing of paste liners evaluating the crystallinity of the material revealed that paste extruded liners were found to have comparatively low crystallinity therefore exhibiting a high permeation rate.

Glass-Lined Process

Glass-lined systems, a common option for lined piping, are generally extremely brittle and susceptible to thermal and mechanical shock. Glass-lined piping is also easily damaged with temperature cycling. Additional characteristics of this type of piping include the following:

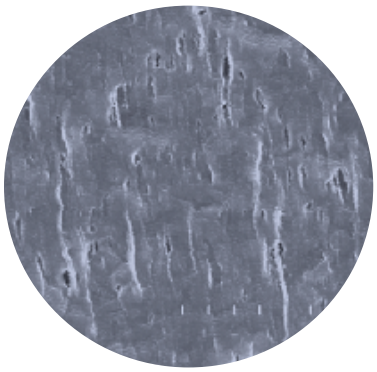
- Temperature and pressure ratings vary based on diameter.
- Risk of damaging pipe by thermal shock at operating temperatures above 121˚C (450˚F).
- Requires gaskets at each connection and if gaskets are not supplied by the manufacturer, warranty may be voided.
- Limited geometries (reducing fittings such as tees and elbow are not recommended).
- Typically, 25% more expensive than PTFE-lined piping systems.

ATL PTFE Liner Processing Techniques - 60% BETTER!

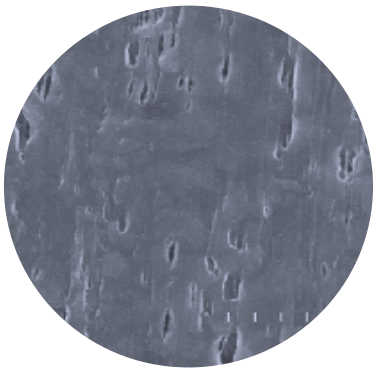
- Through years of testing and end market application Resistoflex® has found that the PTFE Isostatic Molding process is the best method for making Pipe & Fitting linings.
- PTFE Isostatically Molded liners have excellent isotropic mechanical properties, which results in high hoop and axial strength. The combination of the thick wall design and isotropic properties result in the ability of the finished products to withstand full vacuum at elevated temperatures (450°F/232°C) and high cycling conditions for all sizes ranging from 1" - 12" (25 - 300 mm).
- ATL PTFE liners are produced by combining the solid attributes of Isostatic Molding along with carefully formulated resins and proprietary processing techniques. The result is a molded PTFE liner that provides optimal crystallinity and strength. The crystalline areas are impermeable, meaning there is no space for the permeants to pass through.
- ATL PTFE liners provide the best permeation resistance in the industry.

RESISTOFLEX®ATL Myths and Facts/Testing

A common myth in the industry is that paste extruded PTFE liners produced from fine powder resins yield a lower void content. The less voids in the liner, the less space for the permeants to pass through. With the controlled processing techniques developed by Resistoflex®, we have reduced the void content and thus reduced the rate of permeation. The micrographs below taken at 15,000X magnification illustrate the size and frequencies of the voids were significantly reduced in Resistoflex®ATL PTFE.



Paste Extruded - PTFE liner

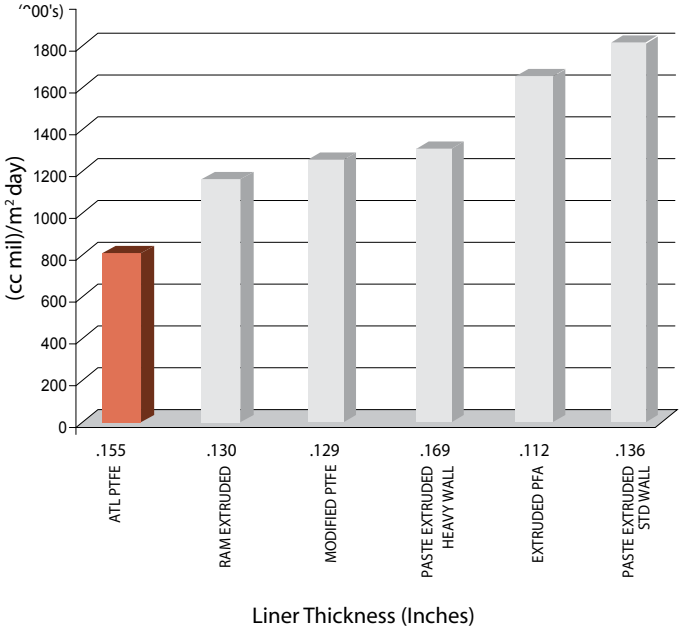


Resistoflex®ATL PTFE liner

Independent field and laboratory tests measured permeation resistance in piping systems provided by various manufacturing methodologies. Test results for various resins and processing techniques are illustrated below. These results show that the Resistoflex®ATL PTFE offers the best permeation performance available for lined pipe.

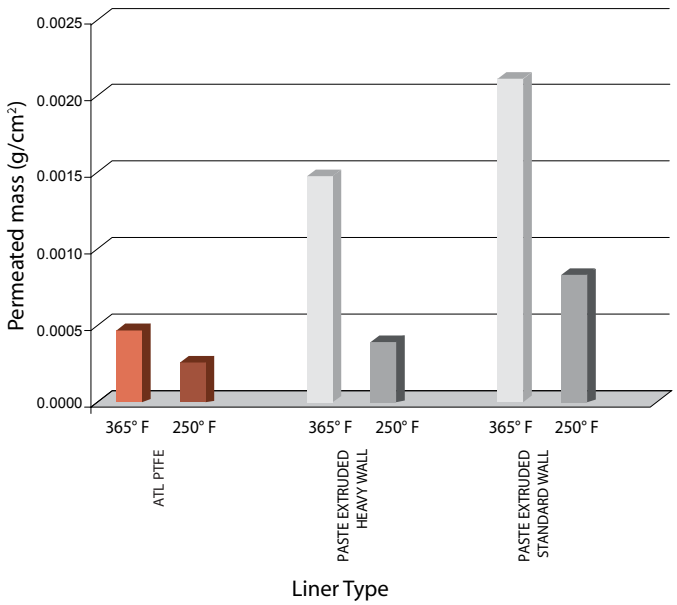
Helium Permeation Rate at 350°F (177°C)

Result: Resistoflex®ATL outperforms all other PTFE liners
Testing performed by an independent third party lab



36% Hydrochloric Acid Permeation Rate

Result: Resistoflex®ATL outperforms all other PTFE liners
**Testing performed by MERL UK - see back cover*



RESISTOFLEX®ATL Product Offering

ATL Product Offering

A 1"-12" ANSI and DN25-300 DIN PTFE lined piping system that meets all ASTM F1545 requirements and the following:

- PTFE resin conforms to ASTM D-4894 and is certified for food contact in compliance with FDA regulation 21CFR 177.1550
- ATL PTFE is lined using Resistoflex® highly engineered and patented Thermalok® technology
- Product is available in carbon steel and stainless steel housings and flanges
- Approved to PED Cat III

Resistoflex®ATL Product Offering

ANSI Dimensional Standard Products

- All dimensions and tolerances according to ANSI B16.5 (see Resistoflex® Plastic Lined Pipe & Fittings Design)
- ISO 9001 Certified
- Economical ductile iron (A395) fitting housings and flanges available
- ANSI B16.5 Class 150 & 300 flanged systems available

DIN Dimensional Standard Products

Dimensions and tolerances according to DIN 2848:2000.

- TA Luft certication
- GKV / DIN 2874:2002-06 requirements for PTFE
- DVGW conformity
- DIN 2848 PN 10 & PN 25 flanged systems available

In addition to careful processing, adequate liner thickness and rigorous testing provide confidence that the liner will do its job under all process conditions. The table below illustrates typical advertising claims for various PTFE lined pipe suppliers.

Standard Manufacturing: PTFE Liner Thickness Comparison

Diameter NPS (NB)	Resistoflex®ATL HD Isostatic Molded Liner	Competitor A Std Wall Paste Extruded Liner	Competitor B Std Wall Paste Extruded Liner	Competitor C Std Wall Paste Extruded Liner
1" (DN 25)	.130" (3.3 mm)	3.0	3.0	1.78
1.5" (DN 40)	.150" (3.8 mm)	3.0	3.0	2.3
2" (DN 50)	.155" (3.9 mm)	3.0	3.0	2.3
3" (DN 80)	.155" (3.9 mm)	3.5	3.0	2.3
4" (DN 100)	.160" (4.1 mm)	4.5	3.0	2.5
6" (DN 150)	.255" (6.5 mm)	5.0	5.0	3.8
8" (DN 200)	.310" (7.9 mm)	5.0	5.0	3.8
10" (DN 250)	.350" (8.9 mm)	5.0	5.0	3.8
12" (DN 300)	.450" (11.4 mm)	5.5	5.0	4.3
ASTM F1545 Documentation	Yes / ALL	Limited	Limited	Limited
Vacuum Rating	Full Vacuum / 450°F (232°C)	DN 25-100 FV / 150°C >100 mm: No	DN 25-100 FV / 100°C >100 mm: No	No

All dimensions and tolerances according to ANSI B16.5 (see Resistoflex® Plastic Lined Pipe & Fittings Design Manual).

RESISTOFLEX®

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MERL Scientist Credentials - HCL Testing

Dr. Robert Campion BSc, PhD, CEng, FIMMM
Author of more than 50 scientific and technical publications on elastomers, thermoplastics, cured rubber/metal & rubber/rubber bonding, autoadhesive tack, rubber compounding, polymer durability in fluids, and high pressure gas permeation and diffusion. Served as Committee member of the Polymer Science Group of the Institute of Materials (IOM) and Chairman of IOM Polymers in Extreme Environments conferences. Special research interests, normally applied to the Offshore Oil Production or Automotive industries, include high pressure gas permeation & diffusion through elastomers and thermoplastics, fuel permeation, fluid/polymer compatibility & ageing issues, polymer structure/property relationships, novel compounding approaches, and adhesion bonding.

Dr. Nickie Smith BSc, PhD Chemical Engineering (Polymers)
Senior scientist with a chemical physics background and expertise in structure property relationships in polymer blends. Project manager for wide range of single client commercial projects relating to materials selection, development and evaluation, chemical ageing, life prediction and durability of polymeric materials. Research interests include development of accelerated test methodologies to determine low permeation rates in automotive fuel systems. Collaborated on a wide range of UK government and European Commission funded research projects relating to the development of new materials and their evaluation.

** MERL permeation graphs are normalized for test duration.*

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ELRO® DUO-CHEK® FLOWSEAL® SINCE 1864 JENKINS® FK® KROMBACH ARMATUREN
NOZ-CHEK® PV® RESISTOFLEX® revo® Saunders® the science inside
STOCKHAM® Triangle® UNI-CHEK® wta® XOMOX®

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