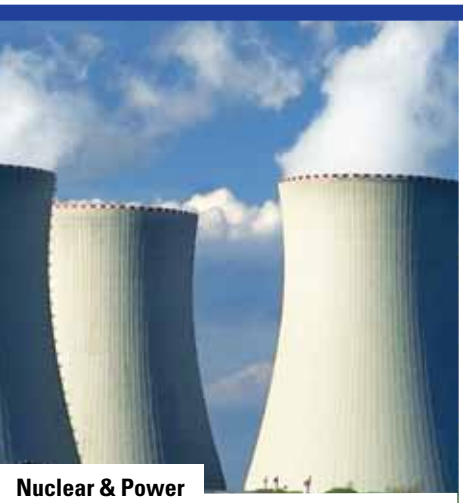
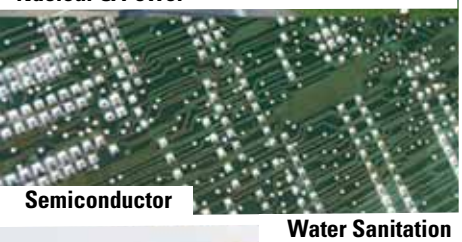
Kynar® PVDF MEMBRANES

Kynar® PVDF, the high performance choice for industrial membranes


Nuclear & Power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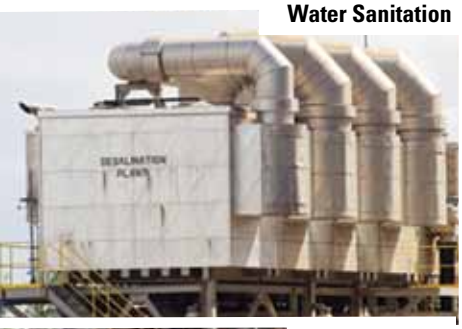

Water Sanitation

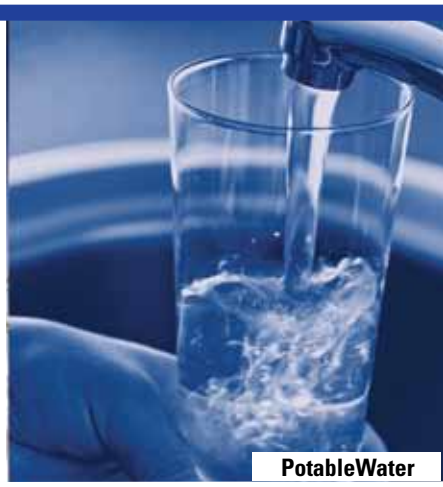

Beverage


Paint


Medical

Membrane Bioreactor (MBR)


Food


PotableWater

ARKEMA
The world is our inspiration

Kynar® PVDF resin is well established in the chemical process industry for its excellent chemical resistance, mechanical toughness, and long-term durability. These same qualities make this resin a choice material for microfiltration and ultrafiltration membranes. Kynar® PVDF resins are soluble in several solvents allowing them to be solvent cast by the phase inversion process. Kynar® membranes may be prepared as flat sheets, hollow fiber, and tubular configurations via the TIPS and NIPS processes.

Kynar® resins are USP Class VI compliant and listed in the federal register, NSF-51 and NSF-61, which enables the resins to be used in food contact and potable water applications. Outstanding chemical resistance of Kynar® PVDF allows a broad range of applications including potable, high purity, and waste water treatments. Medical applications include blood and protein filtrations. Chemical process applications include paint, dairy, food, and beverage filtration.

Dense Kynar® membranes may be used for solvent separation by pervaporation. Microporous Kynar® membranes may be used as a substrate material for composite membranes. Table 1 lists the Kynar® grades commonly used for membrane casting.

Table 1*: Kynar® PVDF Grades for Membrane Casting

Grade	Melt Viscosity[1]	Solution Viscosity[2]	Material Form
Kynar® 741[3]	18	100	Powder
Kynar® 761	27	400	Powder
Kynar® 761A	32	1000	Powder
Kynar® MG 15	37	1700	Powder
Kynar® 301F	30	800	Powder
Kynar® HSV 900	50	8000	Powder
Kynar Flex® 2800/2801	25	600	Pellet/ Powder

[1] Kps@100 s^{-1}, ASTM D3835/232°C
[2] Nominal cps using spindlevisco meter at 20RPM #2 spindle, 20°C
[3] Recommended for TIPS process
** Contact a technical representative for more information on Kynar® viscosity*

Figure 1: Cross section of hollow fiber membrane made from Kynar® 761.

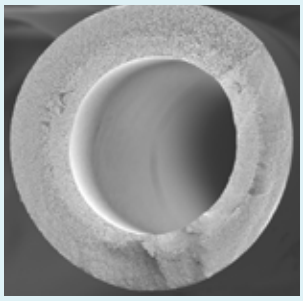
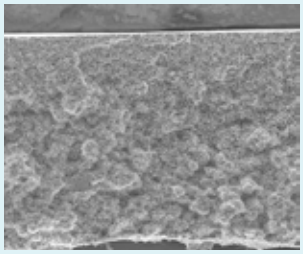


Figure 2: Cross section of a flat sheet membrane made from Kynar® 761.



Kynar® Grade for Every Application

A range of Kynar® PVDF resin grades is available to help customers tailor their membranes for specific applications and processing. The Kynar® 700 series resins are manufactured in a range of viscosities, permitting customers to select the optimum product for their membrane process. Kynar® MG 15 is a new grade designed specifically for hollow fiber spinning. Kynar® HSV 900 is a very high viscosity grade especially suitable for hollow fiber casting and other applications requiring high gel strength. Also available are Kynar Flex® copolymer grades (VF2-HFP) with even higher pH chemical resistance and greater flexibility. Kynar® membranes are stable in applications over a pH range from 1.0-13, and often used in exposure to citric acid, sulfuric acid, hydrogen peroxide, sodium hypochlorite, sodium hydroxide, ozone, and high levels of free chlorine.

Kynar® PVDF membranes are radiation resistant and as a result, can be sterilized by conventional methods as well as radiation. Kynar® PVDF, due to its superior stability can be sterilized by E-Beam or gamma radiation, as well as steam, and a variety of chemical methods.

Kynar® resins are supplied in either a fine powder or pellet form. Powders are often preferred for ease of dissolution. Table 2 lists a selection of the available membrane grades along with general material properties.

Table 2*	Units	Kynar® 700 Series Kynar® MG Series Kynar® HSV 900	Kynar® 301F	Kynar Flex® 2801
Physical Properties+				
Specific Gravity D792/73°F (23°C)		1.77-1.79	1.75-1.77	1.76-1.79
Water Absorption % D570/68°F (20°C) Immersion/ 24 Hours	%	0.01-0.03	0.02-0.04	0.03-0.05
Mechanical Properties+				
Flexural Strength @ 5% Strain D790/73°F (23°C)	psi (MPa)	8,500-11,000 (58-76)	7,000-9,000 (48-62)	3,000-5,000 (20-34)
Flexural Modulus D790/73°F (23°C)	psi (MPa)	240,000-335,000 (1,655-2,310)	200,000-260,000 (1,379-1,792)	70,000-120,000 (620-827)
Tensile Yield Elongation D638/73°F (23°C)	%	5-10	10-15	10-20
Tensile Yield Strength D638/73°F (23°C)	psi (MPa)	6,500-8,000 (45-55)	5,000-7,500 (34-52)	2,900-5,000 (20-34)
Tensile Break Elongation D638/73°F (23°C)	%	50-200	50-250	200-400
Tensile Break Strength D638/73°F (23°C)	psi (MPa)	5,000-8,000 (34-55)	4,500-7,000 (31-48)	2,500-5,000 (17-34)
Tensile Modulus D638/73°F (23°C)	psi (MPa)	200,000-335,000 (1,379-2,310)	150,000-200,000 (1,034-1,379)	80,000-130,000 (551-896)
Thermal Properties+				
Melting Temperature	°F (°C)	323-342 (162-172)	311-320 (155-160)	284-293 (140-145)
D3418 Tg (DMA) @ 1Hz	°F (°C)	-41- -37 (-40- -38)	-41- -37 (-40- -38)	-42 - -39 (-41 - -39)

+ Typical property values. Should not be construed as sales specifications.
** Contact a technical representative for more information on Kynar Flex® PVDF grades.*

Solution Viscosity

Kynar® PVDF resins offer a very wide range of solution viscosities. Figure 3 and 4 illustrates solution viscosities of Kynar® 761, Kynar® 761A, Kynar® MG15, and Kynar® HSV 900, in N-methylpyrrolidone (NMP) and Dimethyl acetamide (DMAc) over a wide range of concentrations.

Figure 3: Kynar® solution viscosity in NMP 25°C @ 10S-1

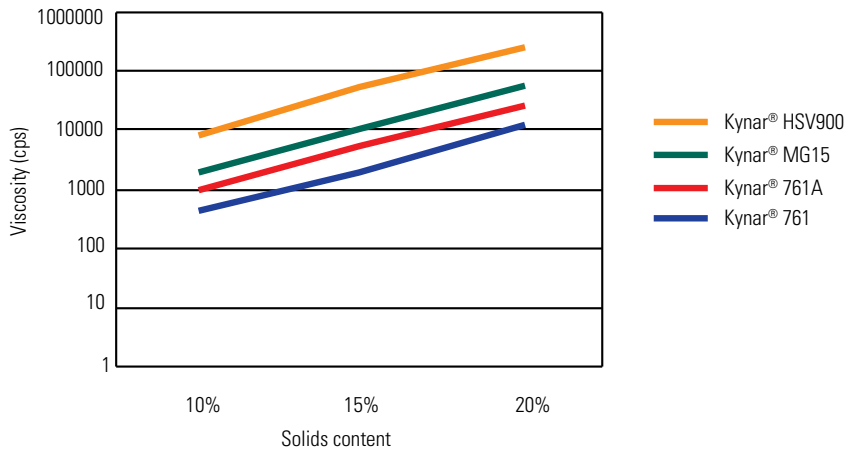


Figure 4: Kynar® PVDF solution viscosity in DMAC, 25°C @ 10S-1

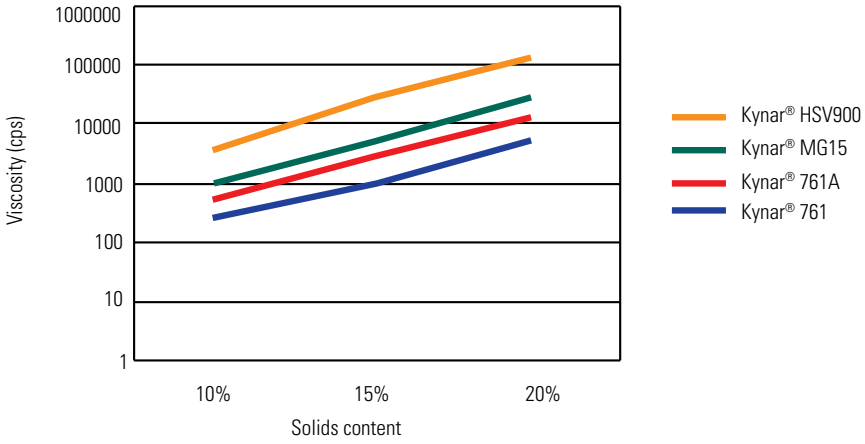
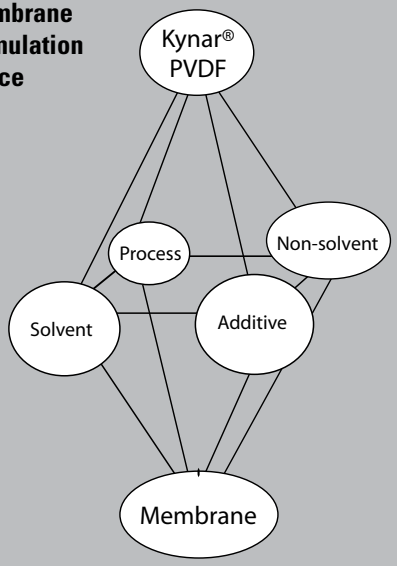


Table 3: Active[a] Solvents

Solvent	Boiling Point °C	Flash Point °C
Dimethyl Acetamide[b]	166	70
N-Methyl-2-Pyrrolidone[b]	202	95
Dimethyl Formamide	153	67
Dimethyl Sulfoxide[c]	189	88
Triethyl Phosphate	215	116
Tetramethyl Urea	177	65

[a] Solvent will dissolve at least 5-10 percent Kynar® resin at ambient temperature.
[b] Most commonly used solvents.
[c] DMSO is a product offered by Arkema

Figure 5: Kynar® membrane formulation space



Kynar® PVDF in the Membrane Process

Kynar® resins are compatible with a variety of pore forming additives such as lithium salts, polyvinylpyrrolidone, and polyethylene glycols. Non-solvent additives in membrane dopes include alcohols, water, and organic acids. A very large formulation space exists for Kynar® membranes, permitting wide flexibility in preparing the optimum membrane for a particular use. Figure 5 illustrates the interaction of Kynar® resin with process and formulation variables to ultimately create the product membrane. Process variables include temperature, humidity exposure and casting speed.

Solubility

Kynar® PVDF resins have solubility properties suitable for easy processing by a variety of typical membrane forming processes. Table 3 list active and latent solvents. Generally, Kynar® resins are not soluble in aliphatic hydrocarbons, aromatic hydrocarbons, chlorinated solvents, alcohols, acids, halogens and basic solutions. Figure 6 shows excellent clarity of a completely dissolved Kynar® PVDF solution in DMAc.

Figure 6: Appearance after complete dissolution in DMAc

Kynar® PVDF Resin Chemical Resistance

Kynar® PVDF resins have exceptional chemical resistance compared to other membrane materials such as cellulose acetate, polyamide, polypropylene, polysulfone, and polyethersulfone resins. Kynar® resins have excellent chemical resistance to harsh chemicals such as chlorine, bromine, hydrogen peroxide, ozone, alcohols, sodium hypochlorite, chlorine dioxide, inorganic acids, and organic acids.

This chemical resistance is advantageous in chemical process applications and industrial wastewater recovery. In water treatment systems, the outstanding chemical resistance and mechanical strength of Kynar® PVDF membranes provide durability important to reducing overall lifecycle costs. Additional chemical resistance and physical property information can be found at www.kynar.com.

Kynar® PVDF Highlights

- **Kynar® PVDF resin has a 45-year track record in successful membrane applications.**
- **Kynar® PVDF is commonly used for flat sheet and hollow fiber membranes.**
- **Kynar® PVDF resin is available in a wide range of solution viscosities.**
- **Kynar® PVDF resin has outstanding resistance to ozone, chlorine, bromine, hydrogen peroxide, chlorine dioxide, and cleaning agents, making it a material of choice for water treatment plants.**
- **Kynar® PVDF resin meets standards for direct food and beverage contact.**
- **Kynar® PVDF resin can handle temperatures up to 150°C depending on chemical service, product design, and steam sterilization**
- **Kynar® PVDF is resistant to ionizing radiation for use in nuclear and biopharma applications.**
- **Kynar® Membranes can be made by solution phase inversion and thermally induced phase inversion.**
- **Membrane bioreactors (MBR) are a preferred application for Kynar® PVDF**
- **Kynar® PVDF is suitable for ultrapure, deionized, and potable water filtration.**
- **Kynar® PVDF is used for microfiltration and ultrafiltration especially for virus rejection**

Select KYNAR® and KYNAR FLEX® PVDF GRADES have the following regulatory listings and approvals

ORGANIZATION	REGULATION
National Sanitation Foundation (NSF)	NSF-61 Potable Water, NSF-51 Food Equipment, NSF-14 Plumbing System Components
Food & Drug Administration (FDA)	177.2510 & 177.2600 Repeated Contact with Food, 177.1520 Single-Use Adjuvant for Use in Polyolefins 1% Concentration
United States Department of Agriculture (USDA)	Use in Process or Storage Areas to Contact with Meat or Poultry Food Products
3-A Sanitary Standards Inc. (3-A SSI)	Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment
United States Pharmacopeia (USP) Class VI	USP Class VI
Chicago Rabbinical Council (CRC)	Kosher Certified

See MSDS for Health & Safety Considerations.
For environmental, safety and toxicological information, contact our Customer Service Department at 1-800-KYNAR50 to request a Material Safety Data Sheet or visit our web site at www.kynar.com.

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