Scinor

TIPS Fact Sheet

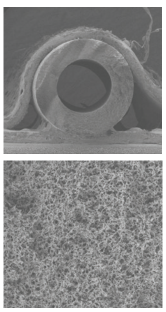
Thermally Induced Phase Separation (TIPS)

PVDF Membranes

In recent years, the large majority of ultrafiltration membrane manufacturers have adopted polyvinylidene fluoride (PVDF) as the polymer of choice for creating hollow fiber membranes for demanding water applications. The requirements for high flux rates, appropriate pore size, reliable membrane integrity, mechanical strength and durability, cleaning chemical compatibility, and relatively low cost, have made PVDF the choice over other polymers such as PAN, PES, and PE, and alternative materials such as ceramic membranes.

While not commonly known in the industry, there are two basic methods for creating PVDF membranes that result in significantly different end-products: **Thermally Induced Phase Separation (TIPS) methods and Non-solvent Induced Phase Separation (NIPS)**.

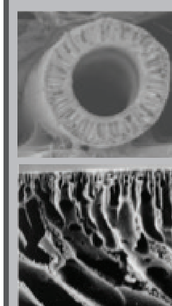
TIPS PVDF Membranes



SEM of TIPS fiber. Note the isotropic structure.

Scinor's patented Thermally Induced Phase Separation (TIPS) manufacturing technique provides for the strongest, most chemically tolerant, and most permeable membrane in the industry. TIPS PVDF membranes are isotropic, meaning they have the same mechanical properties in all directions and throughout the depth of the membranes. This adds a level of integrity and durability robustness not seen in other membranes on the market.

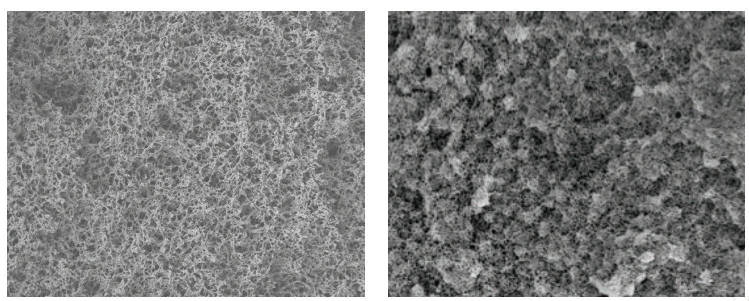
NIPS PVDF Membranes



SEM of NIPS membrane. Note the 'finger' structure.

NIPS membranes are anisotropic (i.e., mechanical properties vary depending on the direction in which they are measured). They exhibit a "skinned" structure, with tight inner and outer surface pores, typically with a rating of 0.02 µm-0.04 µm, supported by a channeled structure that doesn't provide any filtration capability. They exhibit higher fiber breakage rates and lower tolerance to cleaning chemicals.

Moreover, the TIPS process provides larger structure with more cross-links creating interconnected pores, providing multiple flow paths for water and cleaning chemicals, resulting in increased flux, reduced TMP, and better recovery after chemical cleaning.



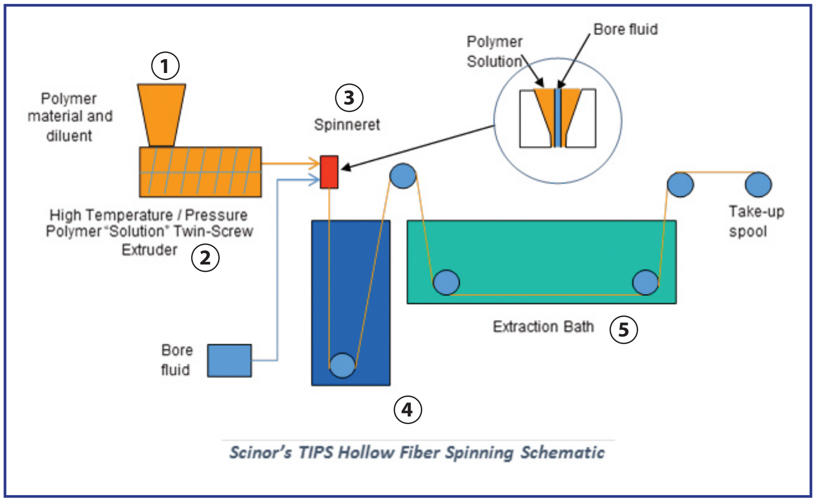
SEMs of TIPS(Left) and NIPS (right) surfaces, demonstrating the strong multiple crosslinks of the TIPS fiber.

Parameter	Scinor TIPS	Typical NIPS
Pure Water Flux	49 GFD/PSI	8-20 GFD/PSI
NaOCl Tolerance during CIP	5,000 mg/L	500-2,000 mg/L
Tensile Strength	5.3 MPa	3.6-4 MPa
pH range during CIP	1-13	1-12
*Fouling Rate	0.16 PSI/min.	0.41-0.78 PSI/min.
Permeate SDI15	<3	<3
Permeate Turbidity (NTU)	<0.1	<0.1

** Note: Indicates relative fouling rate under identical raw water and flux conditions within one minute.*

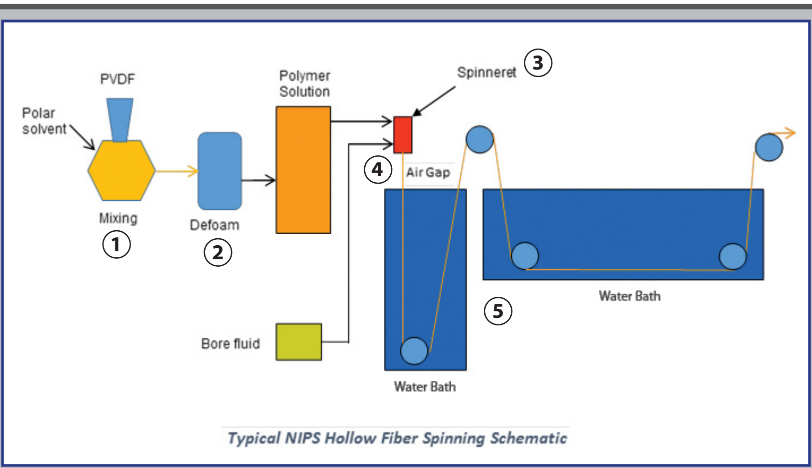
Manufacturing Methods

The Scinor TIPS process is a patented manufacturing process for PVDF hollow fiber membranes that was developed by scientists at the prestigious Tsinghua University in Beijing. Compared to NIPS membranes, Scinor TIPS membranes exhibit higher flux, greater mechanical strength (meaning low fiber breakage), and unsurpassed chemical tolerance. The homogeneous sponge-like structure is permanently hydrophilic and extremely consistent as a result of our precision automated production line.



Scinor's TIPS Hollow Fiber Spinning Schematic

(1) PVDF polymer and a low molecular weight diluent (solid) are mixed and a (2) twin-screw extruder pressurizes and raises the temperature of the mixture above 200C creating a homogenous liquid solution. (3) The solution is passed through the spinneret which forms the hollow fiber shape. The fiber is cooled in a water bath (4) which solidifies the diluent in a uniform crystallized PVDF structure. (5) In a separate step, the diluent is dissolved with alcohol creating the interconnected pores uniformly distributed within the PVDF structure. In the Scinor process, the solvent and diluent are both reused.



Typical NIPS Hollow Fiber Spinning Schematic

(1) PVDF polymer is dissolved in a polar solvent and (2) mixed for several hours before being de-foamed. (3) The solution is forced through the spinneret which forms the hollow fiber shape. (4) An air gap between the spinneret and water bath partially volatizes the solvent. (5) The water bath (non-solvent) induces the solvent to flow out of the fiber while being displaced by water. This bi-directional flow prior to PVDF crystallization forms the micro-pore structure on the surface as well as the coarse "fingers" in the support layer.

Conclusion

Scinor's TIPS manufacturing process yields a uniform, highly permeable, interconnected pore structure with stronger chemical bonds within the crystalline structure. This results in PVDF membranes with higher flow capacity, longer life, and greater chemical resistance.

Scinor Water America, LLC
40 Wall Street, 28th Floor
New York, NY 10005
800.774.1385 | scinor.com