Multizone Polypropylene Membranes: Toward "Digital" Design of Membrane Filters

Asymmetric filtration membranes, having pore sizes that vary with depth, are well known and commonly used to advantage in applications where high flux and/or throughput (loading capacity) are desired. These membranes typically have gradient morphologies, in which the pore size gradually changes from a large pore size at one surface to a smaller pore size at the opposite surface. While highly effective in many filtration applications, such membranes are challenging to design and optimize. The pore size as a function of depth is complex and inherently difficult to predict, typically originating from a gradient in the kinetics of phase separation during membrane fabrication resulting from a mass transfer process occurring at one surface of the nascent membrane.

Recent work at 3M has combined the thermally induced phase separation (TIPS) process with a coextrusion approach, creating polypropylene microfiltration membranes having two or more remarkably discrete through-thickness zones of different pore size. The pore sizes and relative thicknesses of the zones can be varied independently over wide ranges. Such multizone membranes exhibit flux and throughput performance comparable to more conventional asymmetric membranes, and can be regarded as "digital" asymmetric membranes.

These digital membranes are inherently amenable to optimization for a given application or fluid stream, due to the relative ease of varying the thickness and pore size of each of the membrane zones as independent design variables.

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