UNDERSTANDING REVERSE OSMOSIS POLYAMIDE ACTIVE LAYER MACROSTRUCTURE AND PERFORMANCE THROUGH INDIRECT MICROSCOPIC OBSERVATION OF FILM GROWTH

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Given the random nature of reverse osmosis polyamide macrostructure, it is difficult to understand the relationship between its structure and its separation characteristics. Many have addressed this subject and a few have reached significant conclusions to date. Acknowledging that membrane chemistry is the most important lever in controlling performance and not structure, to truly understand which features of the polyamide film can be manipulated to affect performance, there may be value in understanding its formation mechanism. Building upon a basic grasp of this mechanism, it may be possible to fine tune membrane performance through structure manipulation.

While direct observation of polyamide film growth is not yet possible on a microscopic scale, new methods have been developed for indirect observation of the process. These methods, pseudo-stop-motion imaging and reactive post-polymerization potting, have provided valuable insight on the formation mechanism. The pseudo-stop-motion imaging technique was developed to view the polyamide structure on a microscopic scale at discrete points in time during the interfacial polymerization, from the first appearance of polyamide material on the support surface to the end of the polymerization. Essentially watching the process occur diminished the need for complex modeling to produce a basic growth hypothesis. Furthermore, the method can be used for any type of polyamide, and is limited only by the resolution of electron microscopy.

Reactive post-polymerization potting is a technique developed to understand the structure of polyamide in its as-formed state. Historical microscopy has been performed on dried membranes, but not on films immediately following polymerization. The resulting structures are strikingly different from those observed in the literature via SEM and TEM, and when taken in context with the growth mechanism proposed from pseudo-stop-motion imaging, it further supports a mechanism of polyp inflation rather than continuous film formation. Well-controlled pilot-scale polyamide casting has been performed to corroborate the proposed mechanistic theory, and the theory will be framed within the broader context of polyamide membrane development.