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For more than 30 years polyimides (PA) have been one of the main polymers for the fabrication of thin film composite membranes. Several researchers have assessed the main fabrication variables that influence the final structure of the polyamide layers including monomer concentration, solvents, additives in aqueous and organic phases and type of support to mention a few [1,2]. However, few studies have reported the influence of the fabrication tools used in the preparation of the PA layer. Each research group report their own recipe and fabrication method according to the general criteria of avoiding bubble formation during fabrication as that would later compromise the function of the membrane, but each process step must be well controlled to obtain reliable and consistent membrane performance. In general, the fabrication of the polyamide membrane layer is carried out in two steps. A polymeric support is initially brought in contact with the aqueous phase containing *m*-phenylene diamine (MPD) monomer and then with the organic phase containing the trimesoly chloride (TMC) monomer in order to promote PA formation through interfacial polymerization. The critical step occurs immediately after the support has been in contact with the aqueous phase, because formation of irregular drops could be initiation points for defects during the second step. Several tools have been used to eliminate the drop formation including air-knifes, rubber wipers, rubber rollers, glass rollers, or for that matter the absence of any tool using only water evaporation. In this work different methods of avoiding drop formation during the membrane preparation are tested to evaluate how the preparation methods influence the membrane structure and the final membrane properties. Understanding the membrane formation and consequently the defect formation will help to control and reproduce membrane preparation both in laboratory and industrial scale [3]. Specifically this work focuses on the preparation of a polyamide membrane layer supported by a polysulfone support after immersion in MPD/aqueous solution followed by immersion in TMC/heptane solution. The polysulfone support is in contact with the MPD/aqueous phase using immersion or pipetting. Further the use of a rubber wiper or absence of any tool to eliminate the aqueous solution droplets is evaluated. Both NaCl rejection and water and NaCl fluxes are evaluated, in order to relate them with the structural characteristics of the membranes using SEM, contact angle and streaming potential.

[1] Asim K. Ghosh, Byeong-Heon Jeong, Xiaofei Huang, Eric M.V. Hoek , Impacts of reaction and curing conditions on polyamide composite reverse osmosis membrane properties, Journal of Membrane Science 311 (2008) 34–45

[2] Liwei H, McCutcheon J, Impact of support layer pore size on performance of thin film composite membranes for forward osmosis, Journal of Membrane Science 483(2015)25–33

[3] R. Rangarajan, N.V. Desai, S.L. Daga, S.V. Joshi, A. Prakash Rao, V.J. Shah, J.J. Trivedi, C.V. Devmurari, K. Singh, P.S. Bapat, H.D. Raval, S.K. Jewrajka, N.K. Saha, A. Bhattacharya, P.S. Singh, Paramita Ray, G.S. Trivedi, N. Pathak, A.V.R. Reddy, Thin film composite reverse osmosis membrane development and scale up at CSMCRI, Bhavnagar, Desalination 282 (2011) 68–77