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VISUALIZATION BY DIGITAL HOLOGRAPHIC INTERFEROMETRY OF FLUX VELOCITY EFFECT IN CROSS-FLOW REVERSE OSMOSIS

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By means of digital holographic interferometry (DHI), changes in the optical path followed by the light due to changes in the refractive index can be visualized as interference fringes. When a reverse osmosis process takes place, the appearance of the polarization concentration layer changes the concentration distribution near the membrane, and therefore the refractive index deitribution, thus allowing to follow the process as an interfere fringe pattern.

The formation and development of the concentration polarization layer in the RO process will decrease the effective driving force and therefore, will decrease the permeate flux. One method to reduce or to control concentration polarization is the increase of shear at the membrane surface using a greater cross-flow velocity.

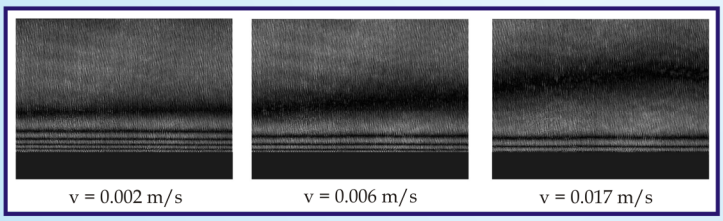

Figure 1. Interferograms at different cross-flow velocities

In this work, DHI has been used to visualize the effect of cross-flow velocity during reverse osmosis of salts. All the experiments were carried out at a constant pressure of 6 bar, using a special module designed with transparent windows to observe the membrane surface. In all experiments a thin film reverse osmosis membrane was used. Two solutes (NaCl and Na_2SO_4), with different feed concentration (3.5 - 8.5 kg/m^3) and different cross-flow velocities (0.002 - 0.017 m/s) (Re = 10 - 77) were used. In every run, the module was filled with the salt solution. The reference state (recorded by a CCD camera) was obtained with the salt solution flowing at the initial cross-flow velocity without pressure. During the reverse osmosis process, different fringe patterns were digitally reconstructed.

In all runs, the higher the cross-flow velocity, the lesser the number of interference fringes that appears, showing that the concentration polarization has a minor effect. In Figure 1, five interference fringes can be observed when velocity was 0.002 m/s, four when velocity was 0.006 m/s and three when velocity was 0.017 m/s (concentration profiles corresponding to these interferograms can be seen in Figure 2). Furthermore, when higher cross-flow velocities (which reduce the concentration polarization layer) were used, the permeate flux increased (figure 3).

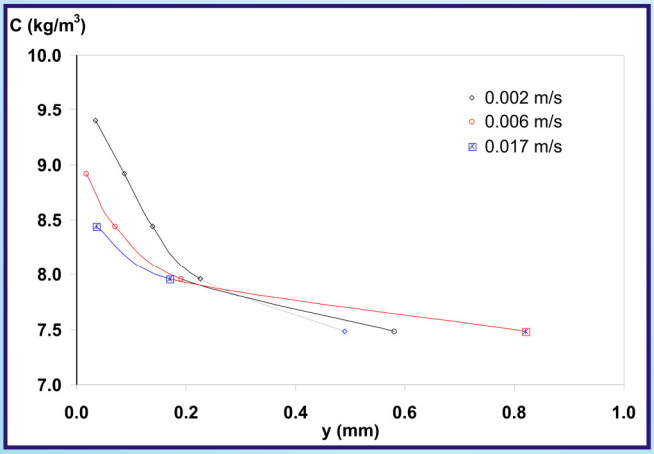

Figure 2. Concentration profiles corresponding to the interferograms of figure 1

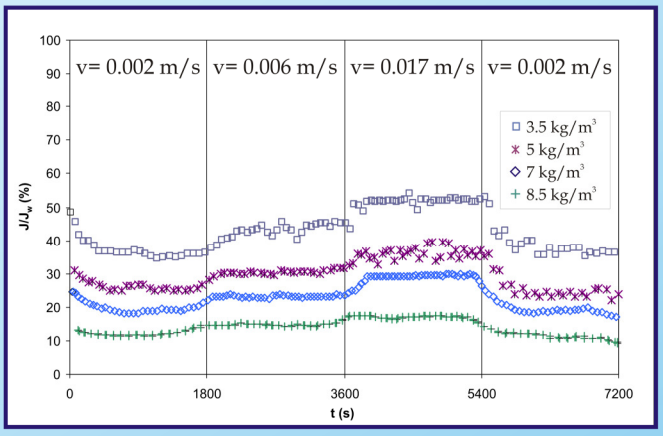

Figure 3. Evolution of the permeate flux at each cross-flow velocity and different feed concentration