Deashing and concentration of sugar solution using combination of electrodialysis and reverse osmosis

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This study reports on the performance obtained during pilot-scale tests for an innovative treatment process to deash and concentrate sugar-rich water originating from a biorefinery industry. The process consisted of electrodialysis (ED) first to deash the sugar solution, followed by reverse osmosis (RO) to concentrate the deashed sugar solution. This process was proposed as a more sustainable alternative to the currently in-use process which consists of ion exchange (IEX) for deashing combined with evaporation to concentrate the sugar solutions.

To prove the concept, a sugar solution originating from the hydrolyzation of cellulose was used for the tests. The solution contained 3.4 wt% C5/C6 sugar and ~3.0 wt% sodium chloride (NaCl). The experiments were performed on pilot-scale using the two technologies. Both steps were operated in batch modes. For ED, the diluate was recirculated in the feed tank until a certain electrical conductivity of the diluate was achieved. Likewise, RO concentrate was recirculated in the feed tank until a certain brix was reached for a constant flux. The concentration of ash was estimated by monitoring the electrical conductivity. On top of this, the temperature was continuously monitored and the volume and mass of the initial and final solutions in each process step were measured. Finally, the sugar and ash concentrations were analytically measured to perform a mass balance and estimate deashing rate and the sugar losses.

ED proved to be an effective technology for the deashing of sugar solutions. The EC of the sugar solution was successfully decreased to 0.2 mS/cm (99.6% EC reduction) by ED. During deashing by ED, less than 1% of the sugars were lost to the ED concentrate stream. The experiment proved that with ED, target ash reduction could be achieved without the use of chemicals and minimal sugar losses towards the concentrate stream. In addition to this, RO also showed satisfying results in concentrating sugars from 3.4 wt% to 21.6 wt%, corresponding to a concentration factor of 6. This result was achieved while only using electrical energy and with a negligible loss of sugar into the RO permeate.