Self-dewatering Polyacrylic Acid-Alginate-Graphene Oxide hydrogel as an osmotic drawing agent in groundwater fertigation

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Abstract (Arial 10)
Here, we report a graphene oxide-based hydrogel (which is a follow-up from Alabi et al. [1], [2]) used as an osmotic drawing agent for groundwater fertigation. In this work, a PAG hydrogel was fabricated from polyacrylic acid (PAA), sodium alginate (SA), and graphene oxide (GO) and showed a high swelling ratio of 25.8. For comparison, another PA hydrogel was prepared without GO nanosheets. Then, the hydrogels were characterized using SEM, EDX, AFM, FTIR, Raman, and the swelling ratio test. The characterization techniques indicated the successful synthesis of the hydrogels. Afterward, the two hydrogels were tested using DI water feed for water production. The PAG hydrogel showed higher water production at 26 ± 1 mL compared to 15 ± 1 mL for the PA hydrogel. In addition, self-dewatering of hydrogel was achieved in this setup. No external energy source was required. Instead, the dewatering relied solely on the weight of the feed and the testing cell to exert mechanical compression on the hydrogel, allowing it to release the entrapped water within the hydrogel, while not causing damage to the hydrogel's structure, and its absorption capacities. Afterward, the PAG hydrogel with higher water production than PA was selected to carry out the FO fertigation treatment of groundwater. Before the water test, the hydrogel was soaked in KCl solution, allowing KCl to infiltrate the hydrogel's structure and enhance the hydrogel's osmotic pressure. The PAG hydrogel showed a high water draw for DI water, and GW feeds at 56.5 ± 1.5 mL, and 26.5 ± 3.5 mL, corresponding to 4.80 ± 0.12 L/m² h, and 2.3 ± 0.31 L/m² h respectively. Moreover, the product water as a diluted fertilizer solution achieved a concentration equivalent to 0.14 M KCl, suitable for irrigation application. The results of this study contributed towards a more sustainable FO process by identifying a new hydrogel material as a drawing agent, which not only achieved self-dewatering to release entrapped water but also effectively diluted the fertilizer KCl for fertigation application. Some of the future work on this hydrogel could be to investigate the impacts of different operating conditions (e.g., feed pH, feed temperature) on the performance of the FO process.

References

[1] A. Alabi, C. Aubry and L. Zou, ACS Omega, 2022, 7, 38337-38346.
[2] A. Alabi, L. Cseri, A. Al Hajaj, G. Szekely, P. Budd, and L. Zou, Environmental Science: Nano, 2020, 7, 3108–3123

Figures

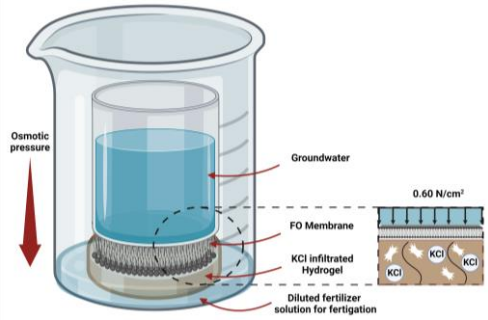

Figure 1: The testing setup of the hydrogels for fertigation