

Addressing water and food scarcity through a novel system for greenhouses, experimental validation and model predictions

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Document Version

Publisher's PDF, also known as Version of record

Citation for published version (Harvard):

Pasqualin, P & Davies, P (ed.) 2023, 'Addressing water and food scarcity through a novel system for greenhouses, experimental validation and model predictions', STEM for Britain 2023, London, United Kingdom, 6/03/23 - 6/03/23. <<https://stemforbritain.org.uk/2023-Posters/Paris%20Pasqualin.pdf>>

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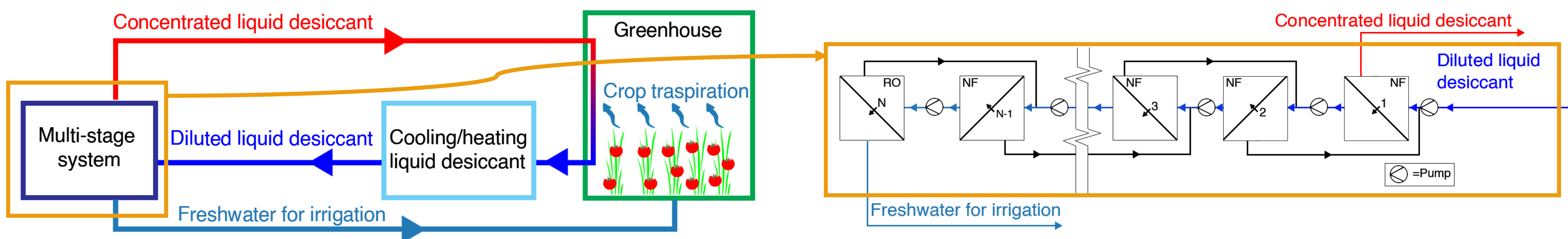
The issues

- **Water scarcity** is a growing issue that will affect two-thirds of the world's population by 2025 [1], not only due to short supply but also due to increasing use for agriculture. In fact, agriculture uses 14% of freshwater in the UK, and 72% globally [2].
- Water scarcity will limit agriculture and lead to **food scarcity**. Food scarcity will be intensified by the increasing world population, estimated to reach 9.7 billion by 2050 [3].

Proposed solution

Concept design:

- To tackle these issues, we developed a solution that recovers freshwater from greenhouses by utilising liquid desiccants to absorb moisture generated by crop transpiration.
- The novelty lies in the multi-stage system which simultaneously establishes closed-loop water and liquid desiccant cycles.
- The proposed solution is theoretically six times more energy-efficient than conventional systems that do not recover freshwater [4].



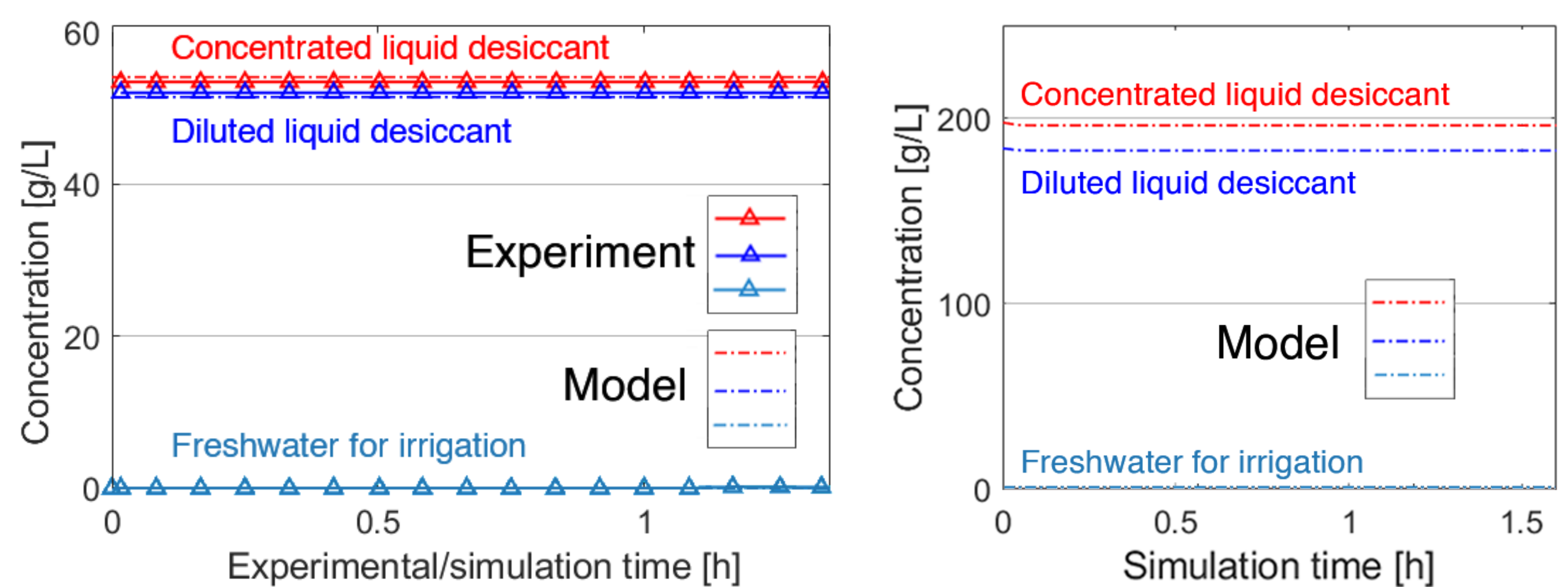
Experimental validation:

- We constructed a two-stage membrane system designed to concentrate magnesium chloride, a non-toxic liquid desiccant. In case of leaks, these can be beneficial because magnesium chloride is a fertiliser that enhances quality and yield of crops.
- The liquid desiccant was concentrated from 51 to 55 g/L. Higher concentration was not possible due to the maximum allowable working pressure of the membranes, equal to 40 bar.



Model predictions:

- We developed a model to predict performance. Experimental and model results agree within 5%. However, to meet the needs of greenhouses, a concentration above 180 g/L is required [5].
- According to the validated model, a four-stage system operating at 80 bar could concentrate the liquid desiccant from 184 to 196 g/L.



What next?

- Excluding public water supply, East of England is estimated to require more than 60% of its water needs for agriculture [6]. The proposed solution can decrease irrigation by at least 90% and thus can be integrated into England's national framework for water resources, which involves agriculture and environmental protection.

Policy paper
Meeting our future water needs: a national framework for water resources [6]

- However, research funding is needed to make the proposed solution a reality since some of the membranes for the multi-stage system are not yet commercially available. These can be fabricated, but so far this has not happened because of lack of demand.

References

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