Hybrid solid-liquid composite wall panel for sustainable indoor humidity pumping

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Elevated indoor humidity levels pose a serious problem for the occupants' heath and thermal comfort perception. Typically, indoor humidity management is achieved using mechanical cooling systems either as standalone devices or as hybrid systems integrated with liquid or solid desiccant dehumidifiers. However, the standalone systems are energy intensive, while the hybrid systems are bulky in size, limiting their implementation in commercial and residential buildings. For this reason, passive humidity pumping systems are sought to mitigate excessive increase in indoor moisture levels in a sustainable approach. Buoyancy-driven liquid desiccant solution that is circulated in a membrane-based loop between the indoor space and the environment can transport the necessary water vapor mass. However, to eliminate the need for a cooling system to cool the regenerated solution, an insulator is installed on the inner side of the loop. The insulator should not retard the moisture flow, but rather create a sink to further pull the water vapor towards the solution. Accordingly, metal-organic frameworks (MOFs) are used due to their low thermal conductivity, high water permeability and fast adsorption kinetics with exceptional water uptake capacity.

In this proposal, a sustainable system is developed using a buoyancy-driven liquid desiccant integrated with MOFs panel for passive humidity pumping. A numerical model integrating the heat and mass transfer in the different sorbents will be developed and validated experimentally. The validated model will be used to size the proposed sustainable system for a case study in Beirut. The system performance is evaluated for spaces with high latent loads to determine the energy cost reduction resulting from its implementation.