Vapor absorption into desiccant droplets: An opposite process to droplet evaporation

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In the past decades, the droplet evaporation phenomena have attracted an enormous amount of research. As a converse process to droplet evaporation, the vapor absorption phenomena into liquid desiccant droplets require detailed investigations both for it academic value in heat and mass transfer analyses and for its practical values in all kinds of energy-saving systems. Here, we focus on the relations and differences between the droplet behaviors during water evaporation and during vapor absorption. Experiments are carried out for pure water droplets and for 54wt.% Lithium Bromide solution (LiBr-H_2O) for different conditions. The results reveal that, the vapor diffusion on the air side dominates the evaporation process, while the solute diffusion on the liquid side dominates the vapor absorption process. When the ambient condition changes, the vapor pressure at the droplet interface will change accordingly. Since droplet evaporation is an air-side-dominated process, the evaporation rate is greatly influenced by the ambient temperature. While for LiBr-H_2O droplets, since the process is dominated by the diffusion on the liquid side, the vapor absorption rate is not obviously affected by the ambient temperature. Moreover, the driving force (vapor pressure difference) for vapor diffusion is constant during droplet evaporation, leading to the linear decrease of droplet volume in the constant contact radius (CCR) mode. When it comes to LiBr-H_2O droplets, as the solution interface gradually grows saturated due to water absorption, the driving force decreases along with time, therefore, the droplet volume increases following a saturation trend.

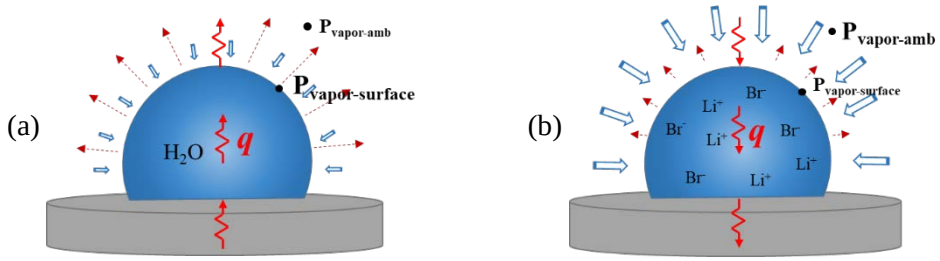

Figure 1 Principles of (a) evaporation of water droplet, and (b) vapor absorption into LiBr-H_2O droplet.