Energy Saving Desiccant Dehumidifier for Efficient Air Conditioning

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Industry Problem

20% of the total energy consumed in developed countries is utilized for air-conditioning. Thus, especially for places experiencing warm and humid conditions, besides the huge energy bills paid by the end-users, air-conditioning equipment is responsible for enormous carbon emission. Thus, HVAC industry requires innovative solution which can substantially boost the performance of air-conditioners. Hyper-efficient dehumidifiers that can utilize the low-temperature heat that the condenser otherwise rejects, need to be designed to completely eliminate the latent-heat load on the evaporator and help make air-conditioners highly energy efficient.

Solution

NUS researchers have developed a dehumidifier that can be easily installed/retrofitted in the ducting, upstream of the air-handling unit (AHU) of a conventional central air-conditioning unit as shown in Figure 1(a). The dehumidifier is a bank of tubes that is coated with a solid-desiccant on its external surface, see Figure 2. It realizes quasi-isothermal dehumidification and regeneration processes (as opposed to adiabatic processes in conventional desiccant wheels) which makes the dehumidification/regeneration process highly efficient only requiring ultra-low grade heat for regeneration. As shown by the process line in Blue in Figure 1 (b), it can completely handle the latent heat load of outdoor air by utilizing (i) the room-return air as the regeneration air-stream (ii) warm water at ~38 °C from the water-cooled condenser during regeneration (iii) cool water at 30 °C from the cooling tower (or an auxiliary water-condenser). Note that the air-states in Figures 1(a) and (b) are consistent.

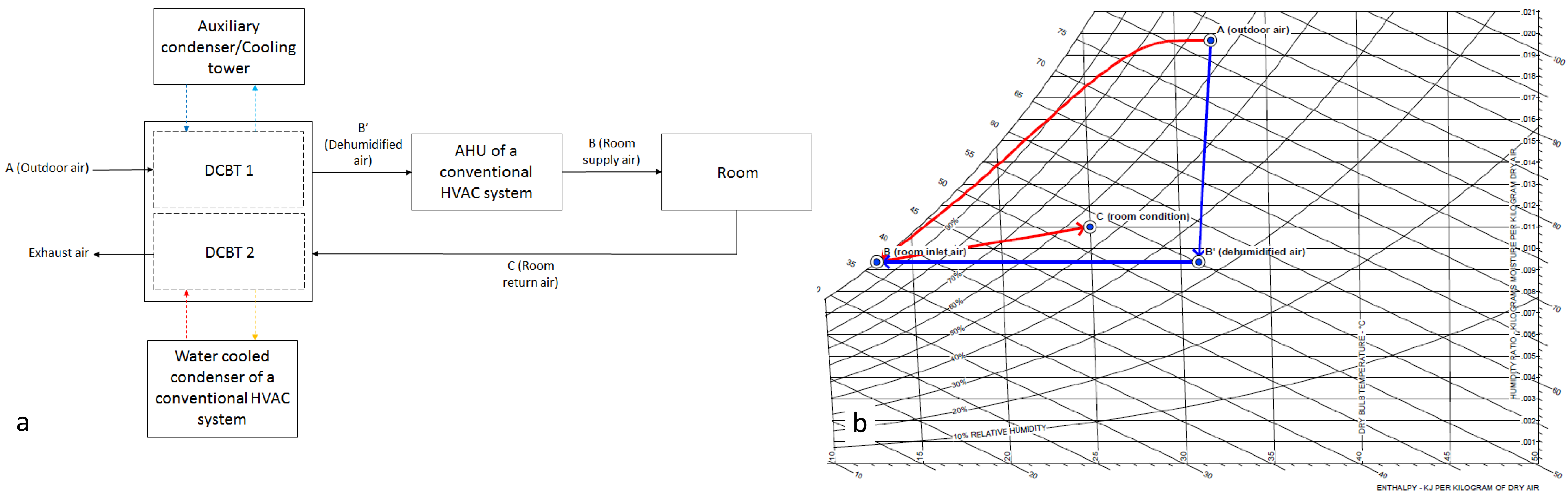

Fig. 1: *(a) Schematic of the HVAC system retrofitted with DCBTs (b) Psychrometric Chart showing the dehumidification and cooling process. Note: Red line shows conventional cooling process using AHU alone while the blue line shown the process after installing DCBT upstream of the AHU*

Value Proposition

- Easy to retro-fit (only air-ducts and water piping need modification).
- It can completely handle the latent heat load, so low lift chiller may be used implying greater COP.
- Ultra-low temperature (Only 8 °C more than cooling-tower water temperature) waste-heat from condenser required for regeneration.
- >50% savings on compressor's energy utilization
- Smaller capacity compressor and smaller evaporator/condenser coil size required for the same cooling load.
- Overall energy-savings is >30%.
- No moving parts hence it needs little maintenance

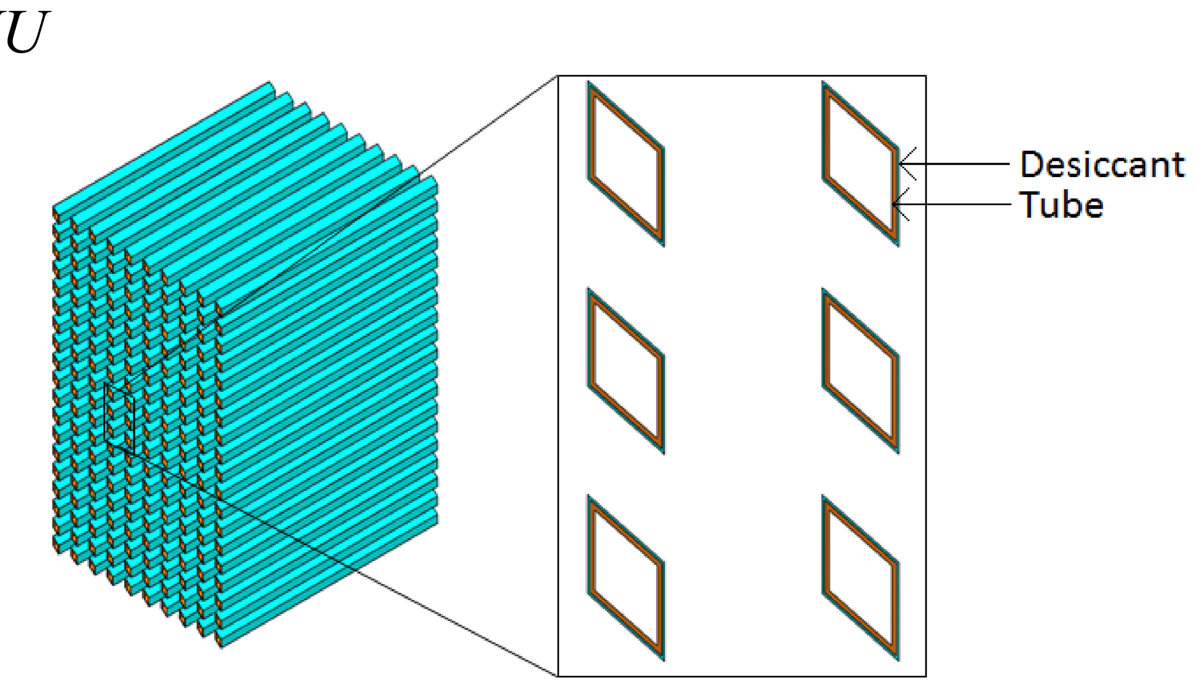

Fig. 2: *Desiccant coated bank of tubes (DCBT)*

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