Material synthesis for developing waste energy driven next generation cooling system

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Vapor compression refrigeration systems (VCRS) are most commonly used for space cooling and refrigeration. In a VCRS, a refrigerant (such as R134a) is compressed in a mechanical compressor, which increases its temperature and pressure. Then it flows through a condenser where it releases heat and become liquid. The liquid refrigerant then flows to an evaporator through an expansion valve, which reduces its pressure and temperature. In evaporator, it absorbs heat from the surroundings. The gas is then compressed again and the process repeats, continuously transferring heat from the desired cooling area to the surroundings. Two major disadvantages of this system are: compressor consumes a huge electricity and the commonly used refrigerants have very high GWP. Hence, the operating cost is high, and the system hugely contributes to global warming.

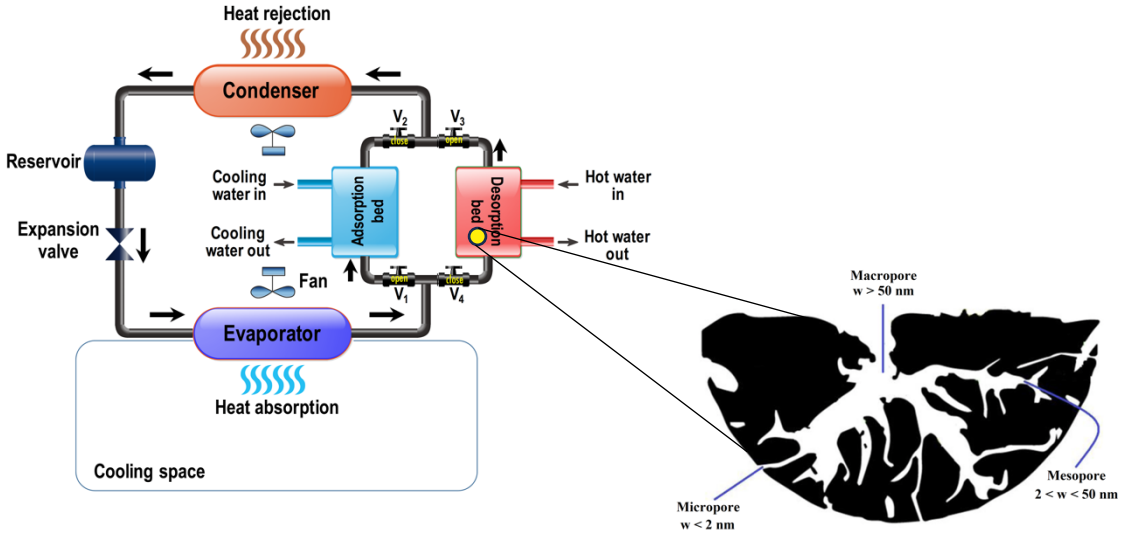

Fig. Major components of a typical adsorption cooling system.

Adsorption cooling systems (ACS) can resolve these issues and are considered as the next generation of cooling. The only difference between VCRS and ACS is that the compressor is replaced by a set of adsorption bed which can be driven by waste heat instead of electricity. Solid adsorbent is the core material of the adsorption beds. Adsorbent material has to be highly porous with a high affinity for the refrigerant vapor (adsorbate). Pores can be visualized as very deep narrow tunnels (pore width < 50 nm) through the material. Achieving high porosity and large surface area was always challenging. My research work is mainly focused on the synthesis and characterization of highly microporous (pore width < 2 nm) activated carbon from waste biomass precursors. Various high porosity activated carbons have already been synthesized in our laboratory using steam, CO_2 or KOH. The high adsorption capacity of these waste biomass-based carbon samples were also confirmed using various low-GWP (HFO, HFC, CO_2) refrigerants.