Power Extraction from a Compressed Air Humidification System

Humidity gradients exist throughout the natural and man-made environment, for example at building exhaust systems, and at thermal power plant flue gas exhausts. Where these gradients exist, dry air can be used to draw vapour by the partial pressure difference between the air streams. There exists a potential for this water vapour transfer to do useful work. We present here a novel conversion process driven by humidity gradient potential, which we term as compressed air humidification. Humid and dry air are introduced on opposite sides of a membrane that is permeable to water vapour and selective to air. Under this condition, water vapor is driven from the wet side to the dry side by the partial pressure difference between the gases. If a load is placed on the dry side, then mechanical work can be extracted as the load is acted upon. We present the energy and power density of the process, which are a function of the membrane's properties, the humidity difference between feed (wet) and draw (dry) airs, and the applied pressure. Results are shown for theoretical and experimental analysis under various conditions.