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Induced Thermo-Osmotic Convection for Heat and Mass Transfer

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Abstract : Consideration is given to a mechanism of heat and mass transport in solutions similar than that of natural convection but with one important difference. Here the mechanism is not promoted by density differences in the fluid occurring due to temperature gradients (coefficient of thermal expansion) but rather by solubility differences due to the thermal dependence of the solubility (coefficient of thermal solubility). Utilizing a simplified physical model, it is shown that by the proper choice of the concentration of a given solution, convection might be induced by the alternating precipitation of the solute -when the solution becomes supersaturated, and its posterior recombination when changes in temperature occurs. The spontaneous change in the Gibbs free energy during the mixing is the driven force for the mechanism. The maximum extractable energy from this new type of thermal convection was derived. Experimental data from a closed-loop circuit was obtained demonstrating the feasibility for continuous separation and recombination of the solution. This type of heat and mass transport -which doesn't depend on gravity, might potentially be interesting for heat and mass transport downwards (as in solar-roof collectors to inside homes), horizontal (e.g., microelectronic applications), and in microgravity (space technology). Also, because the coefficient of thermal solubility could be positive or negative, the investigated thermo-osmosis convection can be used either for heating or cooling.

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