Electrokinetic methods applied to the evaluation of energy extraction from water salinity differences

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Recently, a new method has been proposed for obtaining (so-called blue) energy from the free energy decrease when salty and fresh waters are mixed [1,2]. Such method is based on the different capacity of the electric double layer (EDL) in the interface between an electrode and its contacting solution when the salinity varies. If we have an electrode immersed in salty water and wash it with fresh water, the EDL expands. As a consequence, counterions move against the electric force, thus decreasing the capacitance and increasing the electric potential of the charge in the electrode (Fig. 1). Hence, with this method we can extract directly electric energy.

The challenge now is to optimize the system in order to obtain the maximum energy with the minimum leakage. A first strategy that the authors propose is to increase the area of the electrode/solution interface by making a porous electrode made of a swarm of colloidal particles. The presently existing theoretical description at the nanoscale level is restricted to planar EDLs with no interaction with the EDLs of neighbour particles and for moderate potentials. Here we use a more general model without such restrictions. We show the effect of the shape of the interface (spherical or cylindrical), particle concentration and the size of ions on the extracted energy of this system. From this analysis, some strategies for optimizing the extracted energy are proposed.

Fig. 1. Specific capacitance of a porous electrode simulated as a swarm of spherical particles 10 nm in radius, with a volume fraction of 65 %. The KCl concentration in solution is indicated.

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