

Energy of salinity gradient - new source of energy with minimal environmental impact.

Knijajev V.

Institute of Marine Technology Problems FEB RAS, Russia

The areas with a drop of salinity of natural waters and solutions can be used as sources of energy. Basically these sources are connected with the ocean. First of all they are estuaries of rivers flowing into sea. Also they are waters of highly saline brines and salt deposits near reservoirs with the fresh or relatively weakly salty water.

Solutions of various concentrations are characterized by different chemical potentials, the useful energy can be obtained during the equilibrium mixing of solutions. The processes taking place during mixing of solutions are opposite to the processes running during freshening. That is why most methods of conversion for salinity gradient energy (SGE) are reverse to methods of solution freshening. Molecule exchange of the solvent or dissolved matter between solutions may proceed through membranes, a surface of the intermediate body or surfaces of different phase state solutions.

Based on these principles some methods for SGE conversion have been developed:

- The osmotic methods based on the use of difference in osmotic pressures of solutions of various concentration divided by the semipermeable membranes;
- Reverse elektrodialysis when EMF arises during directed movement of ions with a charge of different signs via alternating anion and cation exchange membranes, which divide solutions of different concentration;
- Mechanochemical based on the use of deformation of a certain class of polymers sunken by turns into solutions of various concentrations;
- Methods using the difference of pressures of the saturated vapor above solutions of various concentrations;
- The “cryoscopic” based on the use of freezing temperature difference of the fresh and salt water as well as the difference of specific volumes of water and ice.

The reverse elektrodialysis is the most promising with exploitation of the SGE source of the type river water-sea water. It allows to convert directly SGE into electric energy. Based on this method the experimental installation was created in the laboratory of non-traditional energy. This installation was tested under the field conditions using the fresh water from artesian well and marine water from a bay. This method was proved to be effective by testing. However the installation

has low specifications when the home-produced ion exchangeable membranes MA-40 and MK-40 are used. Similar results were obtained also in testing of the dialytic batteries abroad. To achieve the economic competitiveness of the method it is necessary to develop and produce special membranes of lower cost with less specific surface resistance and thickness, more stable to environmental effect and longer service life.

The laboratory of non-traditional energy develops methods using the difference of vapor pressure (A.s. No. 1325191) and methods based on the use of solution freezing (these designs are now being patented). Development of these methods of SGE conversion allows to avoid the problems connected with membranes.

Based on the formula derived for estimation of the energetic potential of SGE we were able to obtain values of the average power and theoretically possible annual output of energy in the mouths of some Primorye rivers flowing into the Sea of Japan. Estimation of the change of energetic potential for a year and years of different water content was made for a number of rivers. Rivers of Primorye are characterized by irregular hydrological regime resulting in the change of SGE energetic potential by an order of two for a year. It is reasonable to choose the power of stations designed for operation on minimum discharge of water guaranteed for most part of year. In this case 4-5% of average yearly potential and 1-2 % of an average potential of August the most abounding in water were used. With allowance of EFF of the most effective operational regime of power station about 1% of average yearly energetic potential will be consumed for SGE transformation into 25%. During spawning period in late summer and early autumn less than 0.5% of energetic potential will be consumed. This portion of renewed energetic resource falls inside the limits of 0.5-1% imposed by ecologists. Even when working on the minimum guaranteed discharge of water the power of such sources is quite sufficient for power consumption of remote settlements where the SGE power installations will be suitable economically at the initial stage of introduction.

It should be noted that there is no necessity in so strict limitations for SGE because this is the most "ecologically pure" source of energy. During the use of SGE power stations the environment will be affected only locally replacing the natural process of non-equilibrium mixing of the river and seawater by equilibrium mixing in power installation. When using the highly salty brines their damaging effect on environment is generally ruled out because the mixed brines will return back into the lifeless highly salty reservoirs or underground deposits of salt.