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Renewable energy from the osmotic power potential in European estuaries – (SALINITY POWER)

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Objectives

Large amounts of renewable energy can be extracted wherever freshwater from rivers and lakes meets with the saltwater in the ocean. If freshwater and saltwater is separated by a membrane the freshwater will spontaneously migrate through the membrane and dilute the saltwater due to the chemical potential difference. The flux of water through the membrane generates a hydrostatic pressure corresponding to a water head of 100 m or more which can be used to generate power in a hydropower turbine. This technology is called pressure retarded osmosis (PRO) and has an enormous unexploited power production potential world-wide.

The PRO process is similar to a reverse osmosis desalination plant running backwards. Most of the components are thus well known and proven technology. The major challenge is to develop an efficient and cheap forward osmosis membrane that is capable of transferring large amounts of freshwater towards a significant pressure gradient.

Specific objectives include: Increase the membrane performance to 4 W/m^2 at a mass production cost of 4 €/m^2. A feasibility study to establish the potential for salinity power in a European renewable energy production scenario will also be concluded.

Results

A wide range of membrane types have been developed and tested during the first 24 months of the project and the characteristic parameters such as permeability of water and salt, and osmotic pressure have been studied. In process simulation experiments a membrane performance of more than 1.5 W/m^2 has been verified. This is about half the power density objective at this time in the project. However, reverse osmosis measurements of the same membranes showed a potential power density of about 5 W/m^2, which shows that indicate the future capability of present membrane types. Present membrane performance is more than twice the values measured one year ago and the progress is steady. Until now the scientists have not observed any fundamental obstacles in membrane development suggesting that membrane performance of 4 W W/m^2 or more can be achieved by clever membrane design and engineering.

The various tasks of the feasibility study are in progress and preliminary results are encouraging. Concept development and process simulations show that osmotic power can become competitive on the European renewable energy market. Although technology development will continue after the completion of the present project it is evident that significant progress has been made towards establishing a new environmentally friendly power source.

Potential exploitation by end users

The present project is the only major research activity into salinity power exploitation world-wide. The consortium partners are world leaders in the development of a vast unexploited power source which has a technical generating potential estimated at 250 TWh per year only in Europe. The efforts of this consortium are expected to establish the necessary theoretical and practical know-how (pre-engineering level) for the future construction of a salinity power plant. The project is further expected to bring about a breakthrough in membrane development by achieving a power density equivalent to 4 W/m2 of membrane. Even if membrane development is expected to continue beyond the duration of this project a membrane power density in this range would verify the market feasibility of the concept.

The feasibility study will establish the competitiveness and environmental performance of a salinity power plant in operation. Although firm conclusions are premature recent results suggest that salinity power plant can be constructed with a very gentle environmental impact and so that the local environment and biodiversity is well conserved. Taking this into account and assuming realistic membrane performance and cost data it is expected that salinity power will be competitive with other emerging renewable energy sources such as off-shore wind power and biomass power generation.

Provided the successful development of salinity power the demand for membrane will increase substantially compared to present global production capacity and the construction of power plants will sustain a massive expansion of the membrane industry over a period of many years.

Statkraft SF is the second largest producer of renewable energy in Europe with a strong position in hydro power generation. The company has a strategic vision to become a European leader in environmentally friendly energy. Participation in the SALINITY POWER project is part of the long term strategic perspectives in Statkraft SF and offers a great potential for future renewable energy generation.

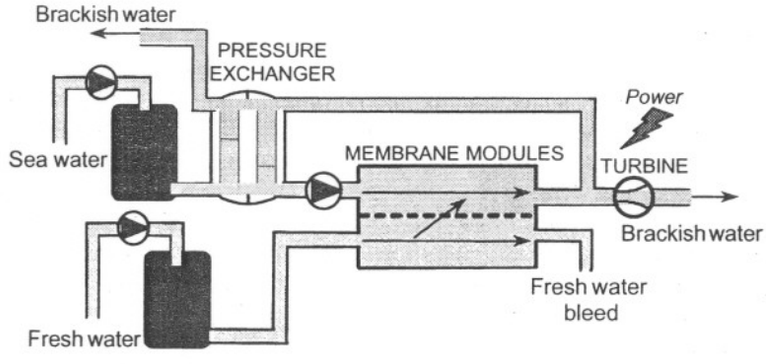

Figure 1: Simplified diagram of the PRO process.

References

[1] Aaberg, R.J. (2003) REFOCUS The International Renewable Energy Magazine **Nov/Dec**, 48-50