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Management of Membrane System’s Energy Conversion Processes

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Description

The fundamental processes of internal energy conversion to free energy and energy dissipation allow life to continue on Earth. Based on the version of the Kedem–Katchalsky–Peusner (K–K–P) formalism for concentration polarization conditions, we present a novel method for evaluating F-energy in a membrane system with ternary solutions of non-electrolytes. Using this formalism, the energy conversion efficiency coefficient and the production of S-energy can be used to calculate F-energy. The Peusner coefficients, which are required to calculate S-energy, the degree of coupling and energy conversion efficiency coefficients must be calculated under the K–K–P formalism. The F-energy calculations, on the other hand, make use of the S-energy equations and energy conversion efficiency coefficients. The peusner coefficients and form of the Kedem–Katchalsky–Peusner model equations make it possible to examine the transport properties of membranes and the conversion of energy in membrane systems. Entropy, energy production, indicated peusner coefficients and their nonlinear osmotic pressure dependences were demonstrated by us. Pseudo phase transitions from non-convective to convective states or the other way around were the source of these nonlinearities [1,2].

The paper's method can be used to evaluate F-energy resources. The findings can be applied to a variety of membrane systems utilized in medical, environmental and chemical engineering applications. As a component of process management, it can be utilized in the design of new technologies. One of the fundamental processes that ensure the survival of life on Earth is energy conversion. It occurs in membrane systems, among other types of micro- and macro systems. The cognitive and practical aspects of membrane transport processes can be studied. The molecular mechanisms by which biological or synthetic membranes exchange fluids and dissolved substances are studied in cognitive studies. The transport of substances that are necessary for living organisms to maintain their metabolic activity, maintain pressure balance and maintain structural integrity is controlled by membranes in living systems. The study of membrane transport has applications in the food industry, bio refineries, energy-based renewable sources and water and wastewater technology. It also has applications in medicine for drug carriers like liposomes, Nano micelles, or dendrimers or active membrane dressings that provide energy. This feeding, which is known as nutrition, occurs in living systems by the uptake of particular nutrients. This is true for each and every living cell in the organism. Food contains energy, the wellspring of which is the sun. The sun, wind, minerals, chemical reactions, nuclear reactions and other natural sources also provide the energy necessary to initiate and operate technological processes. However, given the limited resources at hand, its transformation into a usable form ought to be highly effective. Thermodynamic models of transport, including membrane transport and the laws of thermodynamics are two of the specialized research tools needed to evaluate this efficiency. Processes and systems are designed and managed with the help of these laws and models. Boiler and water-cooling systems are among the most crucial parts of the energy conversion process [3].

In these frameworks, layer partition assumes a fundamental part. The chemical potential energy, which is a component of the internal energy (U), is referred to as this energy. The expression F = U TS, where T is the absolute temperature and S is the thermodynamic entropy, connects its free energy (F) portion to the internal energy. Degraded energy is measured by the TS product. F-energy is transformed into mechanical work related to the movements of entire systems as well as the movements of mass and charge within them in physicochemical systems, including living organisms. Free energy can be converted into mechanical work in thermal, osmotic-diffusion, electrical, or mechanical ways. The appropriate thermodynamic stimuli, such as gradients, determine them: electrical potentials, mechanical pressure, temperature and concentration. A specific thermodynamic stimulus can trigger electric charge transport, heat transport and specific diffusion and/or osmotic transport of a substance. Moving against viscous forces, also known as dissipative forces, entails performing distributed work, while moving against external forces entails performing useful work. Thermodynamic models based on Onsager non-equilibrium thermodynamics, statistical physics and network thermodynamics, as well as diffusion and friction models, were developed to describe transport processes in membrane systems. The dissipation function, which is a measure of energy loss, is assumed to exist in models that make use of Onsager thermodynamics. It is reasonable to assume that there are linear relationships between the fluxes and the driving thermodynamic forces in close-to-equilibrium systems, also known as those with a low free energy dissipation rate [4].

By determining energy dissipation (S-energy), our goal in this paper is to determine the amount of free energy (F-energy) that is available for thermodynamic work. We propose a novel form of network K–K–P equations with the peusner coefficients and the equation for the global source of entropy to determine energy dissipation. We also measure the volume flux () and solute fluxes of glucose, calculate novel membrane transport coefficients and determine the matrix coefficients. In addition, we introduce a coefficient for energy conversion efficiency, which is necessary for determining F-energy. Our comprehension of membrane transport under concentration polarization conditions is enhanced by the presented results that describe how peusner coefficients, energy conversion efficiency coefficient and S-entropy production are influenced by osmotic pressure. We use a cellulose membrane in this study however, in order to describe the transport of a multi-component solution through the membrane and enhance the energy production properties of novel membrane systems, our method of determining the F-energy can be adapted to other kinds of membrane systems. To function, the systems described in this paper require energy. The process of converting energy into another form is known as energy conversion. Both microsystems and microsystems follow the same procedure. The system's effectiveness may decrease with each subsequent stage of conversion. As a result, effective energy management is crucial. The process of minimizing energy consumption while still achieving the required level of performance is the goal of energy management. The processes of energy production, consumption, avoiding energy drops and minimizing energy losses can all be optimized with appropriate management [5].

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Conclusion

A thermodynamic model that takes into account concentration polarization and the findings of studies on membrane system transport and F-energy estimation is presented in this paper. The transport properties of new nanoparticle-modified polymeric membranes with improved hydraulic performance, high separation efficiency and control over the phenomenon of pore blockage can be studied using these findings as a foundation. One of the most important aspects of designing technological concepts in the management of an enterprise, particularly thermal and utility power plants and businesses where boiler and district heating systems and water-cooling systems are operated is that the obtained results can be used to modernize existing technologies.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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