



Overview of pressure-retarded osmosis (PRO) process and hybrid application to sea water reverse osmosis process

Jihye Kim^a, Jijung Lee^a, Joon Ha Kim^{a,b,c,*}

^a*School of Environmental Science and Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju 500-712, Korea*

Tel. +82-62-715-3277; Fax: +82-62-715-2434; email: joonkim@gist.ac.kr

^b*Center for Seawater Desalination Plant, GIST, Gwangju 500-712, Korea*

^c*Sustainable Water Resource Technology Center, GIST, Gwangju 500-712, Korea*

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ABSTRACT

The development and exploitation of sustainable and environment-friendly energy resources are required in order to resolve global energy shortages. Recently, salinity gradient power (SGP) has been considered a feasible candidate, with high potential to become a substitute for the current use of fossil fuels due to benefits such as less periodicity, abundance and no emission of carbon dioxide. In this paper, one SGP, pressure-retarded osmosis (PRO) system, was reviewed in terms of its mechanism, limitations and available applications. In the PRO system, water permeates through a semipermeable membrane from the feed solution to the draw solution, and energy is generated by depressurizing the permeated flow through a hydro turbine. Models for understanding its mechanism and for improving of its performance were reviewed. In addition, applications of sea water reverse osmosis (SWRO), wastewater treatment (WWT) and PRO hybrid process were introduced in order to develop new water-energy nexus processes. In particular, it is thought that the SWRO-PRO hybrid process and SWRO-PRO-WWT hybrid process can contribute to reducing the total energy consumption in SWRO plants as well as to applying the SGP energy to other engineering fields.

Keywords: Pressure-retarded osmosis; Renewable energy; Salinity gradient power; Power density; SWRO-PRO hybrid system; SWRO-PRO-WWT system

1. Introduction

The global economic system has a strong dependence on fossil fuels, which are one of the major forms of energy resources. In attempts to meet the increasing demand of energy, oil consumption has currently reached almost 1,000 barrels a second [1], in other words, approximately 2L a day per person. As fossil fuels are rapidly being depleted, the golden age of oil has almost passed and this generation is now

encountering perhaps the biggest challenge of the twenty-first century [2]. Furthermore, climate change is accelerating because of the increased consumption of fossil fuels. Thus, as Ciamician stated as far back as 1912 [3], it is now time to transition from fossil fuels to renewable energy resources.

In order to overcome the drawbacks of fossil fuels, sustainable and environment-friendly energy resources need to be explored. To date, several candidates of renewable energy have been investigated, such as biomass, geothermal and hydro energies, due to their sustainability [4]. Such renewable energy resources

*Corresponding author.