



Theoretical analysis of sliding vane energy recovery device

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ABSTRACT

This paper presents a theoretical analysis of a novel energy recovery device, termed 'sliding vane work exchanger (SVWE)'. The device operates as a combined positive displacement pump and a positive displacement turbine whereby hydraulic energy recovered from the brine in the turbine section of the device is conveyed to the feed in the pump section by means of dual sliding vane rotor assembly disposed within an elliptical chamber. The paper presents models for flow variation, friction and leakage losses, and overall volumetric and hydraulic efficiencies of the device. Furthermore, a parametric study was carried out to investigate the effect of geometrical, physical, and operational parameters on the performance of the device. The study indicates that the viability of the SVWE as an energy recovery device is highly dependent on having low values of vane tip friction and vane tip leakage.

Keywords: Work-exchanger; Energy recovery; Reverse osmosis; Seawater; Desalination

1. Introduction

Energy recovery (ER) is a method used in major industries to minimize the energy input to the overall system by the utilization the energy exchange from one sub-system to another sub-system of the overall system. Energy exchange can either be in thermal form such as sensible or latent energy, or mechanical form such as kinetic, potential or pressure energy. A common application of the ER principle is between exhaust and intake subsystems whereby portion of the energy available in the waste stream is transferred via an ER device to the input material flow. Water industry is an industry concerned with producing potable water with acceptable quality at minimum cost. Desalination of sea water is one of those industries that employ expensive processes to produce potable water because of its high energy demand. The reverse osmosis (RO) desalination has been demonstrated to be one of the least costly methods of desalination even without the

usage of ER devices. Although the power consumption in RO plants is not the major problems when compared to membrane life, it is still one of the important aspects of the RO process. Since the advent of RO in 1970s, tremendous effort was undertaken to find a way to reduce the associated operating costs. Among the recent advances to reduce the cost of desalinated water are the application of energy recovery devices (ERDs) and the improvement in RO membrane. Therefore, reducing the energy cost by reducing the energy wastage in the high energy brine is of vital importance. ERD can be classified as energy recovery turbines (ERT) or work exchangers (WE). Examples of the first class include Francis Turbine (FT) or reverse running turbine, Pelton impulse turbine, PIT, and hydraulic turbocharger (HTC). These devices operate on the whole flow with reported efficiency range (70–85%) depending on capacity. Examples of the second class include devices using floating reciprocating pistons in stationary cylinders such as (DWEER) system, other uses direct contact between feed and brine separated by a reciprocating buffer in a rotating

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