Abstract
Energy Recovery Devices: Comparison and Case Studies

2001 Membrane Technology Conference
March 4-7, 2001
San Antonio, Texas

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category: Advances in Technology or Operational Applications

Energy conservation is becoming an increasingly important issue in water purification. Owners and engineers alike are looking for new methods to cut down on operating costs without increasing operation and maintenance requirements. Energy consumption has always been one of the largest operating costs in membrane water treatment plants. Energy consumption was dramatically reduced in the past several years through the introduction of new low pressure membrane elements. Additional energy savings may be realized through the incorporation of energy recovery devices (ERD's). These devices transfer some of the residual pressure from the system concentrate to boost another flow stream. The units have historically been used on seawater systems to increase the feed pressure at the head of the membrane system. There are new innovative applications of ERD's on interstage applications in brackish water and even membrane softening systems. Additional benefits are obtained from using boosters on interstage applications such as improving hydraulic balance, increasing permeate quality, and potentially extending membrane life by balancing flux rates and loading.

There are several different types of energy recovery devices commercially available. The focus of this paper will be to present information on several main types and evaluate their advantages and disadvantages from an objective, non-commercial perspective. The types of ERD's that will be compared are: reverse turbine (i.e. Hydraulic Turbocharger); Pelton Wheel; Pressure Exchanger; and electric motor drive (EMD) incorporating energy recovery. The reverse turbine-type Hydraulic Turbocharger uses a turbine that is rotated by the high-pressure brine. The energy is then transferred to a forward turning turbine that adds pressure to the feed or interstage stream. This process boasts a hydraulic recovery of 92-97%. The Pelton wheel is another high efficiency mechanism, recovering up to 90% of the brine energy. The high-pressure brine is aimed by a nozzle to hit a paddlewheel, which then turns a turbine to pressurize the incoming feed. The pressure exchanger uses a cylindrical rotor, which rotates in between the two flows (brine and feed). Energy is transferred thru the rotor, from the brine to the feed, with an observed efficiency near 95%. The final ERD, the electric motor drive, is commonly used on SWRO systems, and has displayed energy savings of 20-35%, in recent pilot studies. This system also uses the high-pressure brine stream to power the feed pump using hydraulic mechanisms. How each manufacturer evaluates and promotes their efficiency will be carefully reviewed and explained. Herein, data on capital costs and energy savings and recovery, of each of the ERD's, will be discussed and evaluated. Several brief case studies will be included presenting specific data on the performance of the ERD's.