Desalination and Water Purification Research (DWPR) Program – FY 2017

Laboratory Scale – one year projects

California

Understanding Formation of a Critical Disinfection Byproduct: NDMA and Previously Unidentified NDMA Precursors in Advanced Potable Reuse Treatment Plants

Orange County Water District
Federal Funding: $149,894
Non-Federal Funding: $539,747

This research is aimed at developing water supplies by increasing wastewater reclamation effectiveness, specifically targeting limitations associated with the occurrence and fate of N-nitrosodimethylamine (NDMA) and NDMA precursors in the wastewater reclamation process. The goal of this study is to evaluate NDMA and NDMA precursor occurrence and fate at an advanced wastewater reclamation facility. There is a significant concern is that NDMA can form in the product water after UV treatment likely due to the incomplete removal of NDMA precursors during advanced treatment. This research will allow for a greater understanding of NDMA formation in advanced water treatment facilities and identify strategies for reducing the amount of NDMA formed post treatment.

Connecticut

Development of Magnetic Hybrid Nanomaterials for Effective Silica Removal in Inland Brackish Water Desalination

Yale University
Federal Funding: $150,000
Non-Federal Funding: $39,236

The project focuses on the challenges inland communities face in developing brackish water resources into viable water supply options. The proposed research aims to develop novel magnetic iron-aluminum hybrid nanomaterials for effective removal of dissolved silica from water, which adversely impact the effectiveness of reverse osmosis systems for desalinating brackish waters. It is expected that the proposed magnetic materials could enable brackish reverse osmosis desalination systems to achieve high water recovery.

Developing Module-System Performance Relationships for Forward Osmosis Systems

University of Connecticut
Federal Funding: $149,965
Non-Federal Funding: $16,560

The goal of this research is to increase opportunities for desalination water supply development by demonstrating the effectiveness of two types of water recovery systems and associated performance of multiple membrane technologies that may be used in these systems. Specifically, the work involves evaluating three types of forward osmosis (FO) membrane elements (i.e. plate-and-frame, spiral wound, and hollow fiber) used in water recovery systems where FO is coupled with either reverse osmosis (RO) or membrane distillation (MD). A range of feedwaters with varying salinity and contaminant load will be used in the evaluation to determine the appropriate operating space for each type of system.

Florida

Efficient Nutrient Recovery from Urine to Prevent Downstream Water Treatment Costs and Resell of Valuable Commodities

University of South Florida
Federal Funding: $150,000
Non-Federal Funding: $0

This research aims to address costs of wastewater treatment and reclamation, as well as improve resource recovery during wastewater reclamation that could benefit agricultural and industrial applications. Specifically, the proposal focuses on developing a novel adsorption process to capture nutrients, such as urea, phosphate, and others, by using natural receptors grafted onto porous materials.

Kansas

Fouling-resistant, Self-decontaminating Membranes for Effective Desalination of Oily Saline Wastewater

University of Kansas Center for Research, Inc.
Federal Funding: $54,802
Non-Federal Funding: $54,802

This research addresses the challenge of desalinating oily saline wastewater, such as produced waters generated from energy extraction activities, which limits their viability as water supply options. The aim of this proposed work is to fabricate fouling-resistant and self-decontaminating membranes that enable effective desalination of such wastewater. In this proposed work, the research team will fabricate fouling-resistant, self-decontaminating hydrophilic and oleophobic reverse osmosis membranes coated with photocatalytic titanium dioxide nanoparticles. The proposed work will investigate photocatalytic degradation kinetics of membranes foulants as part of their testing with oily saline wastewater.

Massachusetts

Tailoring Advanced Desalination Technologies for 21st Century Agriculture

Massachusetts Institute of Technology
Federal Funding: $150,000
Non-Federal Funding: $0

This research seeks to address water and food security problems, by tailoring advanced brackish water desalination technologies to provide an integrated solution for productive agriculture in the face of limited water supply. The research will address questions related to three crucial sub-systems: the desalination system itself, the matching of water salinity to the crop system, and the brine disposal system that sustainability treats desalination brine.

The Role of Electrode Microscale Topology in Electro-Diffusion and its Coupling to Macroscale Convection in Capacitive Deionization (CDI) Systems for Water Desalination

Northeastern University
Federal Funding: $150,000
Non-Federal Funding: $5,000

This project aims to improve the viability of a non-membrane technology for water desalination and water supply development. The targeted technology is capacitive deionization (CDI), and the research involves investigating the governing physics correlating the microstructure topology of an electro-sorbing electrode and the ion/salt transport processes within it. A better understanding of these correlations could enable improved CDI design and performance.

Nebraska

Model-guided Optimal Design and Fabrication of an Integrated Solar-driven Hollow-fiber Membrane Distillation Module

University of Nebraska, Lincoln
Federal Funding: $147,217
Non-Federal Funding: $0

The proposed work aims to develop a solar-powered water purification system that could increase water supply development opportunities for communities located in water-scarce regions having access to abundant solar energy. The goal is to develop an integrated solar-driven membrane distillation (MD) process based on high packing density hollow fiber membranes. The project will develop a hybrid mathematical and experimental approach and to fabricate and characterize hollow fiber membrane modules with enhanced distillate flux.

New Mexico

Development of a Novel Janus-HFM based DCMD Process for Cost-Effective and Energy-Efficient Desalination of High Salinity Fracking/Produced Water

New Mexico Institute of Mining and Technology
Federal Funding: $148,704
Non-Federal Funding: $73,242

The purpose of this proposed research involves increasing water supplies for the energy industry by developing cost-effective and energy-efficient desalination technology applicable to high salinity produced waters (e.g., from fracking activities). The research focuses on developing an innovative Janus hollow fine fiber membrane based direct contact membrane distillation process. Major research efforts in this project include: design and fabrication of Janus hollow fine fiber membrane, investigating the spinning parameter effects on membrane morphology, and understanding mass and heat transfer behaviors through the membrane pores.

New York

Innovative Seawater Desalination Systems Coupling Peroxide Oxidation and Reactive Graphene Oxide Modified Membranes

Research Foundation for the State University of New York
Federal Funding: $150,000
Non-Federal Funding: $37,503

The proposed project aims to address the challenge of stably operating seawater desalination during times of ocean algal blooms. The research aims to address these challenges by developing an innovative seawater desalination system that features membranes with improved anti-fouling performance and reduced disinfection byproduct formation compared to currently available systems. The project team will pursue three research tasks to develop the proposed system: (1) fabricate graphene oxide (GO)-modified membranes having anti-fouling properties for microfiltration, ultrafiltration, and reverse osmosis applications within the system, (2) enable the system to have more effective disinfection and seawater foulant oxidation by optimizing the system’s use of peroxides peracetic acid and hydrogen peroxide mixture, and (3) evaluate the synergy between peroxides and GO-modified membranes.

North Carolina

Bromide Removal from Drinking Water Source Impaired by Energy Wastewater Discharge using Electrically Conductive Membranes

University of North Carolina
Federal Funding: $144,438
Non-Federal Funding: $0

This research addresses the challenge of bromide removal from wastewaters generated at coal-fired power plants and shale gas extraction plants, which limits the viability of such produced waters as drinking water supply options. The research involves developing and evaluating a membrane-based electro oxidation process to achieve bromide removal, and convert bromide into bromine as a valuable product. The electro oxidation will take place on carbon nanotube-based electrically conductive membranes. The specific objectives of the research are to: (1) determine the impact of applied electrical potential and flow regime on bromide oxidation, (2) evaluate the performance of bromide electro oxidation and filtration treatment in drinking water matrices, and (3) evaluate organic and inorganic disinfection byproduct formation during bromide electro oxidation.

Oklahoma

Thermoplasmonic Membrane Desalination

University of Tulsa
Federal Funding: $144,396
Non-Federal Funding: $0

This research strives to address membrane technology that limits desalination and water purification performance. The proposal calls for developing a novel hybrid membrane distillation technology utilizing selective absorbing nanoparticles and photovoltaic cells. The main objectives are (1) to synthesize the nanoparticles, (2) fabricate and characterize the membranes, and (3) conduct overall system design, development, and testing at the laboratory scale.

Development of Inorganic Membrane Systems for Treatment of Produced Water

Oklahoma State University
Federal Funding: $150,000
Non-Federal Funding: $0

The proposed project aims to improve water purification technology that could be applied to produced waters and increase their viability as water supply options. The research involves developing a novel dual energy source membrane distillation technology to recover freshwater from reverse osmosis or nanofiltration concentrate at low energy cost. Specifically, the research will focus on (1) developing dual functional membrane materials that allow solar-thermal and electric resistive heating at the membrane surface, and (2) a novel membrane module that enables high energy efficiency processes using both sunlight and electricity as the energy source.

Pennsylvania

Advanced Oxidation for Water Reclamation using Ferrate

Saint Francis University
Federal Funding: $133,519
Non-Federal Funding: $0

The overarching objective of this project is to address disinfection challenges in wastewater reclamation and water reuse, thereby increasing the acceptability of these resources as viable water supply options. Specifically, the research focuses on ferrate-based disinfection, aiming to increase the understanding of ferrate performance in an integrated water reuse context toward enabling the use of ferrate in small systems. The specific objectives of the proposed research are to: (1) assess the oxidation of 1,4-dioxane by ferrate in laboratory and wastewater effluent waters, (2) examine the efficacy and primary mechanism of ferrate disinfection and pathogen inactivation in these waters, and (3) evaluate the overall performance of ferrate in a continuous flow water reuse system treating wastewater treatment plant effluents.

Vapor Adsorption Distillation for Renewable, High-Efficiency, Low-Cost, Zero Discharge Desalination

GreenBlu, LLC
Federal Funding: $149,994
Non-Federal Funding: $149,998

This study proposes a solar-powered water distillation system to improve the current distillation energy efficiency. The proposal features use of disruptive technology, which is aimed at displacing existing technology and establishing new market and industry opportunities. The research will focus on the following tasks: (1) test and optimize the adsorbent recipe used in the distiller, (2) test key subassemblies, (3) construct a proof-of-concept prototype, and (4) test performance.

Texas

Emerging Ion Concentration Polarization for Brackish Desalination

Texas Tech University
Federal Funding: $144,696
Non-Federal Funding: $0

The overall goal of this proposal is to study a new energy-efficient technology for brackish water desalination: ion concentration polarization (ICP). The specific objectives of this project are (1) to verify the energy efficiency of an ICP device, (2) to study the performance of ICP process under various practical conditions, and (3) to assess the feasibility and competitiveness of ICP technology in the brackish water desalination market.

Wyoming

Development of High Permeability Imogolite Nanocomposite Membranes for Desalination and Brine Management

University of Wyoming

Federal Funding: $148,880
Non-Federal Funding: $0

This research aims to address increase water supply development options for inland communities in water scarce regions by developing nanocomposite membranes that could increase the viability of brackish water desalination. The objective of this work is to develop imogolite nanocomposite membranes for desalination that combine high permeability with high rejection by taking advantage of the enhanced water transport through and around embedded nanotubes. The research aims are: (1) synthesize thin-film nanocomposite membranes using imogolite nanotubes as the nano-filler, (2) characterize the water flux, solute rejection, and mechanical properties of imogolite nanotube based nanocomposite membranes for brackish water desalination, and (3) evaluate the fouling potential of imogolite nanotube based nanocomposite membranes by mineral scaling and colloidal fouling.

Pilot Scale Testing – two year projects

California

Increasing Potable Water Recovery to >95%: Pilot Evaluation of Closed Circuit Desalination (CCD) and Forward Osmosis (FO) Alternatives for Concentrate Treatment

Orange County Water District

Federal Funding: $249,966
Non-Federal Funding: $766,682

The objective of this study is to demonstrate capability of increasing potable water recovery from an advanced water reuse facility by applying and comparing two technologies to the waste concentrate stream generated at the facility. The pilot focuses on concentrate generated from a reverse osmosis process. The concentrate is a liquid waste stream that otherwise must be disposed via ocean discharge or other means. The two technologies are closed circuit desalination (CCD) and forward osmosis (FO); neither has been applied to a reuse application in the U.S. which means that the regulatory criteria and requirements have not been developed. CCD technology has a unique design that will be tested using wastewater concentrate and the FO technology will be using the Breach-Activated Barrier™ patent-pending technology. This study will focus on pilot performance with respect to water quality, treatability, and acceptance for potable reuse.

Pilot Scale Evaluation of Flexible Low Energy Reverse Osmosis

Regents of the University of California, Los Angeles

Federal Funding: $299,062
Non-Federal Funding: $300,000

The proposed project will advance a recently developed University of California, Los Angeles technology for flexible low-energy reverse osmosis for pilot scale testing by integrating energy recovery to the system. The objectives of the project are to optimize energy and mitigate membrane fouling/mineral scaling which in turn will reduce cost of treatment and energy consumption.

New Mexico

Innovative Algal/Membrane Hybrid System for Sustainable Wastewater Treatment and Potable Water Recovery

Regents of New Mexico State University

Federal Funding: $399,292
Non-Federal Funding: $399,292

The goal of this project is to pilot test an integrated algal/membrane based system for reclaiming potable-quality water from wastewater to increase water supply, reduce operational costs, energy consumption, and environmental impacts. The focus is to test the viability of the system and its economic effectiveness. The testing would be conducted at Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) treating septic wastewater. Previous research at New Mexico State University (NMSU) has demonstrated the potential feasibility of the proposed treatment technology, and scaling the technology up to pilot scale is the necessary next step in technology verification.

Massachusetts

Pilot Testing Cost and Performance Optimized Photovoltaic-Powered Electrodialysis Reversal Desalination Systems

Massachusetts Institute of Technology

Federal Funding: $199,999 (one year pilot)
Non-Federal Funding: $200,000

The project focuses on the challenges inland communities face in developing brackish water resources into viable water supply options. The project builds on the research generated from the lab-scale to a pilot scale solar-powered electrodialysis reversal (EDR) brackish water desalination system. The goal of the project is to experimentally validate cost and performance optimized for community scale, off-grid, solar powered EDR system.

2nd Year Continuing Pilot Scale Project from FY2016

California

Brackish Groundwater Desalter Brine Recovery Demonstration

Eastern Municipal Water District
Federal Funding: $400,000 ($200,000 per year)
Non-Federal Funding: $1,876,688

This project is the continuation form previously DWPR funded work of a pilot unit sized at 8 gallons per minute (GPM) and increase the size to a full scale system at 100 gpm AquaSel system. Eastern Municipal Water District carried out a pilot scale evaluation of the AquaSel Technology developed by GE Water & Process Technologies. The test is set to be done in two phases, phase one will operate the 100 gpm system under similar conditions as the previous 8 gpm test, and the second phase would involve operating the 100 gpm system under optimized conditions for a period of up to 6 months.