Fiscal Year 2019- Desalination and Water Purification Research Program Project Descriptions

Alabama

University of Alabama: Synthesis of novel reverse osmosis separation layers to enhance the rejection of uncharged molecules in desalination

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

The project is focused on increasing the efficiency of reverse osmosis membranes to reject urea and boric acid which contribute to harmful algal blooms. This work will test the success of removal of these compounds from the water. Results from this research project can be used by others that can further research and applicability of this novel reverse osmosis separation technique for uncharged molecules in water.

Arizona

Arizona State University: Advancing pervaporation for the treatment of concentrates in inland desalination

Reclamation Funding: $150,000 **Total Project Cost: $150,000**

This project proposes to use pervaporation for the desalination of inland desalination concentrates. The objective of the proposed research is to advance this technology as a cost-effective and reliable solution for concentrate management by developing new high-water permeability pervaporation membranes. If successful, this research can provide a path forward for dealing with reducing the cost of concentrate management for inland desalination and potential reduction of environmental impacts.

California

California Polytechnic Pomona Foundation: Repurposing reverse osmosis concentrate for low-cost thermal energy storage

Reclamation Funding: $149,990 **Total Project Cost: $149,990**

The proposed project aims to introduce a novel alternative for concentrate disposal by developing a technology that utilizes the concentrate for storing thermal energy. This effort would potentially lead to preventing the release of concentrate to the environment, reducing cost, and introducing a novel and low-cost method for thermal energy storage using salts/minerals in the concentrate.

Orange County Water District: Evaluation of peroxide disinfectants for biofouling control of UF and RO membranes as a non-toxic alternative to chlorine

Reclamation Funding: $162,388 **Total Project Cost: $802,022**

This project is focused on evaluating an alternative disinfectant and agent for fouling control of ultrafiltration and reverse osmosis membrane treatment processes. If this new disinfectant is found to be an effective biocide for the control of membrane biofouling, it can provide an alternative disinfectant to reduce the formation of toxic disinfection by-products in advanced water treatment facilities generating water for potable reuse.

Sephton Water Technology, Inc: High performance multi-effect distillation project

Reclamation Funding: $99,893 **Total Project Cost: $418,353**

The goal of this research is to reduce the cost of distillation by augmenting the current technology with an ultrafiltration and nanofiltration system to pretreat the natural saline feed water to remove scale forming ions using a new novel process. This new process is being developed through this project by testing new high temperature scale resistant polymer composite evaporator tubes along with pretreatment improvements to accomplish the reduction in cost of distillation. If successful, this technology could be implemented in other areas where problems with scale forming on multi-effect distillation systems exist.

University of California, Los Angeles: Highly efficient and economic multi-string heat/mass exchangers

Reclamation Funding: $150,000 **Total Project Cost: $221,128**

The work proposed under this project is focused on an innovative technology to enable economic and energy efficient thermal desalination based on humidification-dehumidification process. The goal is to increase energy efficiency while driving down costs to enable modular mobile desalination systems capable of treating a wide variety of feed waters.

University of California, Riverside: Sustainable inland desalination concentrate management: An innovative treatment to remove scale-forming substances from brackish desalination brine

Reclamation Funding: $150,000 **Total Project Cost: $301,685**

The goal of this project is to test a novel and laboratory scale advanced oxidation process using persulfate for removing scale-forming substances from brackish water concentrate and reclaiming additional water from the brackish brine. The focus of the project is to develop an innovative photochemical system to remove antiscalant chemicals in membrane concentrate, and simultaneously induce the precipitation and removal of sale forming substances from concentrate.

West Basin Municipal Water District: Development of a modeling tool for the evaluation of brine diffuser shear mortality

Reclamation Funding: $116,966 **Total Project Cost: $467,865**

The results of this project may facilitate cost-effective brine management for coastal regions, while minimizing potential environmental impacts through development of rigorous, science-based methodology to minimize mortality of marine organisms. The project will build upon and extend the current understanding of shear mortality through a combination of literature review, high-end computational fluid dynamics modeling of brine discharge jets, and by leveraging the experience of the team.

Colorado

Colorado School of Mines: Closed circuit desalination with novel scaling control system

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

This work is focused on improving reverse osmosis and membrane distillation technologies, by adding smart control systems. These smart control systems will aid in minimizing chemical cleaning and need for maintenance by integrating a novel early warning system for membrane scaling. If successful, these systems could lower the cost of operation and maintenance at water treatment plants that utilize these technologies and potentially increase the life of the membranes saving capital costs.

Colorado School of Mines: Evaluation of novel integrity tests for reverse osmosis and nanofiltration and performance comparison to non-membrane-based systems for potable reuse

Reclamation Funding: $394,622 **Total Project Cost: $572,570**

The objectives of this project are to improve reverse osmosis and nanofiltration technologies by further studying their direct integrity testing and more effectively demonstrate pathogen removal efficiency. The project will demonstrate online real-time or near real-time direct integrity monitoring techniques can be used as surrogates to monitor pathogen removal by these technologies in potable reuse scenarios.

Mickley & Associates, LLC: Cost models for municipal desalination concentrate management options

Reclamation Funding: $98,100 **Total Project Cost: $196,200**

The benefit of the proposed research is in providing increased understanding of concentrate management costs and enhance cost-related estimation tools for the municipal desalination industry. Today there is not one single approach or cost model that is used across the industry to quantify cost, each entity typically goes by what a contracted consultant company provides. This work will focus on gathering real cost data, analyzing the data and synthesis to obtain a tool that could be used across the industry providing an easier way to compare costs focused on concentrate management costs.

University of Colorado: Concentrate minimization: translation of lab-scale inline CSTRs-in-series crystallizers from model water to real applications

Reclamation Funding: $150,000 **Total Project Cost: $224,011**

This project will focus on scaling up earlier Reclamation funded research to evaluate inline CSTR mixers to accelerate crystallization of salts in concentrate streams. The goal is to find a more cost-effective technology to achieve zero liquid discharge without the use of chemicals. If successful, this project could provide a simpler process at a much lower cost to manage concentrate for inland desalination than the technologies currently available.

University of Colorado: Expanding water resources through efficient waste management in arsenic treatment processes

Reclamation Funding: $145,175 **Total Project Cost: $226,936**

The objective of this project is to improve the economics of treating arsenic-impaired water using ion exchange by reducing the operating costs associated with on-site treatment of spent brine and reusing recovered regenerant salt without adversely impacting treatment performance. The work will focus on

developing a novel treatment process to reduce the operating costs and waste produced from arsenic ion exchange processes, which currently present an economic barrier to utilizing arsenic-impaired water sources.

Florida

University of South Florida: Effective energy recovery in desalination and water reclamation utilities through pressure-retarded osmosis

Reclamation Funding: $130,269 **Total Project Cost: $260,917**

The primary goal of this project is to decrease the cost and overall energy consumption of desalination and water reclamation through energy recovery by optimizing and creating a process model. Key questions will be evaluated, how to deal with membrane fouling, where can the technology be implemented, and what are its environmental impacts. This study will further advance the knowledge and understanding of pressure-retarded osmosis process.

Georgia

Georgia Tech Research: Salinity exchange for low-cost and high-quality potable water

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

This project is focused on a new concept based on three existing practices, desalination, extraction of salinity gradient energy, and direct potable reuse of domestic wastewater. The process is named “salinity exchange” which basically would transfer salts in high-salinity water streams such as seawater to treated low-salinity wastewater. The concept is to find ways to reduce cost, energy consumption, and environmental impact via this new innovative process.

Hawaii

University of Hawaii: Desalination and purification of water using battery intercalation electrodes

Reclamation Funding: $149,799 **Total Project Cost: $301,319**

This proposed work is looking at novel electrodes to be used for desalination of seawater with minimal energy consumption, thus reducing cost. The work will focus on scaling up these novel electrodes by researching and testing various material, architecture, and design. The focus will be on proving the feasibility and scalability of their theoretical transformative desalination technology.

Massachusetts

Anfiro, Inc: Easily cleaned, chlorine-resistant block copolymer NF membranes for desalination pretreatment

Reclamation Funding: $150,000 **Total Project Cost: $600,000**

The project is focused on researching a new nanofiltration membrane to develop low-energy low-chemical cleaning protocols, which will reduce resource and maintenance requirements for the whole desalination treatment system. The objectives will be to evaluate membrane fouling and designing cleaning protocols for the testing of this new membranes.

Massachusetts Institute of Technology: High recovery pulsed electric field electrodialysis reversal desalination to minimize brine and mitigate scale at low cost

Reclamation Funding: $150,000 **Total Project Cost: $150,000**

The goal of this project is to experimentally validate a low maintenance, cost-effective strategy to minimize the brine produced by community-scale electrodialysis reversal brackish water desalination systems by enabling high recovery operation using pulsed electric fields. The results of this work could provide increase in efficiency to reduce the use of chemicals currently being used in water treatment systems. This work is building upon knowledge already gained from previously funded Reclamation research in this area.

New Jersey

New Jersey Institute of Technology: Microwave-assisted reactive and antifouling membrane filtration for water purification

Reclamation Funding: $150,000 **Total Project Cost: $300,118**

The goal of this project is to work on a novel microwave-assisted membrane filtration process that is designed to improve filtration performance and mitigate membrane fouling. The ultimate goals are to transform passive membrane filtration to the next-generation reactive membranes that can prevent surface fouling and enable diverse membrane applications such as disinfection and/or viral inactivation for water reuse.

New Jersey Institute of Technology: Electromagnetic induction interfacial heating for high-efficiency membrane distillation

Reclamation Funding: $150,000 **Total Project Cost: $300,118**

This project will focus on a novel coating for membrane distillation, this research will further investigate the impacts of solution characteristics and membrane surface properties. The results of this work can provide valuable information that could potentially reduce cost and make membrane distillation processes for desalination more efficient. If successful, this could move membrane distillation processes closer to being competitive with reverse osmosis technologies.

New Mexico

New Mexico Institute of Mining and Technology: Thermally regenerable pressure forward osmosis (T-PFO) for concentrating high-salinity produced water

Reclamation Funding: $400,000 **Total Project Cost: $626,802**

The goal of this project is to perform field testing of a thermally regenerable pressure forward osmosis process on concentrating highly saline produced water so that a techno-economic model can be developed to assess the commercial viability of a full-scale system. The project will focus on testing at the pilot scale with one of the sites being at Reclamation's Brackish Groundwater National Desalination Research Facility.

New Mexico State University: Solar-driven multi-functional photocatalytic oxidation membrane distillation for closed-loop water reuse

Reclamation Funding: $149,585 **Total Project Cost: $299,578**

This project aims to develop a multi-functional anti-fouling photocatalytic membrane distillation process that can utilize the full spectrum of solar energy to decompose organic contaminants, inactivate pathogens, and produce high quality water for potable use and concentrate for agricultural irrigation. The laboratory scale work will focus on evaluating the performance of the novel membranes to properly characterize their effectiveness and testing with different types of wastewater streams.

New Mexico State University: Enhanced solar desalination using innovative approaches for concentrate treatment and energy recovery

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

This project proposes passive, low-cost, scalable, and implementable approaches for increasing the output of solar still compared to the conventional design. The goal of this project is to augment the solar input and incorporate novel elements to result in new low-cost technologies for concentrate management. If successful, these improvements could lead to a further understanding on scalability and applicability of solar stills.

New York

Columbia University: Zero liquid discharge treatment of inland reverse osmosis concentrates by solvent extraction

Reclamation Funding: $149,957 **Total Project Cost: $207,098**

The overall goal of this project is to advance zero liquid discharge technology to increase cost-effectiveness and efficiency. This project objectives are to determine the brine volume reduction and water extraction yield of inland desalination concentrates by temperature swing solvent extraction, understand the fate of heavy metals during this process, and quantify the energy requirement for minimum/zero liquid discharge. The research will further the understanding and capability of minimizing concentrate by solvent extraction process.

Oklahoma

Oklahoma State University: Solar thermal distillation technology development for desalination and produced water treatment applications

Reclamation Funding: $149,907 **Total Project Cost: $399,927**

The primary objective of this research study is to develop a cost-effective high-efficiency solar thermal distillation technology for desalination and produced water treatment applications. This novel solar energy powered thermal distillation system is intended to reduce energy consumption, potentially lower the cost of desalination, as well as reduce the environmental impacts by reducing the volume of produced water disposal.

Pennsylvania

Amorphic Tech, LTD: Development and pilot testing of novel unitary pump/turbine energy recovery for reverse osmosis

Reclamation Funding: $186,402 **Total Project Cost: $372,804**

The project is focused on testing a novel technology that can lower cost and have a high efficiency energy recovery. This technology is expected to be more efficient than a conventional centrifugal turbo-pump, while having less than half of the unique components and improving operational reliability. If successful, this project can provide additional options for energy recovery systems for reverse osmosis.

Texas

Texas A&M Engineering Experiment Station: Forensic investigation of reverse osmosis membranes in potable reuse applications: Fouling characterization and implications for cost and performance

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

This work will focus on characterizing the surfaces of virgin, fouled, and cleaned membranes by state-of-the-art microscopy and spectroscopy techniques to determine major foulants and its mechanisms. The information obtained can be used to quantify fouling impacts on life cycle costs filling an important knowledge gap for long-term planning in wastewater treatment.

University of Texas at El Paso: All of the above and the kitchen sink: High-recovery zero liquid discharge desalination for direct potable reuse

Reclamation Funding: $398,492 **Total Project Cost: $805,815**

This project will evaluate high recovery treatment technology for treatment of wastewater effluent, the evaluation of the feasibility of zero liquid discharge, and the development of a parametric model to simulate the technical and economic performance of the system. This project will provide knowledge and understanding of the complexities of wastewater concentrate and the ability to mitigate environmental impacts.

Virginia

George Mason University: Biomass enabled nanomaterials for capacitive desalination and water purification technologies

Reclamation Funding: $150,000 **Total Project Cost: $300,000**

The research goal of this project is to create an innovative, and energy-efficient way to apply biomass for water treatment. The research objective of this proposal is to test the hypothesis that tuning the morphology in micro/nano level and crystallinity of the structures will improve performance of the technology. This research will bring additional knowledge around nanomaterials and biomass for treatment applications in water treatment.