Presentation Abtracts

Selective Salt Recovery from Reverse Osmosis Brine Using Inter-stage Ion Exchange

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Presentation Abstract 1

A treatment for reverse osmosis (RO) concentrate is proposed to recover salts and increases water recovery. The process utilizes cation and anion exchange to exchange all ions in the concentrate stream for sodium and chloride. The sodium chloride stream can be treated further by a second reverse osmosis stage or another volume reduction technique to recover additional fresh water. The second stage concentrate can be used as ion exchange regeneration solution. Regeneration solutions from the cation and anion exchange columns are mixed to precipitate specific salts. Several phases of research were performed to prove the concepts behind this process. First, resin selectivity was characterized under ionic strength conditions common to RO concentrate ion by performing batch isotherms. A MATLAB model was developed to predict breakthrough curves. Regressions developed from the batch tests were used in conjunction with the MATLAB model to predict the number of bed volumes to breakthrough of calcium, magnesium, and sulfate. Model and regressions were verified by column experiments. Second, simulated cation and anion regeneration solutions were combined to precipitate salts, which were analyzed to determine their constituents. Finally, the process was tested with a continuously operated pilot scale system. Mixing of simulated and pilot generated cation and anion regeneration solutions spontaneously precipitated calcium sulfate when mixed at pH below 4.5 and mixed carbonate salts when pH was not adjusted. The pilot system can produce 12 kg of precipitate per cubic meter of RO concentrate and recover approximately 45% of the calcium and 28% of the sulfate.

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Wastewater Reuse at Holloman AFB

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Presentation Abstract 2

Saving Water through the Energy Conservation Investment Program

Holloman is one of the bases in the Air Force extensively adapted to its desert environment with base wide xeriscape landscaping and the use of artificial turf on exercise and parade fields. The 47 acre golf course is the only large area of irrigated ground and up until September 15, 2011 was irrigated with potable drinking water. In 2011, Holloman installed a treated wastewater reuse system for irrigation of the golf course, replacing more than 70 million gallons per year of potable water. This amounts to more than 15% of Holloman's annual water demand.

The funding for this project came from the Department of Defense Energy Conservation Investment Program (ECIP). ECIP is unusual in the DoD as it is a straightforward business based investment program that requires a Savings-to-Investment Ratio (SIR) greater than 1.25 and Simple Payback of less than ten years. Projects that meet the return on investment requirements of ECIP bypass the traditional long lead time budgeting process, thus rapidly increasing military facilities' efficiency.

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Treating High TDS Brackish Water in Sandoval County, New Mexico

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Presentation Abstract 3

In 2009, Sandoval County investigated treatment of a brackish groundwater source for potable water use. The county proposed to develop a wholesale water utility and provide water for the area and the city of Rio Rancho, New Mexico, with 5 million gallons per day to support area growth for 40 years.

The brackish water presented significant treatment challenges, with 12,000 milligrams per liter of total dissolved solids (TDS); extremely high levels of calcium, silica, magnesium, arsenic, and boron, as well as radionuclides; and a temperature exceeding 125° F. A multi-stage treatment process approach was developed using a combination of coagulation/sedimentation, warm lime softening, media filtration, weak acid ion exchange, and reverse osmosis to produce potable water and three distinct waste streams, two of which could produce marketable byproducts.

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Marketability and Selective Recovery of Salts from Brackish Water Desalination

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Presentation Abstract 4

An alternative to concentrate disposal is the identification of potential beneficial uses and markets for salts contained in concentrate, along with the development of innovative technologies for selective recovery of those materials. This research can then be applied to specific situations where concentrate disposal options might otherwise prohibit or severely reduce the feasibility of inland desalination.

A market analysis report was prepared to identify and document potential markets for reuse of salts and brine produced from concentrate. The market analysis report evaluated recovery of dry salts and direct use of concentrate brine by industries that use brine solution as industrial feedstock. Other factors included in this analysis are the uses of salt and market conditions and obstacles and barriers that must be overcome to marketing salts and brine.

Current concentrate management strategies produce a mixed salt waste that has no commercial value. Ion exchange (IX) has been investigated at the University of New Mexico as an intermediate step in a reverse osmosis (RO) system. Combining the IX regenerant waste streams causes salts to precipitate, which can then be recovered. Pilot testing has been conducted to optimize the exchange process, the regeneration process, and the mixing/precipitation process to control the recovery of specific salts.

The purpose of this presentation is to present the results and conclusions of the market analysis report and the results of current research on the use of ion exchange to selectively separate individual salts for potential sale.

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Non-Commercial Thinning Effects on Runoff, Infiltration, and Sediment Yield in a Mixed Conifer

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Presentation Abstract 5

Thinning mixed conifer forests has raised interest because it may increase runoff and sediment yield. However, there is little research that shows non-commercial thinning causes more runoff, infiltration, and sediment yield. The objective of this study was to determine whether non-commercial thinning practices decrease runoff and sediment yield and increase infiltration in mixed conifer forest stands. We accomplished our objective by the use of rainfall simulations. Treatments were control and non-commercial thinning with scattered slash. Study results showed that thinning did not have a significant effect on time to peak runoff, runoff initiation, runoff, infiltration, nor sediment yield. However, site (valley vs. ridge) significantly affected runoff ratio and sediment yield. Runoff ratio and sediment were high at the valley site where litter depth and litter cover were low. Results from this study indicate that thinning overstocked mixed-conifer forests does not represent a risk of increasing runoff and sediment yield.

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Presentation Abstract 6

WITHDRAWN

Use of Low Quality Water for Algal Production: Constraints

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Presentation Abstract 7

The large number of sunny days and mild climate in the southwestern U.S. has led to significant interest in developing technologies which take advantage of these resources such as solar power generation and algal biofuels production. While some of these technologies have no significant water use (i.e., solar photovoltaic power generation) others have a large consumptive water use (i.e., solar thermal power generation and algal biofuels production).

Growth of algae for production of biofuels is the subject of much current research in NM because of the warm, sunny climate and the availability of low cost land. However, algae are grown in aqueous suspensions in open ponds which generates evaporative water losses; annual pan evaporation rates in southern NM range up to nearly 10 ft/yr. Proposals to date have described use of low quality municipal wastewaters, produced water from oil recovery, and ground water from untapped brackish aquifers.

A consumptive water use for algal growth will introduce factors that have not been fully considered to date. These include: 1) water requirements and the availability of water for the process, 2) salt management and disposal, and 3) ownership of water rights and the value of water lost to evaporation. This paper reviews the impact of salinity on evaporative losses and algal growth. It discusses salt production and disposal options associated with algal production. Finally, it gives an overview of the water rights issues related to use of low quality water sources for algal farming.

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An Urban Water Needs Strategy: Proper Water Pricing, Conservation, Rainwater Harvesting & Greywater

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Presentation Abstract 8

Recently the city of Rio Rancho, NM, installed a $39M arsenic remediation plant to bring city water to EPA standards. An additional $2M is being spent on a reverse osmosis system for an out-of-compliance well. These projects were paid for by federal grants with no impact on local water pricing. The authors have lived off-grid for over four years in Rio Rancho, the past two without hauled water. Based on our own usage, only 1-2% of EPA-compliant city water is actually used for human consumption (drinking, cooking, etc.). In other areas of NM water supply is becoming critical and new well fields, piping over large distances, surface water treatment plants, desalination, and other high-cost remedies are being proposed to increase supply. Yet, despite the recent drought, only Albuquerque and Santa Fe have rainwater harvesting rebate programs, and these are insufficient. The authors propose a state-wide rainwater harvesting rebate that covers gutters, utility pumps and large water tanks, covered by increasing water fees. The rebate could be applied to the user's water bill or state income tax. We believe a goal of removing lawns, gardens, and trees from purified city water in five years could be met with a combined rebate/education program. Finally, we examine the possible impact of large-scale rainwater harvesting from malls and big box stores high-quality water supply for selected areas.

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Treatment and Use of Oil and Gas Produced Water as a Media Substrate for Algae Cultivation for Biofuels

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Presentation Abstract 9

Cultivation of high-productivity algae for biofuels is estimated to require significant quantities of water, by some estimates reaching limiting levels of water use at 270 billion gallons yr-1 (BGY) of water (evaporative losses, southwestern US) per 1 BGY of product algal lipid (Pate et al., 2011). Because many lipid-producing algae are salt-tolerant, oil and gas produced water is a likely candidate for growing algae. New Mexico alone produced 33.5 million gallons of oil and gas produced water in 2007 (Clark and Veil, 2009). Limiting factors for growth of these algae include high total dissolved solids (above 40,000 mg/L for many algae), high bicarbonate (above 400 mg/L), high metals such as copper (<1 mg/L is desired), and the presence of organic constituents (volatile and semivolatile organics) and well treatment additives (surfactants and biocides). Treatment of these waters to remove certain organic and inorganic constituents prior to use is being tested at a field site in Jal, NM. In addition, several high-salt and high-bicarbonate tolerant strains, including Nannochloropsis Salina are being tested in the laboratory at Pecos. Output water quality as a result of several different treatment steps contains reduced levels of divalent cations, organic constituents, but some increased levels of trace metals as a result of handling processes. Results of algae strain testing will also be discussed.

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Geothermal Resources Suitability for Desalination in New Mexico

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Presentation Abstract 10

Geothermal resources may provide significant advantages over other renewable energy for desalination. Geothermal energy operates 24 hrs per day and 365 days per year. With the same stream of geothermal water production, geothermal can provide electricity for pumps and the grid, a heat source for distillation processes, and a brine or brackish water source for desalination. Also, the geothermal reservoir provides a suitable confined and permeable sink for disposal of desalination brine. A common geothermal classification system applies temperature. Low temperature resources are less than 90oC, intermediate temperature resources are 90 to 180o C, and high temperature resources are greater than 180oC. Low temperature resources utilize direct-use technology. Intermediate and high temperature resources are suitable for conversion of heat to electricity. Temperature when combined with the subsurface heat transfer mechanism and geologic setting provides a viable approach to match desalination markets and technology with geothermal resources. Convective systems are shallow, generally small volume, and structurally controlled geothermal resources. Conductive systems are deep-seated, very large volume and stratigraphically controlled resources. Convective systems are best suited for small-scale desalination, while conductive resources are suitable for medium- and large-scale desalination. A real economic advantage may accrue even with production and injection wells deeper than 2,000 to 3,000 m depth since conductive and intermediate temperature resources provide electricity, process heat, a brackish water supply, and a brine injection reservoir. However, risk is higher because deep drilling is involved. Also, there are resource leasing, permitting, and royalty issues that are not associated with other renewable energy.

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Brackish Water as a New Medium to Maximize Biomass of Microalgae

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Presentation Abstract 11

Rising fuel costs and global warming have led policy makers and scientists to look for an alternate, less costly, and beneficial approach to fuel production. Algae are a cost effective substitute for biofuels which also consume CO2 during fermentation serving a beneficial purpose in counteracting global warming. The production of biomass is made more efficient by utilizing brackish water which does not consume potable water sources for algae production. The purpose of this research is to find an optimal combination of algae type and medium which will maximize the increase in algae biomass. It is hypothesized that the algae type and the brackish water solution used to grow it are the two factors which affect the increase of biomass. As a result of factorial analysis in this research, it was revealed that the combination of brackish water with Chlorella Microalgae (UTEX- 1230) maximized the percentage of biomass. Inland brackish water was deemed a suitable resource in the production of biomass when used as a medium to grow algae.

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Use of Hybrid Photovoltaic/Thermal (PV/T) System for Water Desalination

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Presentation Abstract 12

Photovoltaic System for Desalination (PV-T) is a system invented by UTEP that combines a special kind of photovoltaic system that is cooled by desalination feed water. El Paso and southern New Mexico are located in an area with high photovoltaic (PV) energy potential. According to NREL, the solar energy potential for a renewable energy project in this region is in the very high range of 6-6.8 kWh per m2 per day.

Water desalination is an energy-intensive process, due to the high water pressure needed to pump water through reverse osmosis membranes. A solar photovoltaic system could greatly contribute to the reduction of electrical costs during the period of highest time-of-use rates charged by electrical utilities. PV power can be used during the period of peak demand; grid power can be utilized during periods of low demand.

Conventional PV systems suffer from loss of efficiency when the PV cells heat up. PV cells absorb solar energy from both the infrared and the visible spectra, but only energy from a portion of the visible spectrum is converted to electrical energy. Heat is produced by the portion of incident solar energy that is not converted to electrical energy. Heating causes the efficiency of PV cells to drop typically about 0.5% per degree C. The loss in efficiency can be restored if the PV cells are cooled. Use of the recovered thermal energy from the PV cells to heat the desalination feed water is beneficial in reducing the power required for desalination.

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Evaluation of Pecos River Salinity Inputs Near Roswell, NM

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Presentation Abstract 13

Los Alamos National Laboratory, in collaboration with the Carlsbad Irrigation District, is conducting a study to identify salinity inputs to the Pecos River in the Roswell Basin. In 2010 and 2011, specific conductance measurements were made along a 30 mile stretch of the Pecos River and 15 miles of tributaries near Roswell. Also, water samples collected from 182 sites were analyzed for major ion content.

Preliminary results indicate the salinity of the Pecos River steadily increases within most of the Bitter Lakes National Wildlife Refuge (BLNWR) east of Roswell. In the northern portion of the BLNWR, the increases are a result of diffuse seepage of subsurface saline waters into the river. However, discrete salinity inputs also occur from drainage of Bitter Lakes surface waters into the river in the southern portion of the refuge. Below the BLNWR, the Rio Hondo and the outflow from Lea Lake (Bottomless Lakes State Park) also constitute significant salinity inputs to the Pecos. Taken together, the salt inputs from the BLNWR, the Rio Hondo, and Lea Lake are about equal in magnitude, and they more than triple the salt flux in the Pecos River under normal flow conditions. When considering block water releases from Fort Sumner reservoir and storm events, the 30-mile river stretch from the northern end of BLNWR to the Lea Lake outflow is estimated to contribute 40% to 50% of the total salinity that enters Brantley Reservoir north of Carlsbad, with approximately 60 wt% of the added salinity being sodium chloride.

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Soil Thermal Properties Under Contrasting Soil Textures, Soil Moisture Regimes and Water Quality

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Presentation Abstract 14

Knowledge of soil thermal properties is needed to quantify the vapor flow through the vadose zone and to prepare efficient irrigation management strategies for semi-arid areas such as Southern New Mexico. This study was conducted to compare and quantify the thermal conductivity (λ), thermal diffusivity (α), thermal resistivity (r), and volumetric specific heat capacity (C), of loamy sand, sandy loam and sandy clay loam textured soils using tap water and lagoon treated wastewater. Core and bulk soil samples were collected from each soil types form West Mesa, West of Las Cruces and USDA-ARS, Jornada Experimental Range, NM. Soil water characteristic curves were obtained at 0, -0.3, -1, -3,-5, -10, and -15 bars suctions using pressure plate apparatus after saturation with tapwater and wastewater from the West Mesa holding ponds. Once core equilibrated to an applied suction, soil thermal properties were determined using KD2 probe (Decagon Devices, Inc.). The λ was higher and r was lower for sand than loam and clay soils for cores saturated with both tapwater and wastewater. The λ, C, α, were lower and r was higher for cores saturated with treated wastewater than with tapwater especially at lower soil water potentials (-5, -10, and -15 bars). The results of the study showed that the application of treated wastewater reduces heat conductance to lower depths and could reduce the evaporation of soil moisture. However, there is a need to simultaneously consider the effect of soil salinity due to treated wastewater application on root growth and vegetation sustenance.

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Design and Piloting of a Brine Minimization System for Concentrate Disposal

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Presentation Abstract 15

The East Cherry Creek Valley Water and Sanitation District is constructing a 10 MGD brackish water reverse osmosis project to provide a new renewable water source. The District evaluated several concentrate disposal alternatives including discharge to the local wastewater treatment plant, direct surface water discharge, evaporation basins, deep well injection and brine minimization and zero liquid discharge. Objections from local agencies, regulatory issues and cost ultimately resulted in the District selecting a combination of brine minimization and deep well injection as the concentrate disposal approach for the project.

The treatment process consists of a two stage low pressure reverse osmosis (RO) skid, followed by a two stage brine minimization RO skid. The brine minimization process relies on pH suppression and scale inhibitors to eliminate a lime or caustic soda softening process typically used prior to treatment with a secondary RO system. Eliminating the softening process and maintaining residual pressure throughout the RO and deep well injection system significantly reduced the capital and expected operating costs. Pilot work at recoveries up to 97% was performed to determine cost effective balance between brine stability, acid dose, and overall recovery. A geochemical conditions analysis was performed for the deep well formation zones to identify potential precipitation reactions that can lead to high injection pressures and low capacity.

This presentation will discuss the design and pilot testing of the brine minimization process and the geochemical analysis of the deep well injection zones.

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Solar Powered Desalination

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Presentation Abstract 16

The world's supply of water is enormous, about 97% is found in oceans and is too salty to drink, the remaining 3%, 2.997% is locked up as ice at the poles and glaciers or in groundwater. Sunpower Systems Corporation has invented a solar collector called "SMARTROF" which is patented worldwide generates steam using solar energy to the invented GREEN PUMP. It uses an overhead cable sun-tracking system that provides rigidity to the trough structure so that the structure itself can be much less expensive than other solar trough systems. The parabolic reflector in the SMARTROF collector focuses sunlight at high intensity upon a heat receiver tube in which water is passed that produces steam at high temperature and pressure. The steam is piped to the Kinetic Pump, which is patented worldwide. The Pump is simple but effective. It has no turbines, gearboxes, standard hydraulic pistons or rotating shafts. It uses a principle that was overlooked by previous researchers in the field. It can efficiently pump water to a pressure that is considerably higher than the applied steam pressure. DESAL combines the SMARTOF, the Green Pump and proven reverse-osmosis (RO) technology to allow the economic production of fresh water from seawater or brackish water using solar energy. This is accomplished by using SMARTOF concentrated solar energy to produce steam, which can be used to directly pump high-pressure seawater into RO desalination units using the green Pump.

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