

SALINE WASTE



A RESOURCE.
IMPACTUS.
TREAT.
VALUE ADDED PRODUCTS.



Statement of Qualifications

(January 2024)



Pact Renewables
Pty Ltd

www.pactrenewables.com

SALINE WASTE

Pact Renewables SALINE WASTE Capability Overview



A RESOURCE.
IMPACTUS.
TREAT.
VALUE ADDED PRODUCTS.
MANAGE.

Pact Renewables has conducted numerous SALINE WASTE investigations, ranging from scoping studies to laboratory testing and field piloting/demonstration, helping industry, governments, and communities around the globe to assess, identify options and implement SALINE WASTE solutions to minimise impacts on their operations and the environment, whilst generating value to offset treatment costs.

Areas of SALINE WASTE Expertise:

- > Characterisation
- > Definition of impacts and management options
- > Treatment technology feasibility assessments
- > Development of optimised technology platforms for water and product recovery, as well as removal of toxic and hazardous wastes
- > On-site evaluations from test rig to pilot scale and demonstration

What are SALINE WASTES?

Saline wastes are liquid, slurry, or solid waste streams with elevated concentration of dissolved ions, ranging in salinity from 10 g/L total dissolved solids (TDS) to several fold the salinity of seawater (around 35 g/L TDS). The chemical makeup, level of salinity, pH, hardness, turbidity, and the concentration of hazardous metals and organic matter in a saline waste stream depends on the waste source, and subsequent changes resulting from impoundment, exposure to diurnal and seasonal evaporation and cooling, as well as physical mixing and/or agitation by wind.

Learn more about our SALINE WASTE management solutions at www.pactrenewables.com or contact us for more information: info@pactrenewables.com



World Economic Forum
January 2023, Davos

Sources of SALINE WASTE

- Industries generating saline waste, in brine, slurry, or solid forms, with some containing elevated concentration of metals, and often stored in surface impoundments, include:
- > Mining and mineral processing operations generating saline effluents with complex chemistries
 - > Desalination, including various seawater and inland desalination processes co-producing reject brine
 - > Oil/gas exploration and production from conventional and unconventional sources generating saline produced water and fracking effluents
 - > Energy generation by coal combustion, waste-to-energy, and geothermal energy production methods generating flyash and air pollution control residue (APCr) often characterised by elevated soluble salt and hazardous metals requiring removal and safe land disposal
 - > Hazardous waste treatment companies, providing PFAS treatment solutions but faced with the challenge safe disposal of saline waste containing PFAS residue in an evolving regulatory environment
 - > Municipal/industrial sewage waste incineration operations generating fly ash containing elevated concentration of soluble salt and heavy metals
 - > Petrochemical/metallurgical processes generating various types of brine effluent
 - > Mineral extraction from saline sources, such as lithium and potassium sulphate, which generates spent brine that requires reinjection, diluting and contaminating the feedstock.
 - > Cement manufacturing operations producing cement kiln dust, often requiring removal of soluble salts and hazardous metals prior to land disposal.

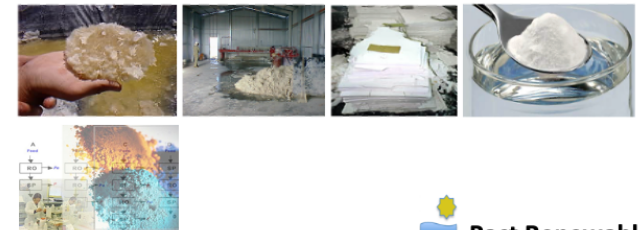


Environmental and Operational Challenges

- > High salinity damages landscapes and has negative impacts on waterways and coastal ecology
- > Discharge of untreated brine to the environment also incurs a high carbon footprint
- > Potential for liabilities, damage to both corporate reputation and ESG commitments to shareholders
- > Increased regulatory requirements for reducing risks by treatment to remove toxic elements and discharge minimisation through application of one or more of reuse, recycle, dissolved salt load and metals reduction, and volume minimisation steps
- > When disposed saline effluent becomes a wasted resource
- > Climate change impacts increasingly necessitate the need for treatment of saline effluents for water production in water-stressed regions

Resource Recovery

- Saline wastes are a long-neglected resource increasingly being identified as valuable for:
- > Production of industrial minerals, mineral compounds, and metals, with some identified as critical for emerging renewable energy and energy transition technologies
 - > Integrated recovery of water and metals from leachates of flyash and APCr subjected to water washing to allow safe land disposal of washed solids
 - > Integration of safe disposal of hazardous wastes practices with recovery of saleable salts, metals, and water from saline waste generated by waste pre-treatment process offers industries with opportunities for implementing sustainable waste management solutions.



Areas of Expertise - Detailed Description

CHARACTERISATION

SALINE WASTE characterisation requires precise sampling to avoid contamination and ensure sample representativeness, based on results obtained using validated analytical methods. Drawing from +35 years industry experience of Dr. Aharon Arakel, Company's director and chief technologist, Pact Renewables has assembled its own sampling protocols, laboratory analytical methods, monitoring and data reporting procedures, that form a core component of the company's QA/QC system. Further, Pact Renewables employs a proprietary predictive brine model that enables a better understanding of changing diurnal and seasonal temperatures and mixing conditions on saline wastes. This model has been rigorously calibrated and validated using samples collected from various dynamic hydrological basins and industrial operations around the globe, which represent nearly all possible inorganic saline waste generation types and industrial operating conditions.

DEFINITION OF IMPACTS AND MANAGEMENT OPTIONS

Pact Renewables has, in collaboration with expert environmental impact assessors, performed numerous reviews of SALINE WASTE impacts on terrestrial, groundwater, and coastal ecosystems, and uses the generated data and knowledge for timely and cost-effective tracking of impact pathways of saline waste on discharge areas. Using this approach, along with our expertise and datasets, we are uniquely positioned to avoid use of default values and information, reducing unnecessary and costly management needs. Further, the SALINE WASTE management options that we offer are all based on consideration of best-fit application of integrated saline waste treatment, recovery of valuable products and removal of toxic elements from impoundments or leachates from washing of flyash, APCr and cement kiln dust (CKD). Our solutions for the sustainable management of saline waste incorporate a substantial cost offsetting component through the recovery of water via the generation and sale of commercial-grade mineral and metal products, and safe removal and disposal of toxic and heavy metals, by using our state-of-the-art SALINE WASTE treatment technologies.

More information: info@pactrenewables.com

TREATMENT TECHNOLOGY FEASIBILITY ASSESSMENT

A two-way engagement process with our clients ensure that their requirements and project information are fully understood and communicated before commencement. Our feasibility assessment of the technology-based solutions involves three main components, namely (1) information collection and screening, (2) description of proposed treatment system options and conceptual design, and (3) cost-benefit analysis of the proposed treatment system options and comparisons using lifecycle assessments. These are commonly carried out according to the following two steps:

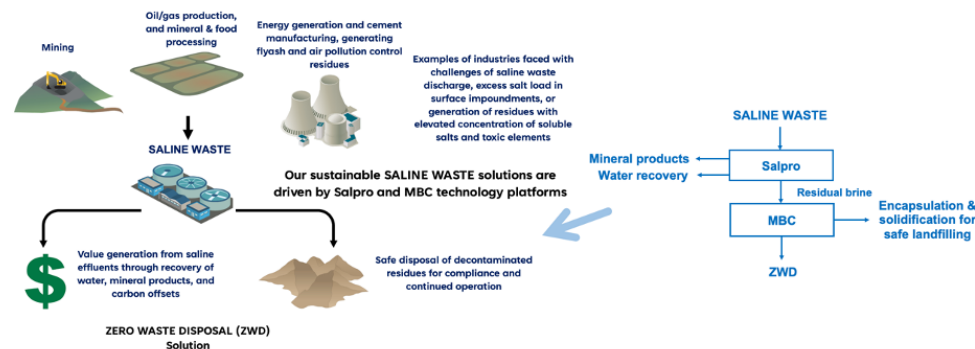
- (a) Desktop pre-feasibility/scoping study incorporating definition of benchmark values, toxic or hazardous waste removal, carbon offsetting options, preliminary specifications and value of products from treatment, and reporting of preliminary techno-economic and lifecycle cost evaluation findings.
- (b) Verification of technology-based solutions incorporating:
 - > Laboratory-based process and products trials, compilation of resource and product inventories, preliminary products market demand and risk analysis
 - > Where required, preparation of a preliminary technology applicability envelope
 - > Indicative carbon offset values
 - > Reporting the findings of technology verification assessments to address client requirements, including treatment plant design parameters and recommendations for follow up field-based piloting and technology/solution demonstration.

DEVELOPMENT OF TREATMENT TECHNOLOGIES FOR SITE SPECIFIC APPLICATION

Sustainable management of SALINE WASTE from industrial operations is challenging, and has increasingly become urgent, considering the need for reducing carbon footprint and removing toxic and hazardous wastes, and limitations with the number of commercially available effective waste reduction technologies. Drawing from a proven technology platform, Pact Renewables develops and designs treatment systems under amicable contract R&D arrangements with clients seeking optimised technology applicability envelope for site-specific application. Pact Renewables has demonstrable technical capabilities to address SALINE WASTE challenges at sites regulated by state or national regulatory agencies, to minimise the environmental liabilities of its clients.

SUPPORT WITH ON-SITE TREATMENT TECHNOLOGY EVALUATION AND DEMONSTRATION

As part of our saline waste solution services, we perform a range of feasibility assessment of our technologies, which may extend from desktop scoping studies, feasibility assessments, and design of piloting and demonstration plants to generate real-time data for detailed techno-economic and lifecycle cost analyses, as well as independent audits of the process and products prior to entering licensing and service arrangements. Our SALINE WASTE solutions use one or more of Salpro, Synpotash, or Climedec technologies, which are outlined briefly below and further described at www.pactrenewables.com/our-technologies





Our Technology Platforms

Salpro: an enabling technology platform for the selective recovery of commercial-grade mineral products from inorganic saline streams by a combination of chemical reaction, evaporation, and separation process steps, using conventional mineral processing equipment. The technology is highly scalable and capable of achieving zero liquid discharge, by converting the bulk of impactful waste into low carbon footprint resources for downstream value adding.

Synpotash: a sustainable technology for the production of high-value, variable solubility potash fertilisers and compounds for alkaline-based fuel cell batteries from potassium containing surface impoundments using a proprietary mineral conversion process and conventional processing equipment.

MBC: a unique sustainable materials and application technology platform for management of hard to abate waste streams (including bittern residues) via an encapsulation process that uses proprietary mineral composites for aggregation or granulation of the waste streams, prior to safe landfilling.

Pact Renewables actively facilitates a paradigm change in governance of saline waste by industries who seek sustainable saline waste solutions.

Contacts

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Key Attributes

> Conducted numerous client projects, globally in multiple industries that required sustainable management of SALINE WASTE, and involved one or more of characterisation, options study, techno-economic of waste reduction methods, lifecycle assessments, pilot trials, client/agency briefing, and demonstration.

> Flexibility in delivery of saline waste solutions through consulting, contract R&D, testing and test-rig scale evaluation, and support with client's piloting/demonstration projects.

> Fit-for-purpose solutions due to flexibility in process selection and optional value-added products, depending on client objectives. This may include hazardous or toxic waste removal, saline waste minimisation, revenue generation potential, or carbon credits/offsets.

> Designed and successfully completed a major zero liquid discharge (ZLD) technology piloting project for seawater desal reject brines

> Saline wastewater solutions based on proven, demonstrated, and licensed technologies. Salpro was selected in 2006 by the U.S. Bureau of Reclamation as the highest ranking ZLD technology, at the time, for saline waste in terms of technical and operational feasibility, environmental acceptability, and economic grounds.

What Services We Offer

> **Consulting:** Expert advice on saline water cycle management from design, planning to monitoring, regulatory reporting, and treatment in multiple areas of expertise, including:

- Recovery of water and mineral products for waste minimisation
- Assessment of options for treatment of effluents generated by washing of APCr and flyash residues, for either safe disposal or reuse of washed solid residues
- Reduction of the salt load of saline impoundments, through mineral recovery for extending the operating life of the impoundments.

> **Desktop Studies:** Including prefeasibility and feasibility studies. As an expert consultant and supplier of the technologies driving our sustainable saline waste and PFAS residuals disposal solutions, we are uniquely placed to undertake integrated lifecycle assessments (LCA) and techno-economic assessments (TEA) on behalf of our clients.

> **Testing and test rig scale evaluations** for preparing design packages for piloting projects.

> **Contract R&D** on behalf of our clients seeking proprietary solutions that are optimised for compatibility with local, state, and national regulatory guidelines, whilst minimising the environmental liabilities of our clients. Generation of site-specific IP, related to and owned by the client, and post-licencing support.

Why Choose Pact Renewables

> Deep knowledge of all scientific, technical, and environmental aspects related to saline waste

> Focused technological solutions, using a proprietary proven technology platform developed by Dr Aharon Arakel (who was recently selected as a Top Innovator by the World Economic Forum) and his team

> The Company follows a fundamental approach based on saline waste minimisation through integrated recovery of products (water and mineral/metal products) for footprint reduction via cost and carbon offsets

> We provide unique technology -based management solutions for problematic saline waste contaminated by toxic metals

> Worldwide experience, past performance, and technology reputation

> Unique expertise in salt and saline waste studies, established project delivery capabilities backed up by specialised in-house facilities for analytical, process/product evaluations, to test-rig stage.

Relevant Project Examples

BHP Billiton (South Africa), City of Aurora, Southern Nevada Water Authority, Eastern Municipal Water District (USA), Department of Agriculture, Fisheries and Forestry (Australia), Environment Protection Authority (USA), Melbourne Water (Australia), Murray Darling Basin Commission (Australia), Occidental Petroleum (USA), Origin Energy (Australia), Petroleum Development Oman (Middle East), Placer Dome (Australia), Ragn-Sells (Sweden), Santos (Australia), Takata Corporation (Japan), WateReuse Foundation (USA).