Clear Solutions

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www.earthsystems.com.au

Welcome to **Clear Solutions**. This biannual newsletter produced by Earth Systems explores up-to-date water treatment issues, solutions and technologies. We encourage you to contact us with feed back on its contents and make suggestions for future issues.

In This Issue

- In Focus: Salinity
- AMD related Salinity
- ABATES: Mine Site Water Quality Freeware

About Earth Systems

Earth Systems is an environmental research and consulting group that has developed and implemented water management strategies for over 13 years. We provide:

- Specialist water quality advice and test work;
- Monitoring, data assessment and management;
- Integrated water treatment systems;
- Equipment service and maintenance;
- Contract treatment.

Earth Systems has developed innovative treatment technologies that can be packaged into a range of integrated water treatment systems suitable for use by industry, water authorities, mine sites and other remote locations. Our team includes more than twenty professional staff and associates.

Earth Systems has worked in more than 15 countries and offers consulting and management services in the water, wastewater, mining, solid waste, environmental data and environmental research fields world wide.

Contact us for our latest catalogue of water treatment equipment, or for assistance with your water quality issues.

water.treat@earthsystems.com.au

In Focus: Salinity Treatment

Introduction

With escalating demands on the world's limited freshwater resources, there is increasing urgency to develop and refine technologies to use and recycle water from a range of sources. At the forefront of this movement is a growing number of salinity treatment or desalination technologies. Primarily developed to produce drinking water from seawater, these technologies are now being used to treat both natural (eg. groundwater) and process waters for a range of purposes, from recycling to discharge to the environment. With the diverse range of desalination technologies available, a number of factors need to be considered when selecting an appropriate treatment option.

Dryland Salinity
a growing problem in Australia

Things to Consider

Salinity can be natural or may develop due to a range of circumstances. As a result saline waters can be highly varied in chemistry. Consequently, salinity from different sources (eg. groundwater, process waters, seawater) needs to be managed and treated in different ways. In some cases, water quality management may help decrease the impacts and costs of treatment. The reason for desalination (eg. drinking water, discharge requirements, process water reuse) will also impact on the technology selected and the economics of the process. For example, many technologies currently in use have been designed to produce drinking water, and treatment to this level may not be required for other applications. All desalination treatment processes produce a waste stream, in most cases a concentrated brine or precipitate. Handling and disposal of this waste needs to be considered when selecting an appropriate treatment technology.

Desalination Technologies

Desalination technologies can be divided into five main groups; thermal (*evaporation / distillation*), membrane (*filtration*), chemical (*precipitation*), biological (*bacterially mediated*) and alternative processes (*eg. freezing*). Most desalination plants currently in operation use thermal- or membrane-based processes, predominantly multi-stage flash (MSF) evaporation and reverse osmosis (RO) respectively. Most of the older and larger capacity plants used for producing potable water from seawater are thermal. As they are decommissioned, smaller membrane-based systems (eg. RO) are likely to become more important. Chemical, biological and alternative processes are

Small Scale Reverse Osmosis Plant.
Photo courtesy of Veolia Water Systems (Aust) Pty Ltd.

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Desalination Processes

Thermal Processes

- Multi-Stage Flash Distillation (MSF)
- Multi-Effect Distillation (MED)
- Vapor Compression Distillation (VCD)
- Solar Distillation (SD)
- Geothermal ("Delta T")

⇒ Typical product water <50-100 ppm TDS

Membrane Processes

- Reverse Osmosis (RO)
- Slurry Precipitate and Recycle Reverse Osmosis
- Electrodialysis
- Electrodialysis Reversal
- Nanofiltration (NF)

⇒ Typical product water <500 ppm TDS

Chemical Processes

- GYP-CIS
- SAVMIN
- Ion Exchange (IX)
- Cost Effective Sulphate Removal

Biological Processes

- Biosulphate Process from BioteQ
- Bioreactors

Alternative Processes

- Rapid Spray Evaporation

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mostly limited in their application, and at present are generally not cost effective for routine drinking water treatment.

Applications and Cost

Thermal processes are suitable for the production of drinking water from highly saline waters. They are typically designed to treat large volumes of water where the flow is constant. The pH of the water is important, impacting on corrosion and scaling of the system, and as a result pre-treatment may be necessary. There is generally limited flexibility in the quality of water produced, and these systems can be difficult to operate efficiently. Typical costs range from ~AUS$0.70/kL product water for Multi-Effect Distillation (MED) (depending on availability of waste heat) to ~AUS$2.00/kL product water MSF.

Membrane processes can be used to produce water of varying quality and are relatively simple to operate and maintain. Systems of this type are sensitive to feed water temperature and chemical composition, particularly iron and silica contents. In order to prevent or minimize fouling and/or scaling, pH correction of the feed water may be required. Oxidants, hydrogen sulphide and micro-organisms must also be removed through pre-treatment to prevent fouling of the membranes. Membrane processes also have the advantage of coping with varying water demands. Typical RO costs range upward from AUS$0.65/kL product water.

Chemical and biological processes are generally best suited for high sulphate salinity, with efficiency a function of the starting sulphate concentration. The efficiency of biological systems relies heavily on the maintenance of appropriate conditions for the selected bacteria. Both generally involve small scale systems with the reagents making up a significant proportion of the operational and maintenance cost.

The cost per unit of water produced varies significantly as a function of the desalination process used and the scale of the operation. Membrane processes generally have lower capital, operating and maintenance costs compared to other methods, with most of the operating costs going towards energy requirements and membrane replacement. Thermal processes become more economical as the size of the system increases and when a waste heat supply is locally available. Energy requirements account for the majority of operational cost of thermal systems (~50%). The cost per unit of water produced is also dependant on feed water quality. This is especially true for membrane processes, but less so for thermal processes. Pre-treatment to alter feed water composition (eg. pH adjustment, chemical addition and precipitation) may reduce operational costs and potentially allow the use of a lower cost alternative process. Disposal of the waste products needs to be included in any economic assessment of desalination technologies.

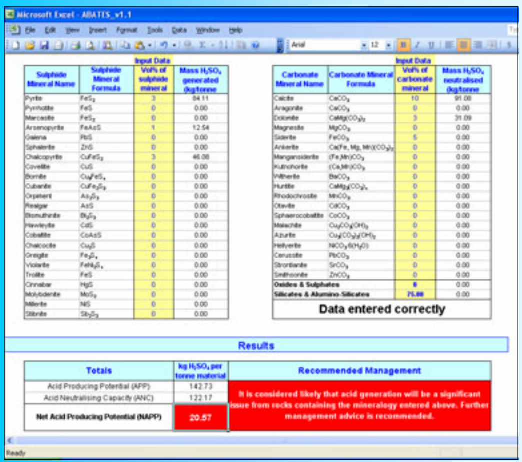
Summary

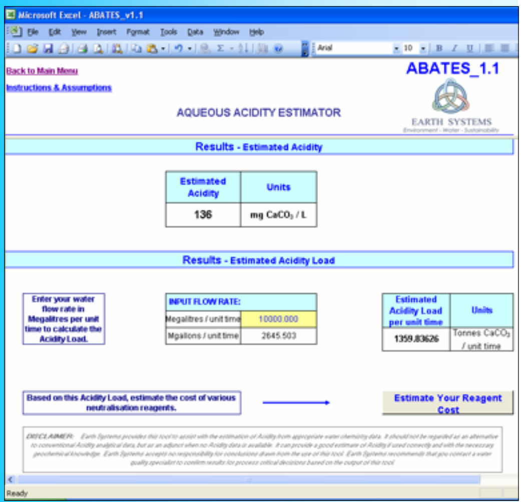
Increased demands on water resources along with technological advances, has made desalination a more viable treatment option for drinking water, process water and environmental applications. Of the many processes available, membrane systems are quickly becoming the most common due to their flexibility, operational simplicity, low maintenance and comparatively low overall costs. However, selecting an appropriate technology is a balance between the influent and final water quality requirements, treatment volumes and economics.

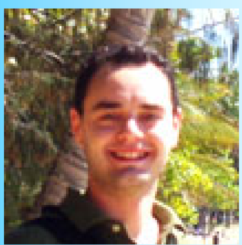
Want more information?

For more on the available options to manage and treat Salinity and Salinity related issues contact Earth Systems

WaterQuality@earthsystems.com.au







New Water Quality Specialist Joins Earth Systems

Dr. German Ferrando-Miguel has joined Earth Systems specialist water quality team. German holds a degree from the University of Barcelona (Spain), a Chemistry Ph.D from Indiana University (USA) and postdoctoral experience at the Federal Institute of Technology (ETH), Zurich (Switzerland) and University of New South Wales, Sydney, where he was awarded the prestigious Vice-Chancellor's Postdoctoral Fellowship. In addition, he holds a Masters of Environment from the University of Melbourne.

German's, expertise in the chemistry of metal and organic contaminants in water and his native Spanish speaking background will benefit a number of our clients within Australia and Internationally.

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ABATES—Water Quality Assessment Tools

Acid and Metaliferous Drainage (AMD) continues to be a significant issue facing the mining sector. Experience shows that dealing with AMD can be a costly, long-term problem if not managed correctly. **ABATES** (**A**cid **B**ase **A**ccounting **T**ool by **E**arth **S**ystems) is an Excel™-based tool developed by Earth Systems to assist with the characterisation and management of acid drainage and mine site water quality.

Comprised of a number of acid-base accounting tools for assessing water quality **ABATES** can;

- estimate the Net Acid Producing Potential (NAPP) equivalent of geological materials based on mineralogical data;
- estimate Total Acidity and Total Acidity Load based on aqueous water chemistry;
- estimate reagent treatment requirements and costs based on aqueous water chemistry and flow data;
- calculate charge balance for evaluating water quality data.

ABATES provides an ideal first pass method for evaluating water quality data and potential water quality impacts. A copy of **ABATES v.1.1** can be downloaded at: http://www.earthsystems.com.au/tools.htm and can be freely distributed without modification.

ABATES will be continually updated and feedback is welcomed. Please be aware that **ABATES** contains macros – so, if prompted, you will need to enable macros on your version of Excel™ for it to operate.

For further information on ABATES contact Dr. Jeff Taylor or Dr. German Ferrando at Earth Systems on (+61 3) 9205 9515 or email WaterQuality@earthsystems.com.au.

Treatment Solutions

SALINITY: An Indicator of Concealed Acid Drainage Issues?

Acid and metaliferous drainage (AMD) resulting from the oxidation of sulphides (eg. pyrite) is accompanied by the generation of low pH, metalliferous and sulphate-bearing waters (ie. acid drainage; *see Clear Solutions June 2002*). The presence of natural alkalinity may result in the neutralisation of these waters. In these cases the only indication of a potential acid drainage issue may be the presence of high sulphate (high salinity) waters.

Treatment options available for lowering AMD related sulphate concentrations in saline waters can be broadly divided into;

- Chemical treatment processes that promote mineral precipitation (eg. addition of Lime/limestone, addition of barium salts, the SAVMIN process);
- Membrane & ion exchange technologies (eg. Reverse Osmosis (RO), SPARRO process, Electrical Dialysis Reversal (EDR), GYP-CIX process); and
- Biological sulphate removal (eg. Bioreactors, permeable reactive barriers).

While mineral precipitation using lime or limestone is the cheapest, the process is controlled by gypsum ($CaSO_4.2H_2O$) saturation which limits the reduction of sulphate levels to ~1200mg/L. The overall costs and efficiency of many of the other systems (ie. membrane and ion exchange technologies) are a function of the feed water chemistry

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(eg. scaling components and trace metals). Both chemical treatment and membrane & ion exchange processes involve the production of various amounts of sludge or brine.

Depending on product water requirements the use of lime/limestone and the SAVMIN process are thought to be the most suitable for the treatment of sulphate-rich mine waters. The management and control of the acid forming materials may assist greatly in lowering the overall sulphate salinity and thereby reduce treatment costs.

Next Issue

- In Focus: Water Chemistry: Pure & Simple
- AcidBLOCK
- Treatment Solutions

For more information on upcoming features contact Earth Systems.

Upcoming Events

- 13—15 May, 2006, **ADST2006 International Conference: Desalination Technologies and Water Reuse.** Sharm El-Sheikh, Egypt. Organisers: Alexandria University Desalination Studies and Technology (ADST). For information visit www.alex.edu.eg/adst/
- 31 July - 2 August 2006, **2006 Biennial Conference and Exposition: Desalination Comes of Age - The Answer for New Supplies**. Anaheim, USA. Organisers: American Membrane Technology Assoc. For information visit www.membranes-amta.org

Useful Web Solutions

- George E. Brown Jr. Salinity Laboratory, California USA: www.ars.usda.gov/pwa/riverside/gebjsl
- Australian Centre for Mining Environmental Research (ACMER): www.acmer.com.au
- On-line Salinity Resource: www.salinity.org.au

Want to find out more ?

Please tick as appropriate and Fax back to Earth Systems:

- ☐ Send me information on Water Quality Management Capabilities
- ☐ Send me *"Alkalinity Producing Cover Materials for Providing Sustained Improvement in Water Quality from Waste Rock Piles"* from the 7th ICARD Conference.
- ☐ Send me *"A Summary of Passive and Active Treatment Technologies for Acid and Metalliferous Drainage (AMD)"* from the 5th Australian Workshop on Acid Drainage.

Comments / Suggestions:

Name

Position

Organisation

Address

Phone Contact

Email

☐ Please add me to the mailing list ☐ Please remove me from the mailing list

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