Water reclamation using reverse osmosis

Commercial Processing Fact sheet

Let's explore various technologies used to reclaim water.

Photo source: esi-africa.com

Fact sheet content

"The characteristics of wastewater vary depending on the source."

Introduction

South Africa is a relatively dry country and has a population of approximately 52 million people (2019), with 60% of the population living in urban environments and 40% in rural areas. The water sources include surface water (77% of total use), groundwater (9% of total use), and recycled water (14% of total use). The dependence on water is not evenly distributed, and cities with universal water distribution systems get most of their water from surface sources (dams and rivers). Due to climate change and industrialization, the access to fresh water is limited and dam levels are generally low. South Africa will face serious water problems if steps are not taken to preserve our water supplies, reduce water contamination, and regulate the supply and demand. One of these steps is to reclaim water.

Objective(s) of the fact sheet:

The objective of this factsheet is to explain the various technologies used to reclaim water. The water source can be contaminated either by industrial waste water, ground water (borehole), grey water or sea water but it can be converted to drinkable water or reused in a production process. The characteristics of wastewater vary depending on the source. Types of wastewater include: domestic wastewater from households, municipal wastewater like sewage or industrial wastewater from industrial activities. Wastewater can contain physical, chemical and biological pollutants.

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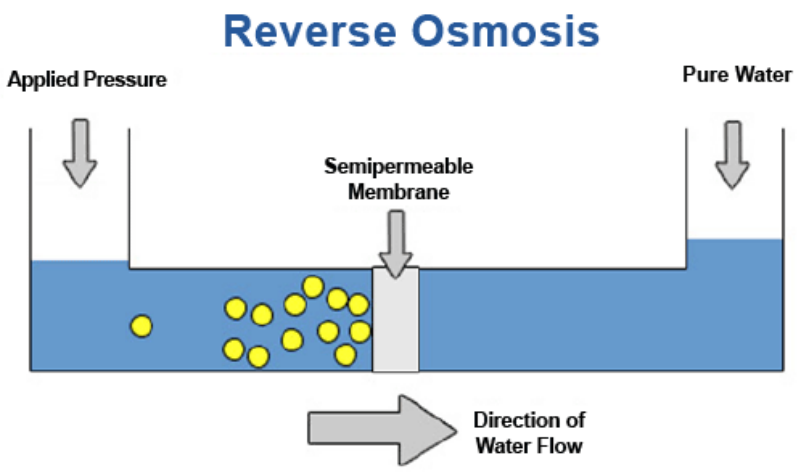
There are numerous processes that can be used to clean the wastewater depending on the type and extent of contamination, but for the purposes of this fact sheet focus is on Reverse Osmosis, Ozonation, Ultraviolet Disinfection and Desalination.

Basic description and use of the technology:

Wastewater is any water that has been affected by human use. Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and any sewer inflow or sewer infiltration".

Reverse Osmosis (RO) is a water treatment process that removes contaminants from water by using pressure to force water molecules through a semi-permeable membrane. The pressure is created by large electrical pumps in industrial and commercial processes. During this process, the contaminants are filtered out and flushed away, leaving clean, drinking water.



Source: Scifoschenonline.org

Source: www.espwaterproducts.com

There are generally four stages in the reverse osmosis process:

Refer to YouTube video clip here… (Additional videos referenced under heading ***"Literature and reference sources").***

Stage 1: Sediment filter:

This pre-filter stage is designed to strain out sediment, silt, and dirt and is especially important since the sediment filter protects dirt from getting to the delicate RO membranes that can be damaged by sediment.

Stage 2: Carbon filter:

The carbon filter is designed to remove chlorine and other contaminants that affect the performance and life of the RO membrane as well as improve the taste and odour of the water. An ion exchange softener bed could also be added.

Stage 3: Reverse osmosis membrane:

The semi-permeable RO membrane in your RO system is designed to allow water through, but filter out

almost all additional contaminants.

Stage 4: Polishing filter:
In a four-stage RO System, a final post filter (carbon filter) will "polish" off the water to remove any remaining taste and odour in the water. Ozonation and ultraviolet light can further polish the water.

Ozonation is a water treatment process that destroys microorganisms and degrades organic pollutants through the infusion of ozone, a gas produced by subjecting oxygen molecules to high electrical voltage.

Ozone is a gas, which is formed naturally by Ultraviolet rays from the sun hitting the earth as well as during a thunderstorm when lightning strikes. When this occurs the Oxygen (O_2) molecule is split into two (2) individual atoms which then attach themselves to other Oxygen (O_2) molecules, thus forming an Ozone (O_3) molecule.

The fresh sweet smell in the air after a storm is usually the smell of ozone.

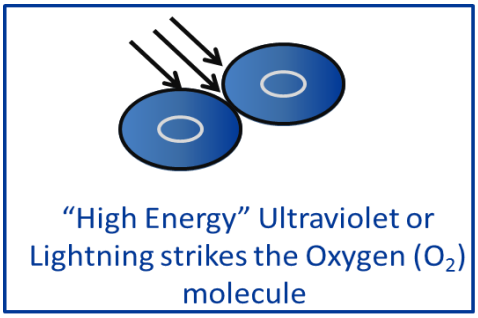
Ultraviolet purification uses Ultraviolet (UV) rays to penetrate the harmful pathogens in water. Ultraviolet light is invisible but we are exposed to it every day from all sources including the sun. UV itself is not enough to purify water for drinking purposes. This is because the UV radiation is only effective for treating bacteria, waterborne microorganisms and viruses. UV light does not eliminate contaminants such as chlorine, heavy metals and VOCs (Volatile Organic Compounds). UV systems are often paired with Reverse Osmosis Systems to provide a complete purification process for the safest drinking water.

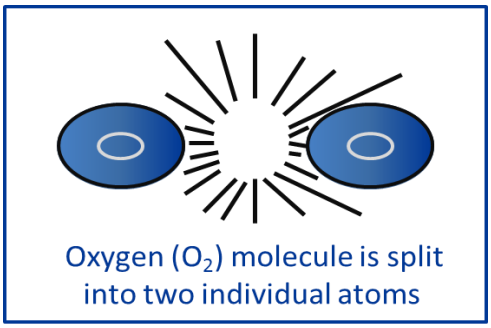
Desalination means any process that removes the excess salt and other minerals from water in order to obtain fresh water suitable for animal consumption or irrigation. The main purpose is to make water fit for human consumption. The salt is usually carried away as brine but in some cases the solid salt is extracted.

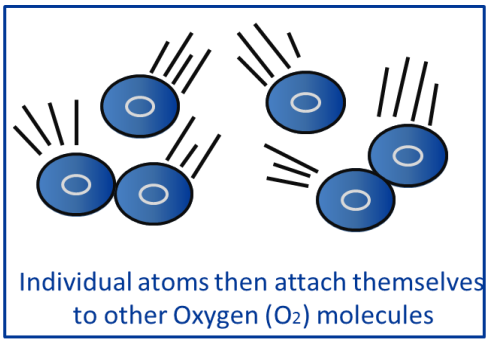
Two principal trends in desalination internationally are: RO (membrane-based) desalination and thermal desalination. RO desalination began to surpass thermal desalination in the mid-1990s, and the gap between the technologies has been growing ever since. Three main reasons for choosing RO are:

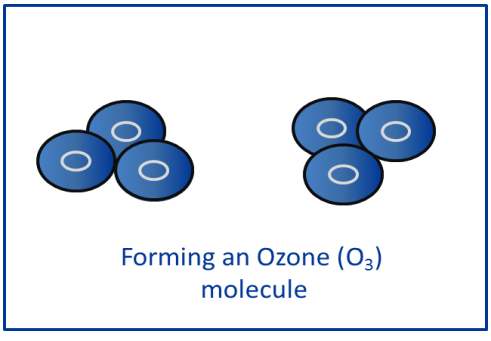
- Lower capital costs,
- Lower energy requirements, and
- Greater operating efficiency, relative to thermal desalination.

Membrane construction has advanced over the years and prices have dropped. Desalination via RO still costs more than traditional sources of water, such as ground and surface water, and operators









Source: https://ozonize.co.za/ozone-generator/

value any savings that can be conferred by membranes. Currently desalination plants are run mainly as backup water supply when experiencing drought conditions. The following developments have occurred in membrane technology:

- It allows more water to pass through the membranes (increasing flux),
- It allows more salt to be removed (increasing salt rejection), and
- It increases the resistance of membranes to fouling.

General considerations when designing an RO plant:

The layout of an RO plant is based on the treatment functions:

- Raw water pre-treatment,
- The RO treatment process,
- Permeation post-treatment, and
- Concentrate treatment.

All RO plants will include the RO treatment process; however, the other treatment functions can vary considerably based on site-specific conditions and the raw water quality. For example; clear raw water will not require all the pre-treatment components.

To develop a successful RO plant layout, the designer must consider all treatment functions and components as an integral unit that will operate together because the treatment functions and components needed to support the RO treatment process. The designer must select the specific equipment needed and develop a plant layout to meet the specific needs or space availability of the site. The system designed must meet the owner's needs in terms of investment costs, operating costs, and compatibility with the surrounding environment.

As the dissolved solids content increases, the required feed pressure increases, which requires larger feed pumps and motors. In addition, as the dissolved solids content of the raw water increases, the overall system recovery decreases, this means that more membrane area is needed to produce the same amount of water.

Generally, seawater RO plants require more space than brackish water plants. The cleanliness of the raw water also plays a significant role in the configuration of an RO plant. The RO process has a very low tolerance for suspended solids. If suspended solids are present in the raw water, pre-treatment processes must be included to remove most of these solids effectively. Pre-treatment processes require space and add a degree of complexity to the treatment plant operation.

Source: NCPC boiler course material

Source: Old Mutual Waste Water Recovery Plant; African Utility Week 2018

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Containerised water treatment plants

Containerised water treatment plants are the best solution to treat water in rural areas, schools, mining sites, industrial applications and new development sites. The containerised water plant is secure and a compact purification plant that can be relocated if needed. The containerised water plant can be used for different sources of water including surface water, brackish borehole water, river water and even sea water. The containerised unit must be self-contained and is easy to operate.

Factors that are taken into consideration when designing a containerised water treatment plant are that the plant should be compact, easy to operate, portable and be as environmentally friendly as possible. All requirements are taken into consideration when creating the best possible solution to the problem at hand.

Cases where advisors could consider implementing RO plants:

- Ultra filtration systems for separation in food processing such as a dairy.
- Lab water systems for medical and pharmaceutical applications.
- Make-up water for steam boilers to reduce amount of blowdown required and prevent fouling on tubes
- Reclaiming the circulating water in a chiller plant
- Drinking water system for bottlers and soft drink manufacturers.
- Ice making for cold storage facilities e.g. I&J and Sea Harvest
- RO plants can be used in food and beverage industries, for potable drinking water, hospitals, agriculture, hotels and resorts, water bottling and ice making, pharmaceuticals and more.
- Waste water minimization can be used in the automotive industry, metal and textile industry using reverse osmosis
- Cleaning and recycling water used in the mining process
- Mines supplying mine workers with clean drinking water
- Municipal water supply for rural areas
- Schools in rural areas

Energy Advisory Services

Eskom's role is to aid the client with basic information in the decision making process. Thereafter the Eskom Advisor will fulfil the role of energy advisor as part of the team that the farmer selects.

Optimise your energy use

Eskom's Energy Advisors, in regions across South Africa, offer advice to business customers on how to optimise their energy use by:

- Understanding their energy needs
- Understanding their electrical systems and processes
- Investigating the latest technology and process developments, including electric infrared heating and drying systems
- Analysing how to reduce energy investment costs
- Optimising energy use patterns in order to grow businesses and industries

Call 08600 37566, leave your name and number and request that an Energy Advisor in your region contacts you. Alternatively, e-mail an enquiry to **advisoryservice@eskom.co.za**.

Alternative funding

Funding offerings are available to help reduce your investment costs for waste water reclamation (or any other investments) in Agro-processing (APSS), Aquaculture (ADEP), as part of Critical Infrastructure(s) (CIP) and when Expanding Processes or Facilities (12L and 12I).
For more info visit: http://www.eskom.co.za/sites/idm/Business/Pages/Alternativefunding.aspx

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