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TECHNICAL PUBLICATION

INFORMATION & STRATEGY FOR THE FACILITY MANAGER

An Introduction to Desalination

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There are many parts of the world where fresh water supply is becoming a very scarce and expensive commodity. As such, there is a growing need to convert other water sources, such as seawater, brackish water, and perhaps even wastewater to freshwater. This task can be accomplished through a process called Desalination which removes dissolved minerals, such as the high salt content, from seawater, brackish water, or wastewater. There are several desalination technologies available today, i.e., Reverse Osmosis (RO), Distillation, Electrodialysis, and Vacuum Freezing. The most popular ones are Reverse Osmosis (RO) and Distillation. This article includes some comparisons between the two.

For the purpose of this article, the seawater, brackish water, wastewater, and any such raw water will be referred to as the "Feedwater." The resulting treated water will be referred to as the "Desalinated Water." The by-product from the Desalination process contains a high concentration of solids and will be referred to as the "Brine."

Reverse Osmosis (RO)

The Feedwater is pumped at high pressure through a permeable membrane that is especially designed for saltwater application (not your regular household membrane). The membrane separates the solids from the Feedwater, by allowing some of the Feedwater to pass through as Desalinated Water, while most of the solids are held back, concentrated, and rejected as Brine. The quality of the Desalinated Water depends on the pressure, the concentration of solids in the Feedwater, and the salt permeation constant of the membranes. Desalinated Water quality can be improved by adding a second pass of membranes, whereby Desalinated Water from the first pass is fed to the second pass. RO is capable of producing Desalinated Water with ≤ 500 ppm of solids.

Distillation

In the distillation process, Feedwater is heated and then evaporated to separate out dissolved minerals. The most common methods of distillation include multistage flash (MSF), multiple effect distillation (MED), and vapor compression (VC).

In MSF, the Feedwater is heated and the pressure is lowered, so the water "flashes" into steam. This process could undergo a series of stages with each stage a lower pressure.

In MED, the Feedwater passes through a number of evaporators in series. Vapor from one series is subsequently used to evaporate water in the next series.

The VC process involves evaporating the Feedwater, compressing the vapor, then using the heated compressed vapor as a heat source to evaporate additional Feedwater.

Distillation is capable of producing Desalinated Water with ≤ 50 ppm, about 10x better than RO.

Electrodialysis

Most of the impurities in water are present in an ionized (electronically-charged) state. When an electric current is applied, the impurities migrate towards the positive and negative electrodes. The

intermediate area becomes depleted of impurities and discharges a purified stream of Desalinated Water. This technology is used for brackish waters but is not currently available for desalting seawater on a commercial scale.

Vacuum Freezing (VF)
A process of desalination where the temperature and pressure of the seawater is lowered so that the pure water forms ice crystals. The ice is then washed and melted to produce the Desalinated Water. This technology is still being developed, and is not yet commercially competitive.

Other Considerations
Desalination may not remove all the pollutants hazardous for drinking purposes, i.e., any materials with low flash points, such as pesticides, solvents, etc. As such, some post-treatment, i.e., carbon filtration, may be necessary to remove these pollutants to meet the health standards for drinking water.

Desalinated Water is relatively more corrosive than its original Feedwater. Therefore some post-treatment may be necessary to prevent corrosion of water pipelines. Distilled water is more corrosive than RO water (from the same Feedwater).

Desalinated Water may be too good and as such too costly to use in its pure form. Therefore, it may be mixed with other water sources to optimize the economics of its use.

The cost of the Desalinated Water generated depends on the Feedwater quality. The poorer the quality, the higher the process cost and vice versa. Generally, the operating cost of Distillation is higher than RO.

Depending on the Feedwater quality, some pre-treatment, i.e. filtration, coagulation, disinfection, etc., may be necessary to prevent fouling and damage to the Desalination equipment. Some things to consider are suspended solids, microorganisms, heavy metals, other pollutants. RO is more susceptible to these contaminants than Distillation, so RO requires more pre-treatment than Distillation.

The Desalinated Water recovery is about 15 to 50% of the Feedwater (for every 100 gallons of Feedwater, 15 to 50 gallons of Desalinated Water would be produced along with the Brine). RO has a higher recovery than Distillation.

Desalination requires energy, either electricity and/or heat. RO uses less energy than Distillation. RO does not use heat.

Desalination produces liquid, solid, and/or head wastes. Due the high concentration of the wastes, it is possible that the final concentration may exceed that of the discharge limits imposed by environmental laws. As such, some post-treatment may be needed to meet these limits. Since RO does not use heat, it does not have a problem with heat wastes.