IRRIGATION FOCUCED DESALINATION

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Abstract

Problem identified

The quality of the water plays an important role when irrigation water is to be re-cycled or saved. When the TDS (Total Dissolved Solids) in the available water is low enough, any method to reduce the quantity of the irrigation water can be used. However, when the TDS is not low enough, saving water is difficult because of the requirement to flush the salts from the root zone. In many cases desalination is considered and in selected cases like the hi-tech greenhouse industry in, for example, the Netherlands, desalination is implemented. To date the only processes available are those developed for industrial or domestic applications with reversed osmosis (RO) as the most common technique. However, even in cases where the cost of RO is not prohibitive, as in the hi-tech greenhouse industry, the amount of volume discharged as a concentrate (typically 50%) is so high that no water saving is possible.

Methodology used

The aim of the demonstration was to show that ion exchange (IX), when implemented innovatively and correctly, could significantly reduce the volume of discharge during desalination. To date, this technology is not implemented in irrigation due to the cost of the chemicals needed to regenerate the ion exchange resins. This contribution will proof that by choosing the right regeneration chemicals and by the innovative modification of the regeneration process, the IX process can be implemented economically.

Desalination normally implies the removal of all dissolved solids from the water. However, in this contribution it refers to the selective removal of sodium, the ion that causes most of the salinity problems related to irrigation. In addition the process was demonstrated in an operation where water is already saved by the re-use of the greenhouse drain water. The aim was the zero discharge of water containing nitrates and phosphates from the greenhouse and in the process also to save water.

The process consists of the following steps: Step 1 – Adsorb the sodium in the drain water, together with all the other cations, onto a cation exchange resin. Step 2 – Remove the sodium from the resin by pumping an equivalent amount plus some excess of potassium chloride through the resin. Step 3 – Regenerate the resin with nitric acid. This produces a nutrient mixture containing nitrate from the nitric acid plus the nutrient cations, free of sodium, absorbed onto the resin in Step 1.

The chemicals used in the ion exchange process all contain plant nutrients. These nutrients end up in the nutrient solution of the greenhouse reducing the volume of fertiliser needed by the grower. It is this saving in the fertiliser that pays for the chemicals and in the process overcomes the main obstacle for implementing ion exchange for irrigation.

The process was demonstrated in a 9 ha tomato greenhouse in Maasdijk, the Netherlands during the 2017 season.

Main results obtained

The process managed to gradually reduce the sodium concentration in the greenhouse re-cycled drain water from 8 mmol/L to 4 mmol/L over a period of 5 months. By keeping the sodium concentration low enough the need to discharge water containing nitrate and phosphate was eliminated. The reduction was achieved by treating 8 000 L/day of drain water and producing 400 L/day of concentrate. This is a 95% recovery, which is much higher than other techniques.

Due to the regulations of the local authorities the grower was not allowed to discharge the concentrate containing the sodium into the sewer. At that stage there was no economical way to remove the concentrate from the greenhouse and the grower decided not to implement the process for the next season.

Most relevant conclusions

Ion exchange can be used economically to control the sodium concentration in greenhouse drain water where such drain water is recycled. This is achieved by generating usable nutrient solution in the regeneration process.

More ways should be investigated to implement IX in irrigation water, for example, in combination with other desalination techniques to reduce the volume of waste.

The generation of nutrient mixtures that can be used as fertiliser makes this approach specific for irrigation water.

This approach could make a contribution towards zero liquid desalination.

Keywords:

Desalination, Zero Liquid Desalination, Ion Exchange