

ENHANCING EVAPORATION

Kern E. Kenyon

4632 North Lane, Del Mar, USA

Email: kernken@aol.com

Published: 18 July 2019

Copyright © Kenyon.

ABSTRACT

A thought experiment is proposed in which an enhancement of evaporation occurs due to surface tension. Very many thin, solid and parallel plates are inserted vertically and held fixed in an air/water interface where both fluids are motionless. Gap distances between plates are constant and small causing a two-dimensional meniscus to form between every pair. Therefore, the surface area and evaporation rate can both exceed those existing before the plates were introduced. Potentially the method could lead to a different way to produce desalinization.

Keywords: Evaporation, surface tension

1. Introduction

Why would anybody attempt to find a method for increasing evaporation? Besides intrinsic interest one answer is that a few practical applications may exist. Two of them are to potentially alleviate consequences of drought and another is to provide an alternative way to produce desalinization. Given the motivation for enhancing evaporation, what is the best way to go about it? Evidently making the surface area of a water body (with air above it) considerably greater than that of a flat surface would be a good start. Surface tension is the key feature in the discussion below, and no importation of an external energy source is needed to accomplish the goal.

2. Thought Experiment

Consider two identical containers each filled with the same amount of ordinary fresh water. In one container a matrix is inserted and held fixed. The matrix consists of very numerous vertical plates that are parallel, equally and closely spaced. They are also thin, solid and smooth faced. Nothing is done to the other (control) container.

By the nature of surface tension water will rise up the sides of the plates forming a two-dimensional meniscus between each neighboring pair. At some range of the parameters of the problem the total area of the water surface will become greater than the area of the surface of the control container. For a given thickness of the plates that will happen as the gap between the plates decreases beyond a certain critical value. In that case the evaporation rate in the container with the apparatus inserted in it is predicted to exceed that of the other container.

3. Idea's Origin

Inside tree trunks it is well known that there exist very many tiny tubes, xylem (up) and phloem (down), by means of which a circulation of fluids takes place. What is still not known exactly is the complete physical mechanism involved. Surface tension could cause fluid to rise up a certain relatively small distance in the xylem tubes, but certainly not all the way from the roots to the leaves, where evaporation occurs.

Greatly reducing the vertical scale of the tree circulation to the point that the physics becomes completely understandable led to the proposed thought experiment. Also changing from tubes to slots is a bit easier to visualize, and in the present example there is only a one way flow (up) as opposed to the up/down flow inside trees.

4. Discussion

A realization of the thought experiment would be welcomed, and it could lead to quantitative estimates of possible increases in evaporation rates with the matrix apparatus in place compared to that of a flat air/water interface, both being under still conditions.

Other configurations than the one selected here may work as well probably. For example, let one container have a floating lid of relatively small thickness that is penetrated by vertical holes with circular cross-sections. Surface tension will make a meniscus inside each hole. For a given size lid, if a sufficient number of holes all have small enough diameters, then the total air/water surface area will be greater than that of the flat surface in the control container. Consequently, the evaporation rate for the container with the lid should exceed that for the other open container, which may at first seem counter-intuitive. This attempt to be similar to the structure of trees is a bit more complicated for the present purpose than just decreasing the gap between plates in the thought experiment.

At constant temperature humid air is less dense than dry air. Humid air produced by evaporation inside the slots and tubes will then rise up and out to be replaced by dryer air thus aiding the evaporation process.

ACKNOWLEDGMENT

Parts of the text were modified due to questions submitted to me by Lex Arnold.