A Solar-Driven Device for Transporting and Distilling Water Using a Porous Cup Evaporimeter

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1. Introduction

We have devised a solar-driven system for distilling and transporting water using a porous material. The method is based on the following principle. The potential energy level of water, lowered at the evaporating surface of a porous material when energy is provided for evaporation, causes water flow along the gradient of the potential energy of water—from a reservoir to the evaporating surface. In order to be continuously filled by water, the system conduit is structured like those of an “atmometer”. The objectives of this study were to confirm the above principle and evaluate its performance under laboratory conditions.

2. Materials and Methods

The experimental apparatus consists of a vaporizer, which is enclosed with a glass condenser, and a reservoir of feed water (Fig.1). The vaporizer (evaporimeter) includes a vessel made of a transparent plastic tube, which is capped with a porous cup on the top and open at its distal end into the reservoir. The condenser was supported and sealed with an acrylic outer tube. An incandescent lamp (100W) was installed above the condenser to provide the radiant energy of 900W/m² for evaporation. The whole apparatus was weighed twice, at the beginning and at the end of the measurement period, to determine the amount of evaporated water. Distilled water was collected and measured with a graduated cylinder. An evaporimeter (Uizin, UIZ-PE100), Bellane-type atmometer, was used to determine the evaporative conditions of the room. Room temperature was not controlled, but measured.

3. Results and Discussion

The vaporizer, without the condenser, lost water at a rate twice that of the atmometer. When enclosed with the condenser, evaporation from the vaporizer was reduced, but still being nearly equal to that from the atmometer. Thus, evaporation maintained a water column as high as 0.5 m in the vessel, even enclosed with the condenser. In other words, a reservoir 0.5 m below the evaporating surface was able to continuously supply the surface of the ceramic cup of our device with ample water.

Energy efficiency for the “potential” distillate of our device (evaporative water loss from the feed water reservoir) was estimated to be 40%. Similar result (45%) had been obtained in the field. But direct comparison was difficult to make, because of the differences in both the apparatus (the length of the vaporizer used in the field measurements was 1.0m) and the environmental conditions. Amount of collected distillate was about 40% of the evaporated water from the vaporizer. Thus the energy efficiency for the distillate productivity of the apparatus resulted in 16%.

The device should be improved to recover more distillate while evaporation takes place to increase its energy efficiency. Likewise, means to increase evaporation should be explored and incorporated in the present system.