Low-Cost Multi-Effect Solar Still: Alternative Appropriate Technology for Personal Desalination

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Additional information is available at the end of the chapter

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Abstract

Multi effect solar still (MES) has a stack of multiple layers for evaporation and condensation. The latent heat dissipated during condensation at the front layers are repeatedly recycled for evaporation at the back layers to increase overall desalination productivity. Despite of high efficiency and long history, MES has not been widely used yet, because of relative high cost. In this chapter, newly designed MES is introduced. Since it has low cost, light weight material and simple structure, it could be easily mass even at less developed country. The cost of production for a 1 m^2 unit is expected to be less than 300 USD. Structural features are introduced with experimental result which was outdoor tested with homemade lab prototype with 0.219 m^2 effective area. 9kg/m^2 per day of fresh water was obtained at sunny day (19.5MJ/m^2) in Seoul, Korea, which is close to WHO's recommended minimal daily water supply for individuals (7.5~15 liters). For more practical implementation, further development on prototype and production process should be made as well as long term outdoor test under actual climate it would be used. Worldwide collaboration would be necessary for speeding up implementation.

Keywords: solar still, multi-effect solar still, desalination, low cost, appropriate technology, water purification, mass production, small scale, renewable energy, solar heat, personal, individual

1. Introduction

Various desalination methods have been developed since clean water is one of the most vital resources for human life. Generally, the unit cost of fresh water production tends to decrease dramatically, as the total scale of production has increased [1]. Therefore, mega-desalination plants have become a popular trend in modern civilization. However, smaller scale desalination is still important for many applications: (i) It could supply water in remote areas where a water supply line is hardly available. (ii) It would be useful for people who cannot afford large investment for a water plant. (iii) It could also be useful as a temporal water source for many people, such as nomads, campers, sailors, or survivors of various disasters.

Thanks to modern technology development, efficient small-scale desalinators became frequently used. Portable reverse osmosis water purifiers powered by electric or fuel engine are commonly used instruments for such purposes. However, such instruments are still too expensive, hard to supply energy source or difficult to maintain for many people in the world, who cannot afford substantial budget, resource or education. For such cases, the desalination method is appropriate technology, which is affordable to the actual users in do-it-yourself (DIY) style and would be a more realistic option than the expensive high-technology solution.

Solar stills are one of the simplest ways of desalination. In solar still, saline water is evaporated by solar heat and condensed to become fresh water. Though it is old, primitive tool, but is still useful for many people. It can be simply made out of low-cost common material, such as plastic sheet or bottles. Therefore, it could be easily installed and operated with do-it-yourself manner. Various solar stills were made and used for long history [2–6]. However, the extreme low productivity has limited its application only to emergency or temporal water source. Considering that the latent heat of water vapour is about 540 cal/g or 2.26 kJ/g and assuming solar energy per unit area as 1 kJ/s m^2 (equivalent to 1 sun, which is nominal full sun intensity on bright clear day on earth), we may get about 1.6 kg of distilled water with 1 m^2 solar still in an hour. However, even this is only a theoretical maximum value. In reality, only few cups of fresh water could be obtained daily, since there is additional energy loss by vapour leakage or heat dissipation. Though several cups of water should be valuable to save thirsty sufferer, but it might not be enough for sustainable use in everyday life. Of course, we can enlarge the area of solar still to increase water production. However, in many cases, sunny land is also finite resource to be occupied only by solar still.

As shown in **Table 1**, WHO, the world health organization, recommended 2.5–3 L of drinking water per day per person for survival, including the basic hygiene and cooking purpose, at least 7.5–15 L per day per person is required [7].

Type of need	Quantity	Comments
Survival (drinking and food)	2.5–3 lpd	Depends on climate and individual physiology
Basic hygiene practices	2–6 lpd	Depends on social and cultural norms
Basic cooking needs	3–6 lpd	Depends on food type, social and cultural norms
Total	7.5–15 lpd	Lpd: Litres per day

Table 1. Minimal amount of fresh water required for a human living, recommended by the World Health Organization.

Therefore, substantial improvement of productivity should be made on solar still for more practical applications. Multi-effect solar still (MES) was developed to overcome this low productivity problem, by recycling wasted latent heat repeatedly [8–27]. As shown in **Figure 1**, in MES, multiple layers of evaporating wicks and condensing surface are stacked together [14].

Saline water flowing through first evaporation wick is partially evaporated, while the condensed saline water is drained out. The water vapour condensed on the first condensation surface would be collected as fresh water. During the condensation process, dissipated latent heat is reused to evaporate saline water running on the second evaporation wick. By repeating this process on multiple layers, the overall water productivity is very much increased. The Tanaka's group proved both theoretically and experimentally that MES can produce over 10–20 L of fresh water per day with a square metre effective area [8], which is comparable amount to that WHO recommended.

Though MES has more than half century history [2, 3] and performance verification, it is not widely used on practical application yet because of relatively high cost. Metal plates covered with fabric, glass cover, metal or wooden frames and airtight vapour sealants were commonly used materials for traditional MES system. Though they enable rigid and effective MES structure, but still they are relatively expensive and heavy material, which increase overall system cost.

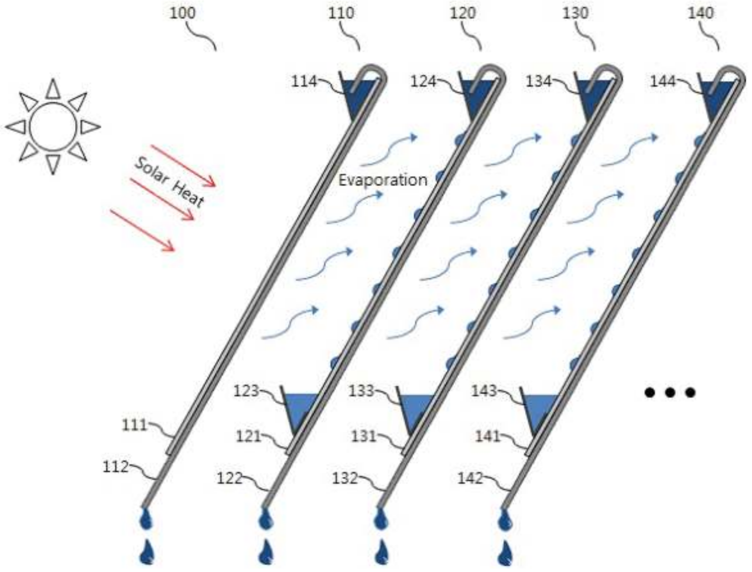

Figure 1. Typical structure of MES. Saline water in upper troughs (114, 124, 134, 144) flows through evaporation wicks (112, 122, 132, 142) and condensed on the condensation surfaces (121, 131, 141) to be collected through the collectors (123, 133, 143).

Figure 1 represents typical inner structure of MES. It may include upper saline water trough, vapour condensing plates, wicks where the saline water evaporates, condensed fresh water collecting guide trough. The structures are packed in sun light passing windows and housing.

For higher productivity in MES, intervals between each evaporation wick and condensing surface should be minimized [9, 11]. However, if the distance is too short, the layers could touch each other, so that water droplet on the condensing surface can move to evaporation wick, which causes loss of distilled water. Similarly, if the saline water overflow into condensing surface, serious contamination of produced water could be occurred. Therefore, the wick and condensing surface should be securely isolated by air gap. Despite air gaps between the layers, there is always a chance of contact within layers because of impact, vibration, and gravitational deformation. To minimize such deformation, various approaches were made. Rigid metallic plates were commonly used for stable condensing layer. However, it resulted in increase of cost and system weight. Spacers were placed between the layers [4]. However, water droplet may flow back to wick along the spacer if too much spacers were applied, which may reduce productivity. The layers were placed vertically to avoid gravitational deformation [8–13]. However, it may increase discrepancy between solar incident angle to the system window, which reduces solar energy usage. Reflecting mirrors [12, 24] or tilted window [8, 9, 13, 27] could be placed in front of the vertical layers to maximize solar intensity. However, it may increase the system cost.

To solve this high-cost problem, new MES was designed and tested. To reduce production cost, alternative light-weight and low-cost material was used instead of such expensive materials. Structure of each component was also designed for easier mass production, which may reduce cost. In the next section, the materials and structure of the low-cost MES would be described.

2. Structure and material of the low-cost MES

2.1. Design of the wick/condenser laminated film layer

In this work, flexible thin plastic film laminated to black fabric wick was used instead of stainless plate covered with fabric wick [14, 15]. The laminated film is obviously low-cost, light-weight alternative than metallic plates. It could be produced by roll-to-roll process, which is mass production favourable. The laminated film was folded like origami as shown in **Figure 2** [14].

Evaporation wick, condensation surface, upper saline water trough, condensed water guiding channel and concentrated saline water draining guide could be included in this single origami structure. Mixing the fresh and saline water at the end of draining guide could be avoided by folding the edge of the film. This simple structure and process may enable mass production and reduce the production cost.

2.2. Design of the spacer layer

Flexible wick/condensing layer is vulnerable for deformation which causes mixing back the fresh and saline water. Therefore, specially designed spacers are required for this system. In

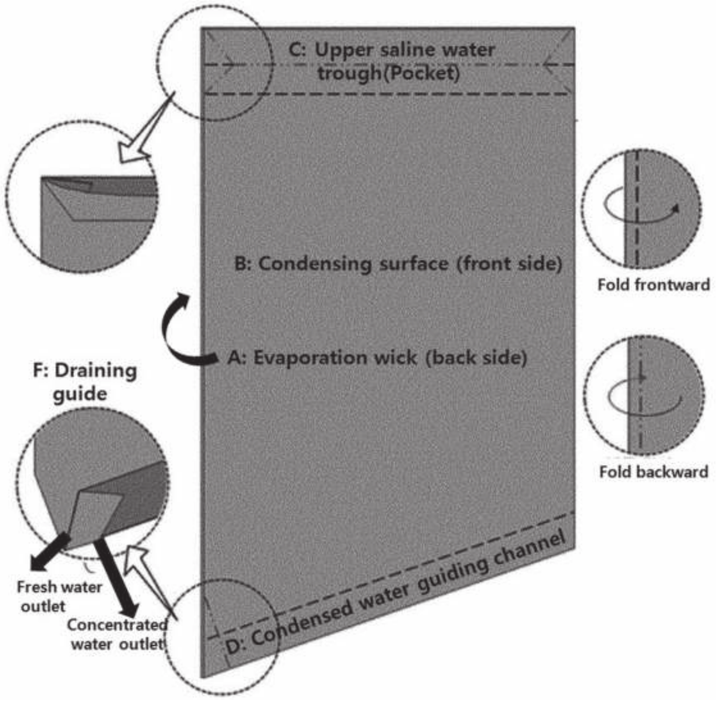

Figure 2. The origami structure of wick/condenser layer. Each part of the structure would have role of the evaporation wick (A), condensing surface (B), saline water feeding trough (or pocket) (C), condensed fresh water guiding channel (D) and draining guide which separate the fresh water and waste water (F).

other hands, tight vapour sealing and thermal insulation are essential for assuring high productivity. In this system, sealing, spacers and inner frames altogether are constructed in one structure, the spacer layer. Its structural features are shown in **Figure 3** [14].

Vertically elongated spacers are connected to upper and lower parts of the frame. The spacer layer has following roles.

Role 1: Internal framework for the MES

It has a role of internal framework structure standing for each layer of evaporation wick/condensation layer film. The spacer layers and wick/condensing films are alternately stacked as shown in **Figure 4**. Though the film is too flexible to be stand alone, the film-spacer combined layer is stiff enough to be stand. The stiffness increases by stacking multiple layers.

Role 2: Fixture for the vertical spacers

The frame holds each vertical spacer in right position and orientation. To avoid a layer’s film touching the next layer film, it is important that each spacer on a layer should be exactly superposed on top of the next layer’s spacer.

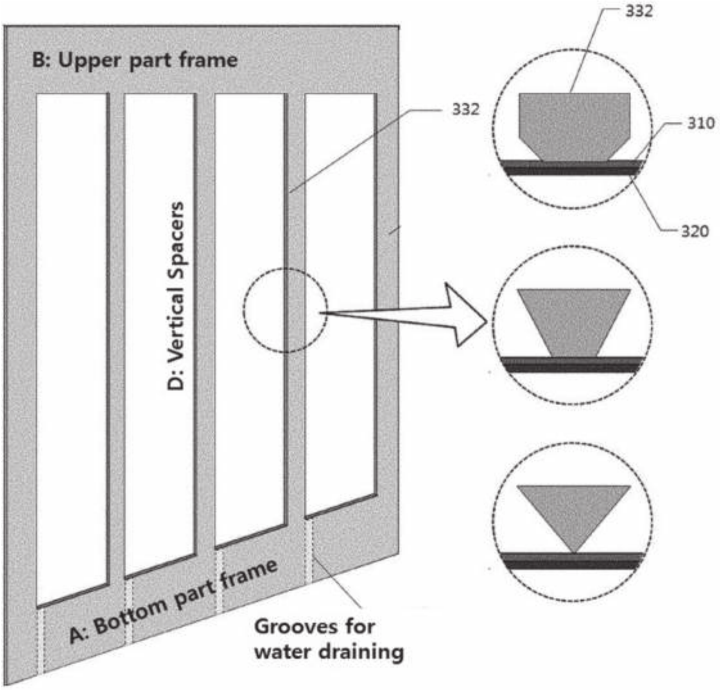

Figure 3. Structure of the spacer layers. The vertical spacers are connected to the perimeter frame. Small pictures in circles represent cross section of the spacers (332) which touches the condensing surface (310) laminated to the wick (320).

Maintaining regular spacer orientation is also necessary. As shown in small circles in **Figure 3**, the cross sections of the spacers were designed to have sharp angles (less than 90°) towards the contacting plane of the vapour condensing surface. Though most of the condensed water droplets drip down straight on the condensing film, some droplet could stagger out while confronting minor defects on the film surface. Staggering motion may increase chance of the droplet hit the spacer. Once touching the spacer, the droplet would be trapped and flow along the sharp-angled crevice by surface tensional force. As long as it was trapped in the crevice, it would not flow back into the saline water running wick. Therefore, it is important that the spacer to be oriented to maintain the crevice located on condensation surface.

For lab prototype, 5-mm thick polystyrene foam board was hand carved with a knife to make the spacing layer, as shown in **Figure 5**. While carving, edges of the spacers were shaped to be 60° angle.

In case of mass production, the foam board could be cut by die press machine (commonly called as Thompson die cutter, a press with pre-shaped knife for cutting soft sheet). While pressing the knife into the foam board, edges of the cutting perimeter are automatically slightly collapsed as round shape, which makes sharp angle at the contact point between the spacer and condensing surface.

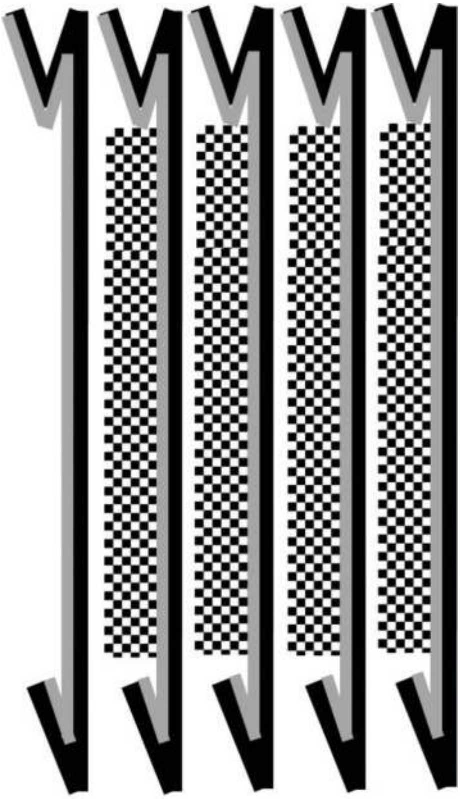

Figure 4. Alternately stacked wick (coloured black)/condenser (coloured grey) film and the spacer layer (coloured as checkerboard).

Role 3: Gasket for vapor and heat

The frame also has a role of gasket and heat insulator which minimize heat and vapour leakage from the system. Since it is made out of soft material, foam board, leakage could be avoided by simply pressing the stacks without using additional sealant. It simplifies assembly process and reduces production cost.

Role 4: Guide of the condensed fresh water

Bottom part of the frame (**Figure 3**) is slightly tilted to the upper part of the frame (**Figure 3**). The upper part of the frame has role of a cross beam, holding saline water containing trough (or pocket) in **Figure 2**. Bottom part of the frame has role of condensed water dripping guide. There are multiple grooves on the bottom frame contacting the condensing film. These grooves are for guiding the collected water to be easily flow into the condensed water-guiding channel. Without grove, condensed water could overflow towards the wick, if too much fresh water produced.

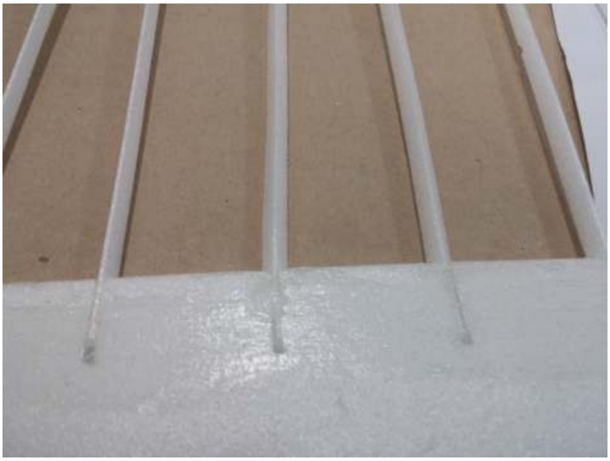

Figure 5. Hand carved spacers.

2.3. Design of the saline water distributer to each wick

Since the evaporation process on each layer repeatedly recycles the latent heat dissipated from the front layer, energy usage of each layer is different. Generally, the layer closely facing sun has more energy for distillation. Therefore, distribution of saline water in proper amount to each layer is critical for high productivity. The Tanaka group did intensive study on how to optimize water distribution, both theoretically and experimentally [8, 11]. They used multiple capillaries with different length to control amount of saline water feed to each layer. Longer capillary reduces flow rate, while short one leads higher flow rate. This is a very useful method, but further simple structure was used in this chapter. A piece of cotton fabric was vertically cut with different width as shown in **Figure 6**.

One end of the piece was immersed in saline water feeding container, and other shredded ends were inserted on the saline water pockets (**Figure 2**) of each layer. Saline water flows along the cotton fabric due to capillary force. Since the flow rate may proportional to the width of the fabric, allocated ratio of saline water to each layer could be simply controlled by controlling shred width of the fabric.

2.4. Durability and maintenance of the system

Heat loss should be minimized for higher productivity in MES. Especially for the current structure, it is important to insulate the front and back sides of the layer stacks, since the sides of stacks are partially insulated already by the frame of spacer layer. Thick (comparable to 10 cm) extended polystyrene foam plate or commercially named as "Isopink" could be placed on the back side of the layer stack. It is commonly used as a construction material for building insulation. For the front window, air-gap window, such as 18 mm thickness, triple layer air-gap polycarbonate could be placed (**Figure 7**). This window material, commercially called

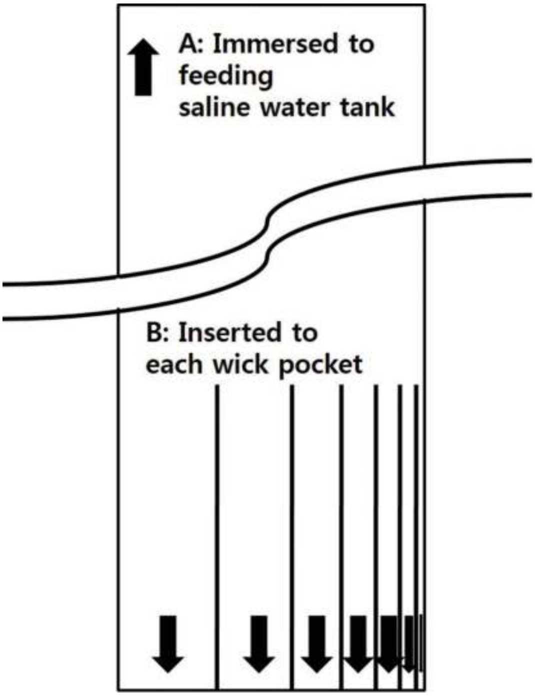

Figure 6. Structure of the low-cost water feeding distributer to each wick.

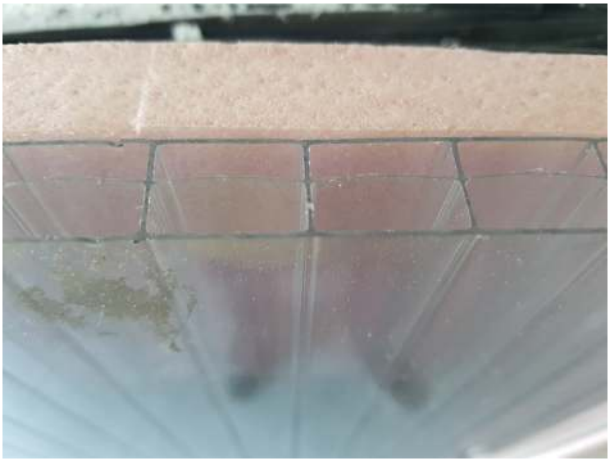

Figure 7. Cross section of the triple layer air-gap polycarbonate window (bottom) and extended polystyrene foam board (up).

Lexan, is frequently used for greenhouse construction. At the outdoor test, described in the next section, no significant degradation was observed, after leaving the prototype exposed to outdoor climate for more than half year. Though no further long-term stability test was made with this system yet, I expect certain level of environmental durability, since both Lexan and Isopink are already market proven as construction material.

Commercial polycarbonate windows are well known for toughness and UV resistance. Therefore, it might be stable for long period. If polycarbonate window is not available, stacks of glass plated with air gap, which has even higher UV resistance, could be used. However, extended polystyrene foam board is somewhat vulnerable to UV light. Though core parts of the system are protected from direct UV light, external case could be damaged for long period. For such case, the housing could be covered with other UV-blocking materials, such as paint or clay. The wicks are protected by UV-resistant window. However, long-term exposure under strong sunlight with continuous water dripping may lead black colour fading out. For that case, the front-most layer could be replaced with the inner layer periodically, since the inner layers are more protected from the UV light, and all the layers are designed to be exactly of same shape. Assuming that the system has 10 layers, and the front-most layer should be replaced after every 2 years, one system can be used for 20 years [23]. For this purpose, the system should have simple structure for assemble and disassemble. Window, stack of the layers and insulating back plates could be assembled by using common string or tie through holes, premade on each component. Unskilled users would be able to do the maintenance without special tool.

2.5. Installation of the system

Earlier MES models were commonly positioned to receive maximum solar energy during the year. With this structure, the evaporation/condensation layer stack was naturally tilted from the gravitational field. However, gravitational deformation of layers could be caused at the MES. It may cause contact of fresh water droplet to the wick or failure of the system.

As the structure proposed in this chapter, such failure would be minimized because of the spacer layers. Therefore, the system could be placed towards sun side with tilted angle (**Figure 8**).

Following the structure described in this section, dry weight of the 1 m^2 system with 10 layers may not exceed 20 kg, since it has only light-weight material. (Actually, I got 15 kg mock-up system, with the window, the 10-layer stack and insulator layer, as shown in **Figure 9**.) Therefore, the user could easily carry and install in DIY manner.

2.6. Expected cost and further cost down

Production cost for the described MES system is estimated in **Table 2** [15]. Material cost could be much lower, if we have massive economy of scale. Further cost down could be made, if lower cost alternative materials are available nearby. For example, multi-layer (air gap) polycarbonate window is relatively expensive material. It could be replaced with plane window and transparent air-bubble wrap which are inexpensive packing materials for wrapping

Figure 8. MES system installed tilted 45°.

Figure 9. One square metre effective area MES prototype with 10 layers, whose weight is 15 kg.

Item	Expected cost	Comment
Housing	50 USD	Window and insulator housing
Inner parts	180 USD	Stacks with 10 layers of spacers, wick/condensing film
Flow controller	30 USD	Feeding rate controller, hoses and container
Processing cost	40 USD	Labour and instrumental cost
Total	300 USD	Model for 1 m^2 effective area, which supplies about 10 kg/day fresh water

Table 2. Estimated production cost of the MES system.

parcels. The material and design could be modified reflecting the best condition where the system would be produced and used.

3. Lab prototype and its outdoor test result

A MES prototype was handmade using the structure described in previous section for testing its practical feasibility.

Black fabric laminated with plastic film was cut and folded to make the evaporation/condensation layer. Five-millimetre thick polystyrene foam board was used to make the spacer layer. It could be either carved out from one large sheet or assembled from small parts of the frames and thin spacers (**Figure 10**). It may be easier to make the layer by assembling small parts

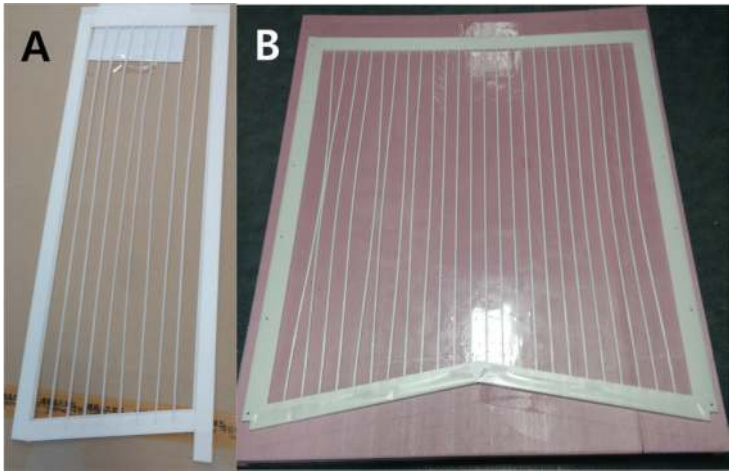

Figure 10. Hand carved and assembled spacer layer (A) and die pressed spacer layer (B).

(and also, save the foam board material), if made with hand one by one. However, for mass production, cutting out from one large sheet by die press would be easier.

The spacer layers were alternately sandwiched with the evaporation/condensation film, while the condensation surface facing the sharp edge of the spacer. Ten identical spacer-film layers were made and stacked. The stack was sandwiched between 1.8-cm triple layer air-gap polycarbonate (Lexan) window and 10 cm polystyrene foam board, by cable tie or box tape. Box tape is useful for short-term usage but may not be a good choice for long-term test, since it would be deteriorated by UV. Common ropes are more recommended. A piece of shred cotton fabric was used for the capillary water distributer. Gutter was placed to collect all the draining fresh water and concentrated waste water in separate beakers (**Figure 11**).

The prototype has 0.219 m^2 active area (27 cm width and 81 cm height) with 10 multi-effect layers. It was placed in relatively non-shaded place in Seoul, Korea (North 37° 34′, East 126° 58′), 45° tilted from the vertical position, facing south (**Figure 12**).

Ambient and inner temperature was measured by thermocouples. For inner temperature measurement, position between first and second layers as well as position backside of the last layer was chosen. Two water collecting beakers were placed on top of load cells to measure weight of fresh and concentrated water drained. A pyranometer was placed as same tilting angle (45°) as the prototype, for measuring solar irradiation. All the data were automatically collected by computer every minute.

Figures 13–15 show the result on a sunny day (On 7 July 2014, the daily accumulated solar intensity was measured as 19.5 MJ/m^2). It shows that it can produce fresh water about 9 kg/L per m^2 day or 0.46 kg/MJ. On a partially cloudy day (30 July 2014, the daily accumulated solar intensity was measured as 13.7 MJ/ m^2), it was reduced to 5.7 kg/L per m^2 day or 0.41 kg/MJ (**Figures 16–18**).

Figure 11. Collecting fresh water from each layer by a gutter.

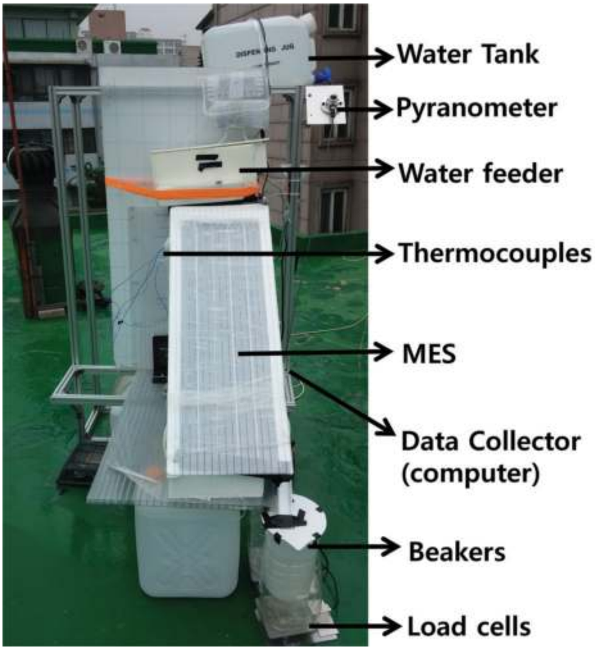

Figure 12. Experimental setup of the prototype MES outdoor test.

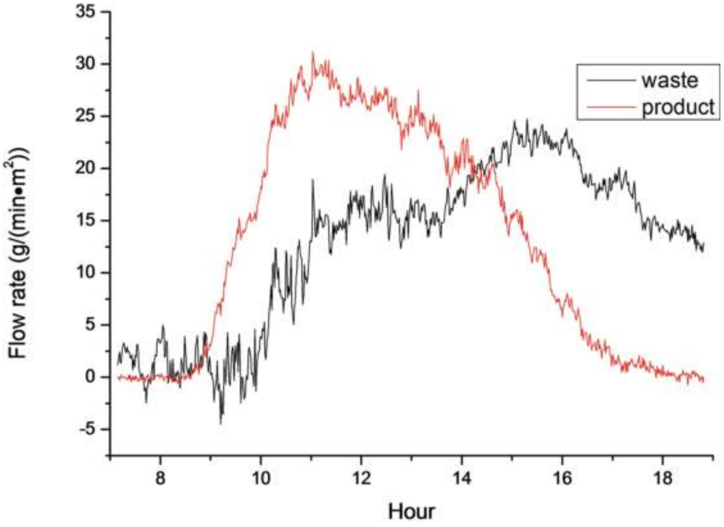

Figure 13. Flow rate (normalized to unit area, 1m2) of the fresh (red, the lower curve at the range after 15:00 PM) and wasted (black, the upper curve at the range after 15:00 PM) water verses time by the MES, measured on a sunny day, July 7th, at Seoul Korea.

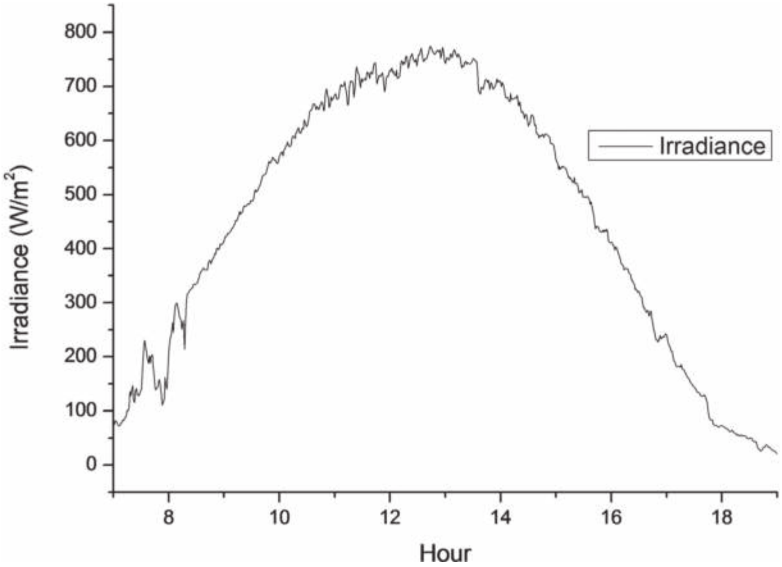

Figure 14. Solar irradiation measured at same day and location in **Figure 13**.

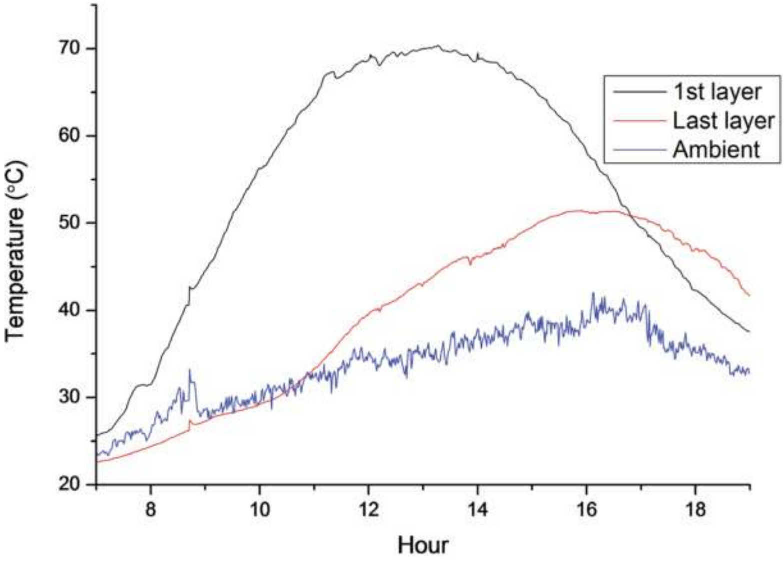

Figure 15. Temperature of ambient (blue, the lower curve at the range between 12:00 to 16:00 PM), backside of the last layer (red, the middle curve at the range between 12:00 to 16:00 PM) and backside of the first front layer (black, the upper curve at the range between 12:00 to 16:00 PM) measured at same day and location in **Figure 13**.

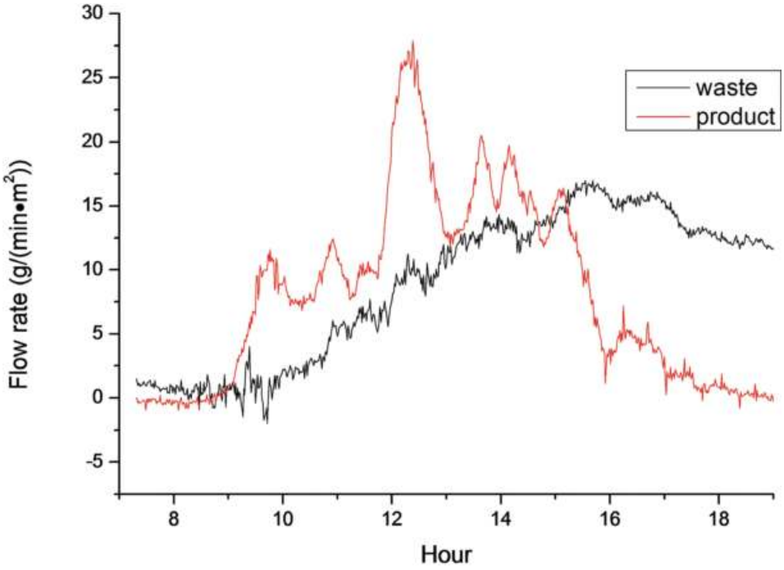

Figure 16. Flow rate (normalized to unit area, 1m2) of the fresh (red, the lower curve at the range after 16:00 PM) and wasted (black, the upper curve at the range after 15:00 PM)water verses time by the MES, measured on a partially cloudy day, July 30th, at Seoul, Korea.

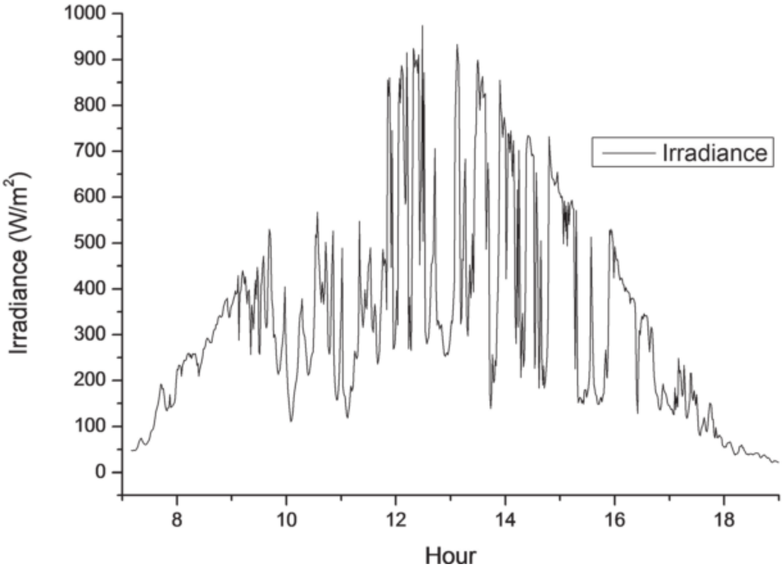

Figure 17. Solar irradiation measured at same day and location in **Figures 16**.

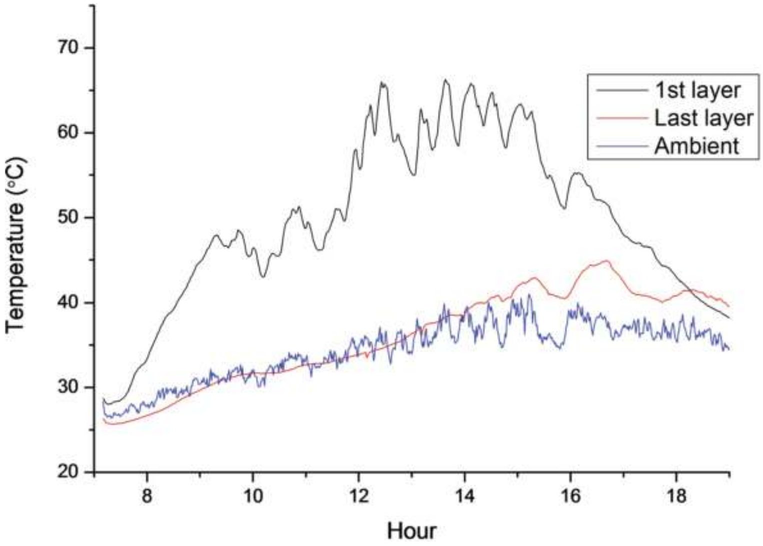

Figure 18. Temperature of ambient (blue, the lower curve at the range between 15:00 to 18:00 PM), backside of the last layer (red, the middle curve at the range between 15:00 to 18:00 PM) and backside of the first front layer (black, the upper curve at the range between 15:00 to 18:00 PM) measured at same day and location in **Figure 16**.

This is somewhat smaller number than previous result reported from other group, who showed that 10–20 kg/m^2 day was obtained [4]. However, considering that the system is not well optimized yet, it would be a good starting point, proving the practical feasibility. There are still many ways that remain to improve productivity. One example is to optimize and control saline water feeding rate. The Tanaka group showed that proper saline water feeding rate is very critical for high productivity [8, 12]. Too much feeding may cause bad productivity, because the saline water would be drained before it gains enough energy for evaporation. Too low feeding rate may cause dry out of the wick, so the system itself could be deteriorated by salt crystal. It was recommended that ratio between fresh water and concentrated water should be around 1:1. As shown in both **Figure 13** and **Figure 16**, this ratio was not controlled well enough yet, especially from around 15:00 O'clock. Better control on water flow may increase productivity. Further optimization on the feeding water distribution towards each layer would also lead higher productivity. Though shred fabric distributer, described in the previous section, was applied on this prototype, there are still room for further optimization of the shred width for each layer.

4. Miscellaneous comments on the experiment

4.1. Checking salt contamination of the condensed water

To avoid salt contamination, saline water in the wick should not flow into condensation layer. Fortunately, in most cases, it is automatically avoided since capillary force in the wick captures the saline water. However, if too much saline water flows into the system abruptly, which could not be kept within the fabric, of course it may overflow into the condensation layer.

To check any trace of salt contamination, simple method could be used [15]. Diluted basic solution, such as aqueous sodium hydroxide solution, could be mixed with the saline water, which would be desalinated by the system. Since even small trace of hydroxide ion increases pH of the solution, it can be easily noticed if the distillates contaminated by salt. Of course, evaporable pH altering material, such as hydrochloric acid, should not be used for such purpose, since it could be evaporated at the wick to change pH of the condensed water.

4.2. Operation of the MES in cold weather

With good insulation and tight seal, inner temperature of the MES was observed to be more than 70–80°C under sun, even below freezing point ambient temperature. This is high enough temperature for water evaporation. However, it is generally not recommended to use it under freezing climate. Though the temperature inside of MES is high under sun, it may freeze during night, which may damage the system if repeated for a longer period. In addition to that, the drained water could be frozen at the outlet of MES at cold weather. At the winter, I found icicles underneath the prototype, which mixed back the purified and concentrated water.

5. Mass production in less-developed country and potential application of the MES

Most of the other competing, small-scale solar desalination instrument requires relatively high-end technology and expensive facility to produce each component, such as nano-porous membrane for reverse osmosis, photovoltaic modules, vacuum tubes etc. It makes less-developed societies difficult to self-supply the tool by themselves. However, MES prototype introduced in this chapter was handmade with elementary tools and materials, such as hand knife, polystyrene foam board and fabrics laminated on plastic film. In other word, it can be relatively easily prepared and studied with minimum budget. In addition to that, it is also easy to be mass produced, not only in advanced countries but also in less-developed countries. Therefore, MES supplying chain could be easily made at the actual countries, where the low-cost small-scale desalination is necessary, regardless of its industrial level.

Wick/condensation layer could be mass produced by roll-to-roll lamination of fabric on plastic film. Lamination process itself is not a high-tech engineering. It would be affordable to most of the underdeveloped countries. However, if it is still too difficult to be manufactured by local industry, laminated material could be produced in more-developed region and then transported to the local producers who do not have expensive machineries. Since the film is light weight and small volume, it is easy to be transported. By the local maker, the sheet material could be cut, folded and assembled with relatively low-labour cost.

Similar approach could be made to the spacer layers. It could be mass produced with foam board by die-cutting press. Any other type of cutters could be used, if the press is not available. Other raw materials, such as foam insulators and windows, are common material for construction, which would be available on most part of the world. All the materials, processes and structures could be modified by the developers reflecting the industrial condition of each one. Because of this industrial flexibility, MES could be useful self-producible desalination tool for many countries.

5.1. Potential applications of the low-cost MES

Low-cost multi-effect solar still could be mostly useful for supplying fresh water for individuals or family who cannot access to public water work. Residents near salty or contaminated water source, remote island or seashore could use this tool. However, it could be useful for public or national level also, not only limited to the individual level. It could be a part of social infrastructure: for example, it can replace highway divider or fences in desert or bridge over sea. Fresh water supplied by MES could be used to cultivate plants along the road. It can be used for fence/wall around buildings or districts to provide fresh water for planting or for citizens. MES modules would also be made in form of tile or curtain walls of buildings. Similar to that photovoltaics module could be part of external surface of buildings (building integrated photovoltaics: BIPV), MES could be part of building (building integrated desalination: BIDSAL), which can produce fresh water for the residents [15]. MES could also be useful as public stockpile against natural disaster or terrorism, in case of existing water line malfunctioning.

6. Suggestion for future work

The MES system introduced in this chapter has both aspects of individuality and publicity. The system could be used as personal water supplier. It could be made, operated and maintained personally without assistance of high-tech industry. However, on the other hands, the system could be more easily produced with lower cost and widely implemented, if mass production industry supports. Once mass produced in low cost, it could be a practical solution to the potable water deficiency problem for large part of the world.

Not only the production and application, research and development of the MES has both individual and public aspects. Initially, I started to develop the low-cost MES as a private project. Because of relatively low material cost and simple measuring instrument, it was an executable project for even an individual. Therefore, I expect that developing MES is relatively easily accessible subject to many other researchers in the world, regardless of their financial status or infrastructure. Every future users, producers or developers of MES in the world may be in different condition: climate; social necessity; industrial level and raw material cost. Therefore, they may need to develop their own optimized system, reflecting their own specific status. Meanwhile, they can share the new findings with others, for worldwide collaboration.

The structure and material introduced in this chapter are just an initial example of low-cost MES. There are many steps that remain before implementation. Further optimization and structural improvement should be made. Practical size prototype should be developed. Long-term stability should be proven by outdoor test under actual climate where the product to be used. Mass production process should be established, reflecting the industrial condition of the producers. Supply chain of raw materials should be established. Local or worldwide distribution of the product should be done with proper instruction of operation and maintenance to the final users. These tasks could be done with international collaboration, especially including the groups in the country where the system has to be implemented. Main purpose of writing this chapter is to suggest active collaboration all over the world. Collaboration between private, public or international supported groups would be helpful for MES implementation. I will also be very happy to be part of the collaboration. Furthermore, it would be helpful to mitigate potable water deficiency problem in the world. Beauty of solar still would be that it may quench thirst of anybody, whether he or she is a drinker or a developer.

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