Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Information for Clogged water bridges for fog harvesting

Jihye Park,[1] Changje Lee,[2] Sangyoup Lee,[2‡] Hyesung Cho,[1] Myoung-Woon Moon,[1] and Seong Jin Kim[1†]

[1]Materials and Life Science Research Division, Korea Institute of Science and Technology, Seoul, 02792, Korea Republic.

[2]Biomedical Research Institute, Korea Institute of Science and Technology, Seoul, 02792, Korea Republic.

[‡]Email : sangyoup@kist.re.kr

[†]Email : kyk756@kist.re.kr

1 Fog-harvesting experiment with a larger fog inlet

Figure S1(a) plots the fog-harvesting efficiency versus shade coefficient, which was measured using a large fog inlet with a diameter of 90 mm in comparison to the mesh with a dimension of 35 mm × 35 mm. The distance between the fog inlet and the mesh was 50 mm as same as that used in the experiments of the main manuscript. In estimating the fog-harvesting efficiency ($=M_{collect}/M_{total}$) for the set-up with the larger fog inlet, M_{total} was calculated to be the water loss through the domain having the same mesh dimension (A_{mesh}) at the fog inlet, as expressed by black arrows in Fig. S1(b):

$$M_{total} = \left(\frac{Q_{35}}{Q_{90}}\right) M_{humid}, \qquad \text{(S1)}$$

where M_{humid} is the mass loss in the humidifier, Q_{35} is the flow rate through the domain with the same mesh dimension at the fog inlet, and Q_{90} is the flow rate through the entire fog inlet. Here, Q_{35} and Q_{90}

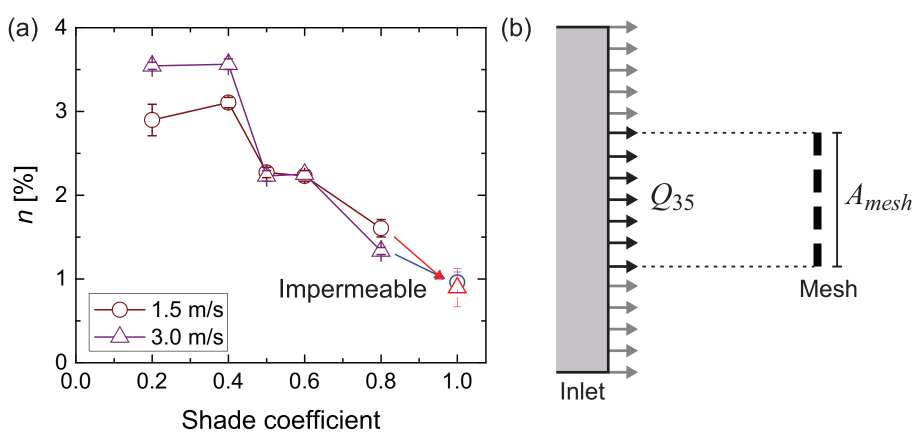

Figure S1: (a) Fog-harvesting efficiency (η) measured versus shade coefficient for the clogging-free mesh with d=7 mm at two different fog speeds: 1.5 m/s and 3.0 m/s. (b) Schematic of the experimental setup with a larger fog inlet than the mesh area.

were calculated by integrating the horizontal fog speed at the fog inlet along the radial axis, by virtue of the particle image velocimetry which will be detailed in the next section.

When the larger fog inlet is used, the η–SC curve predicted in the aerodynamic theory [S1] is well presented by having a maximum η at SC=0.4 for the fog speed of 1.5 m/s (Fig. S1(a)). The noticeable difference from the experimental result with the fog inlet having the same dimension with the mesh (Fig. 5(c) in the main manuscript) is that the fog-harvesting efficiency does not enhance with the increase of the fog speed, for the meshes with high SC and the impermeable plate. It is because the fog flow will circumvent the impermeable plate more easily when the larger fog inlet is used. For this reason, it is more difficult to increase the impact speed of fog particles near the plate in this case. In contrast, the fog flow from the fog inlet having the same dimension as the mesh will lose less fog inertia toward the plate because there is no easy path to avoid the collision with the plate. In this point of view, the experimental setup with the same fog inlet is beneficial to investigate different interaction between the plate and the fog flow for different fog inertia by forcing the control of the fog speed close to the plate.

2 Flow characterization by particle image velocimetry

The PIV (particle image velocimetry) experiment is performed to quantify and visualize the fog flow blockage through the mesh holes by the clogging. Because we are investigating the fog flow rather than the air flow, the fog particles are tracked as tracer particles. During the PIV experiment, the mesh plate is aligned perpendicular to the optical axis (y-axis) as shown in Fig. S2 (a). Fog jet nozzle is aligned with a center of mesh plate at a distance of 50 mm. Light sheet is illuminated orthogonally to the middle of the mesh plate as shown in Fig. S2(a). A sheet of laser with $\sim$500 μm thickness is generated using Nd-YAG double pulse laser (Nano L 50-50 PIV, 532 nm, Litron Lasers Ltd. England) and a 60 degree light sheet generating lens. Then, the flow of the fog particles is recorded using a double frame CCD camera (Imager Intense, LaVision, Germany) with 8.5$\times$ magnification and the size of particle image was $\sim$1–3 pixels in diameter, which is about 1–2 μm when projected in the physical space.

For the fog flow speed of $\sim$ 4 m/s, laser pulse duration is set to 100 μs for a pair of fog particle images. For 2 mm and 7 mm hole meshes, image pairs are recorded at 5 Hz. However, for 5 mm hole meshes, slower frame rate down to 0.8 Hz is used because the formation speed of the clogged water bridge is very slow for these meshes. The, the image pairs are interrogated with a commercial software, Davis 8 (LaVision, Germany), to generate the instantaneous vector plots. The image pairs are processed using multi-pass algorithm with the final interrogation window size of 16 $\times$ 16 pixels and 50% window overlap, resulting in the spatial resolution of 12 μm $\times$ 12 μm.

For the PIV tests, the mesh plate with much bigger dimension of 20 cm $\times$ 15 cm is used. It is because that the erroneous data is obtained, for the mesh with 3.5 cm $\times$ 3.5 cm used in the fog-harvesting

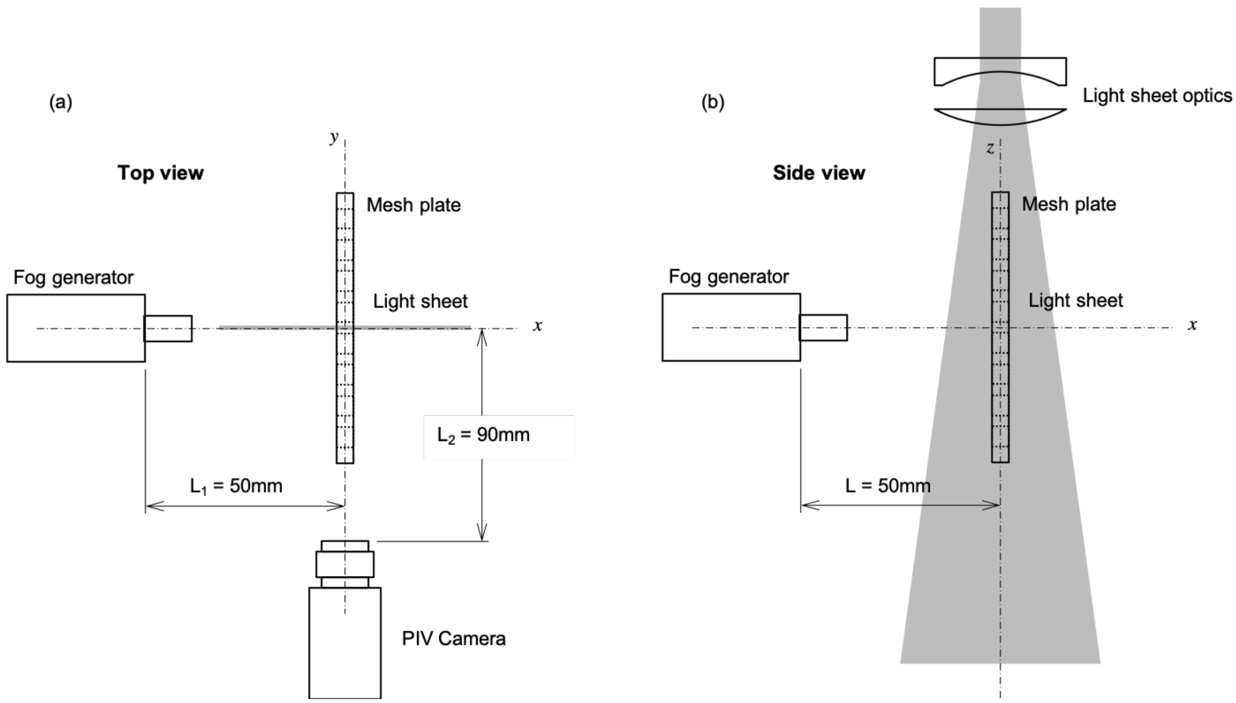

Figure S2: Schematics of particle image velocimetry setup. (a) Top view and (b) Side view.

experiment, by the fog detoured over the edge of the mesh, not through the mesh. For example, for the impermeable solid plate, there must be no fog that penetrates through the mesh. However, when the solid plate dimension is not big enough, the fog flow detouring over the upper or below edge of the plate is measured incorrectly as if it had passed the plate. To minimize this error for quantifying the flow blockage more correctly, the mesh with much bigger dimension in comparison to the fog jet nozzle is used.

References

[S1] Juan de Dios Rivera. Aerodynamic collection efficiency of fog water collectors. *Atmos. Res.*, 102(3):335–342, 2011.