New solar desalination device improves efficiency by suppressing heat loss

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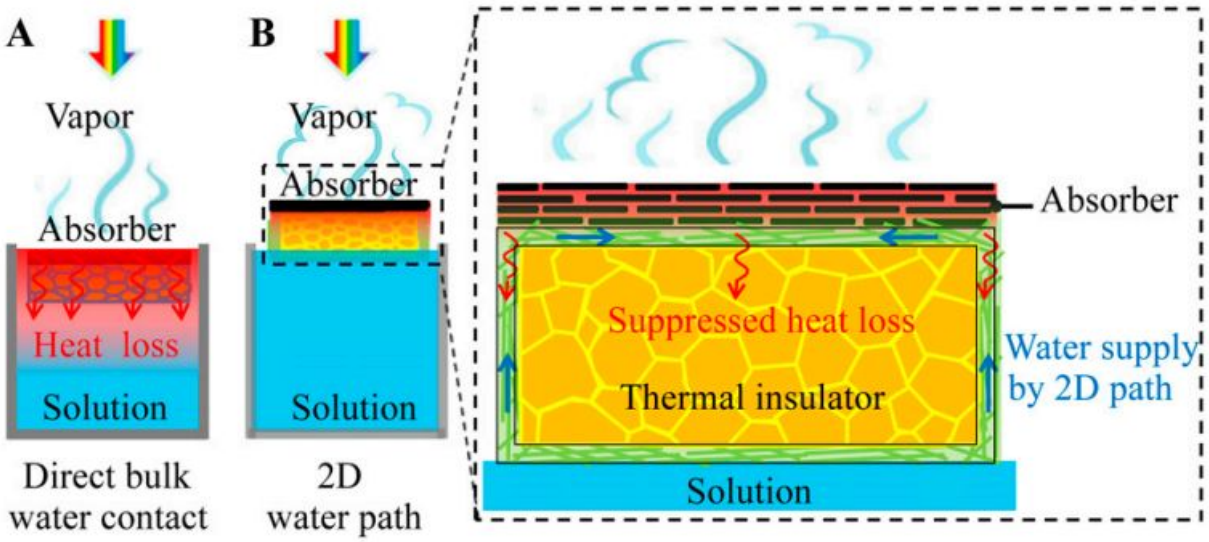

(A) Schematics of conventional solar steam generation with direct water contact. (B) Schematics of solar desalination devices with suppressed heat loss and 2D water supply. Credit: (c) *Proceedings of the National Academy of Sciences* (2016). DOI: 10.1073/pnas.1613031113

(Phys.org)—A team of researchers at Nanjing University in China has developed a new kind of solar desalinating device that does not require a traditional solar concentrator or thermal insulation. Instead, as the group explains in their paper published in *Proceedings of the National Academy of Sciences*, they introduce a 2-D channel for water circulation that works through capillary action, thereby greatly reducing heat dissipation.

As the demand for water continues to increase around the globe, even as supplies diminish, scientists have been hard at work trying to improve water desalination devices—if a cheaper, more efficient means could be found to turn seawater into drinking water, the problem would be solved. Unfortunately, conventional desalination plants are still expensive to operate, running at approximately 80 megawatt-hours per megaliter of water produced, making them practical only in arid regions that have a lot of money to invest—such as the Middle East. For that reason, many researchers have turned to solar power as a possible option—unfortunately to date, such systems are difficult to ramp up in a way that allows them to produce enough drinking water to be useful—mainly because of the need for optical concentrators and thermal insulation. In this new effort, the researchers describe a new type of solar desalination device that works without either of them.

The reason most solar systems require thermal insulation is because of the need to separate water being heated from unheated water—failure to do so would lose heat to the input water supply. To get around this problem, the researchers used simple polystyrene foam to separate the heated water from the input stream and introduced a 2-D channel that relies on capillary action to circulate the water as it is heated by the absorber. Because of its 2-D nature, heat cannot pass backwards through the channel; thus, very little is lost. The team also created an absorber using graphene oxide, because, as they note, it has excellent solar absorbing properties and low thermal conductivity. Another benefit, they note, is that it can be folded, making the device transportable.

The result is a relatively inexpensive, highly efficient solar powered water desalination device. There is one problem still to overcome, however, before the device can be put to use in the real world—because of the materials used it is not clear how long such a device would stand up to real world environmental conditions.

More information: Xiuqiang Li et al. Graphene oxide-based efficient and scalable solar desalination under one sun with a confined 2D water path, *Proceedings of the National Academy of Sciences* (2016). DOI: 10.1073/pnas.1613031113

Abstract

Because it is able to produce desalinated water directly using solar energy with minimum carbon footprint, solar steam generation and desalination is considered one of the most important technologies to address the increasingly pressing global water scarcity. Despite tremendous progress in the past few years, efficient solar steam generation and desalination can only be achieved for rather limited water quantity with the assistance of concentrators and thermal insulation, not feasible for large-scale applications. The fundamental paradox is that the conventional design of direct absorber–bulk water contact ensures efficient energy transfer and water supply but also has intrinsic thermal loss through bulk water. Here, enabled by a confined 2D water path, we report an efficient (80% under one-sun illumination) and effective (four orders salinity decrement) solar desalination device. More strikingly, because of minimized heat loss, high efficiency of solar desalination is independent of the water quantity and can be maintained without thermal insulation of the container. A foldable graphene oxide film, fabricated by a scalable process, serves as efficient solar absorbers (>94%), vapor channels, and thermal insulators. With unique structure designs fabricated by scalable processes and high and stable efficiency achieved under normal solar illumination independent of water quantity without any supporting systems, our device represents a concrete step for solar desalination to emerge as a complementary portable and personalized clean water solution.