UC Solar

Integrated Non-Tracking Solar Collector(XCPC) And Humidification Dehumidification(HDH) desalination System For Affordable Decentralized Potable Water production

UNIVERSITY OF CALIFORNIA UCMERCED

Ali Hassanzadeh, Roland Winston

University of California, Merced, 5200 Lake Rd, Merced, CA USA 95343

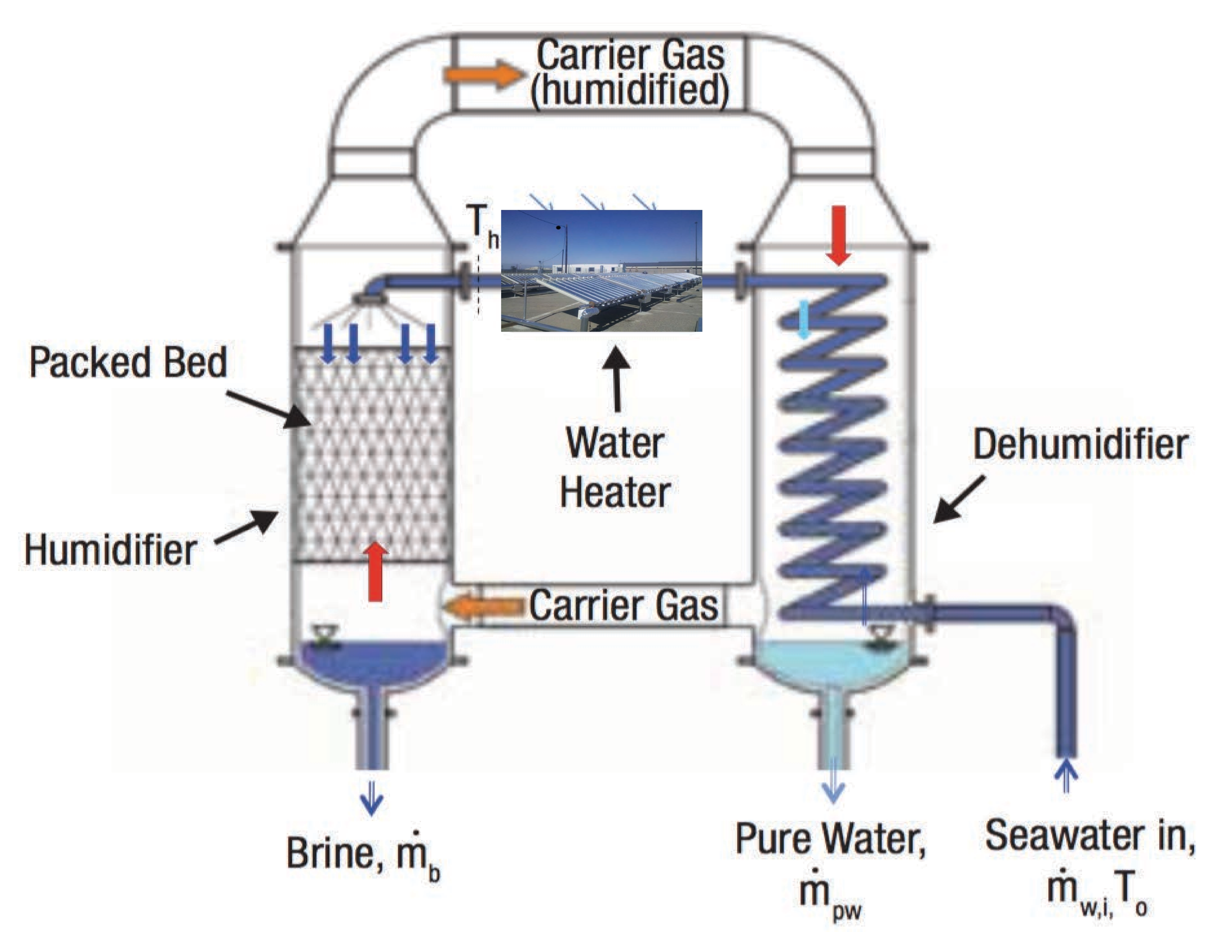
Abstract

Humidification dehumidification (**HDH**) is a promising method for decentralized, small-scale desalination because of its simple system design and compatibility with low-grade energy such as Solar thermal collector. As the HDH working temperature is between 25-95˚c, it is highly compatible with mid-temperature solar thermal collector. One of the best mid-temperature solar thermal collector is external Compound Parabolic Concentrator(**XCPC**) which has two major advantages : it is non- tracking(no electricity consumption) and cheap maintenance.

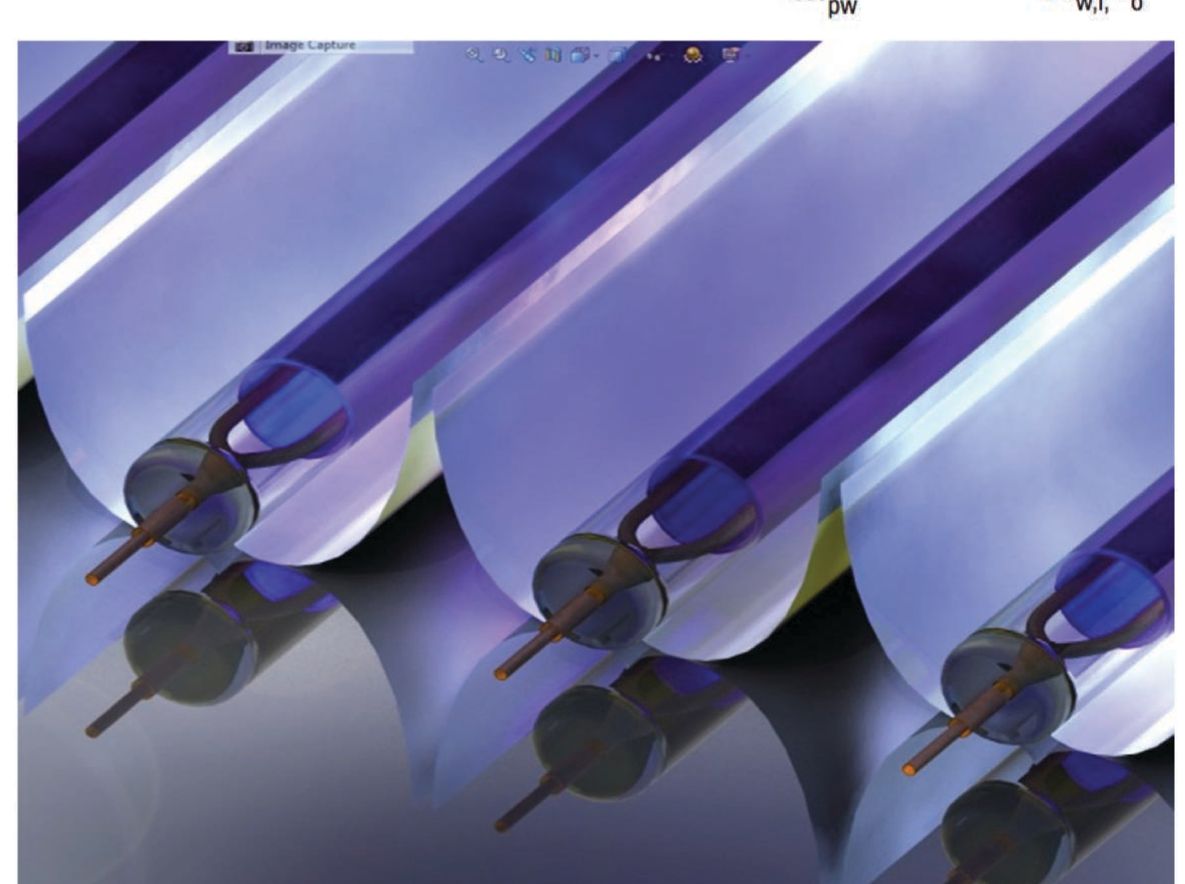
The *distribution difficulties* and *high capital cost* of the centralized water production has made decentralized water production more reasonable and vital especially in rural area and remote county such as Central Valley, CA which is far from seawater. The HDH system combination with XCPC can provide high-quality drinking water(10 ppm TDS)with renewable and cheap energy. Also, in this system, as fresh water and brine are completely divided by evaporation, brine can easily be collected and dumped out of the system.

Fundamental concepts

Nature uses air as a carrier gas to desalinate seawater by means of the rain cycle, in which seawater is heated by solar irradiation and evaporates into the air to humidify it. The humidified air rises and forms clouds. Eventually, the clouds dehumidify as rain over the land, and rainwater can be collected for human consumption. The man-made version of this cycle is called the HDH desalination cycle.



External compound parabolic concentrator is range of mid-temperature thermal collector which can achieve at 200˚c with 50% efficiency without any tracking or moving part. This ability easily directly the system heat up water in the heat exchanger up to 95˚ and be used in the HDH cycle to produce fresh water.



Cost And Performance Evaluation

Properties \ Desalination system	Small-scale		Large-scale						
	HDH	MD	MSF	MED	MVC	TVC	SWRO	BWRO	ED
Thermal or electrical consumption(kwh/m^3)	156	370	190-282(T)	145-230(T)	7-12(E)	227(T)+14.(E)	4-6(E)	1.5-2.5(E)	2.64-5.5(E)
water quality(ppm)	10	300	10	10	10	10	400-500	200-500	150-500
Typical unit size(m^3/day)	10	3	50,000-70,000	5,000-15,000	100-3,000	10,000-30,000	128,000	98,000	2-145,000
Capital Cost($)	48,935-	52,380-	48,000,000-760,000,000	28,500,000-734,000,000	35,000,000	35,000,000	45,000,000	73,000,000	N/A
Cost of water($/m^3)	5(0.5¢/liter)	15	0.56-1.75	1-8	0.9-2.6	1-2	0.45-1.72	0.26-12.99	0.6-1.05
Solar System Compatibility	XCPC compatible and highly efficient	XCPC compatible and efficient	XCPC Compatible, not efficient	XCPC compatible, not efficient	PV compatible	PV compatible	PV compatible	PV compatible	PV compatible

Conclusion

The best and efficient engineering systems are copies of the Mother nature, This system follows the same rule. It is the engineering model of the natural rain cycle :

Rain cycle as **HDH**
- ✓ Extremely clean water
- ✓ Easy separation of Brine and pure water
- ✓ Low capital cost
- ✓ Mobile

Sun heat as **XCPC**
- ✓ Non-tracking
- ✓ Cheap maintenance
- ✓ Working temperature up to 230˚c

As it is shown, the system can fill the gap between expensive Large-scale plants and inefficient small-scale desalination systems.

Acknowledgments and Contacts

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