IWA 17th SWWS AND 9th ROS
10th–14th November, 2024
Curitiba-Brazil

Atmospheric Water Generation as a new, sustainable source of water security in Brazil's semi-arid

du Marchie van Voorthuysen, E.*, Moore, R.A, Brochado, R. P. S.*** and Agostinho, L. L. F.**

*Solaq International B.V., E. du Marchie van Voorthuysen, R. A. Moore, Amsterdam, the Netherlands.
** Water technology Group, NHL Stenden University of Applied Sciences. Rengerslaan 8-10, 8917DD Leeuwarden, Netherlands
*** Universidade Federal de Minas Gerais, Departamento de Engenharia Sanitária e Ambiental, Belo Horizonte, Brasil.

Highlights:

- **Atmospheric Water Generation (AWG) systems are an alternative and promising solution for water supply in semi-arid decentralized cities.**
- **Wet-desiccation AWG systems can be completely sun powered.**
- **Wet-desiccation AWG systems can produce up to 3 m^3 per day.**

Keywords: drinking water; water security; atmospheric water generation

INTRODUCTION

Water scarcity is a world-wide problem, which has been aggravated due to climate change [1]. Global reports indicate that, in 2050, more than 75% of the world population will suffer from any kind of water scarcity. One of the presented solutions is the diversification of the feeding water matrix, which, currently, is dominated by surface water (rivers and lakes) and ground water. Seawater has been entering the market, and it is calculated that both thermal systems and SWRO systems are now sharing around 5% of the total demand. Another very promising technique is Atmospheric-Water-Generation (AWG) [3-5].

The production of liquid water out of natural water vapor in ambient air is called Atmospheric Water Generation (AWG) [3]. The content of water in air is visualized in the so-called psychrometric chart, which gives the mass fraction of water in the air as a function of temperature and relative humidity. In the Brazilian semi-arid, typically, at night, the relative humidity reaches around 80% and the air temperature 25oC. This would imply 16 grams of water for each kilogram of dry air. A full scale AWG unit, under these conditions, could produce an average of 3.5 m^3/day of water from the air.

AWG technologies are designed to be reliable, sustainable and affordable and the water produced is potable. Compare to current water truck solution AWG is: (1) more affordable in most situations, (2) more sustainable (zero waste, zero pollution, solar powered), (3) works anywhere in the world and is (4) modular, off-grid and transportable.

METHODOLOGY

One of the world AWG producers, Solaq, a Dutch company [4], performed pilot tests with a container size system during the months of April and October of 2022 in the city of Quixeramobim, Ceará state in Brazil. The tests were conducted to verify the system production under Brazilian semi-arid conditions [5]. Figure 1 shows the (containerized) system used during the experiments already placed in Quixeramobim for the tests.

Figure 1: System (containerized) used during the tests in the city of Quixeramobim, Ceará state, Brazil.

The tests were conducted in batch intervals but for each test run, the pilot run in continuous operation during the entire night. Solaq AWG system uses wet desiccation, meaning, instead of condensing water onto a cooled surface, the system absorb water from the air in a hygroscopic liquid. In the case of Solaq this liquid is a concentrated solution of calcium dichloride in water. During the operation it is brought into contact with the massive amount of air using ventilators. A fraction of the water vapor in the air is absorbed by the fluid. In the patented Solaq absorber the active fluid-air area is maximized, and the air flow resistance minimized. The absorbed water is isolated from the fluid by means of vacuum distillation, consuming the cheapest energy source that is available on earth: solar energy in the sub-tropical and tropical countries.

The experiments focused basically on evaluating the absorption capacity of the system under Brazilian semi-arid conditions. Additionally, during the tests, the distillation unit was tested regarding its thermal consumption and recovery rate.

RESULTS AND CONCLUSIONS

The obtained results have shown an average absorption capacity of 20 L/h for the 100m^2 area of the absorber (see figure 2).

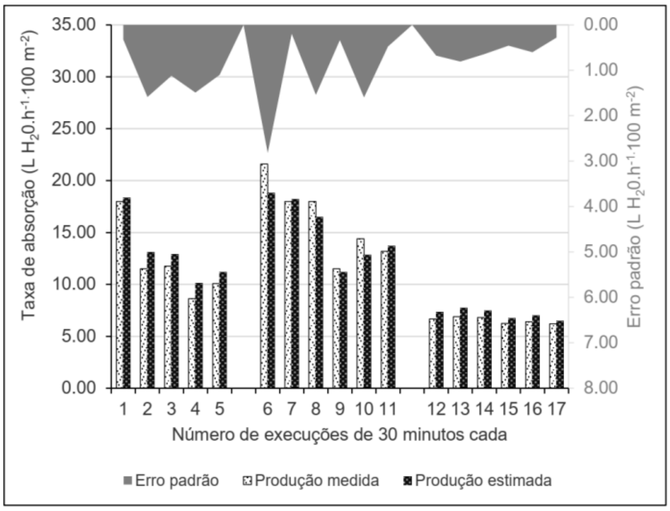

Figure 2: Water production per hour per 100m^2 of absorber.

Extrapolating these values for a real scale system (much larger absorber area), for the same conditions, the expected production capacity of the (real scale) unit would between 3 and 5m^3/day (see figure 3). The tests done with the distiller indicated precipitation of the salt solution inside the connecting tubes. Also, the obtained recovery was lower than expected.

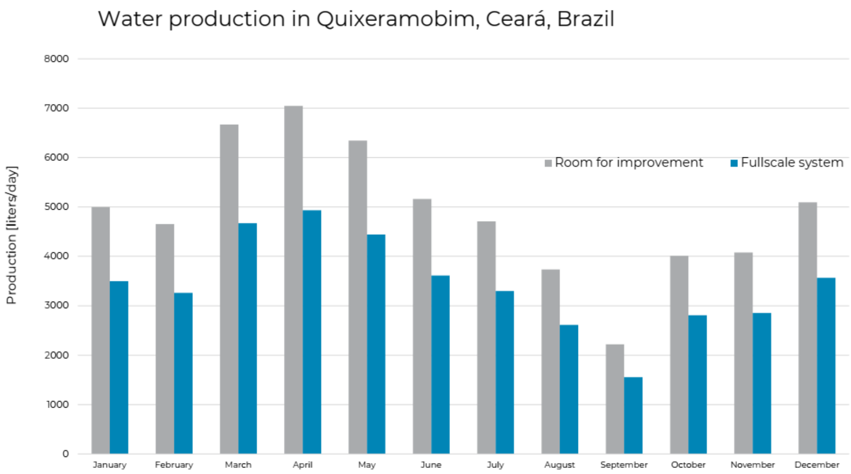

Figure 3: Extrapolation for real scale production using the same production ratios obtained during the pilot tests.

These first pilot tests proved that the system performs adequately inside the climatological conditions of the Brazilian semi-arid. It has also proven the absorption capacity of the engineered system. More tests have to be done focusing on distiller adaptation and performance for the real scale prototype.

ACKNOWLEDGMENTS

The present work was conducted with the financial and technical support from different Brazilian and Dutch organizations. The authors would specially thank the Dutch organization SIA Regieorgaan for the financial support via the KIEM financing route. Also to the Ceará State Meteorological Foundation (FUNCEME) and the Ceará State Research Foundation (FUNCAP), for their unvaluable financial and technical support.

REFERENCES

[1] Water Europe, "The role of water in the issue of public health," Water Europe, Brussels, 2023.

[2] Y. Wang, S. H. Danook, H. A. Al-Bonsrulah, D. Veeman and F. Wang, "A Recent and Systemic Review on Water Extraction from the Atmosphere for Arid Zones.," Energies, vol. 15, no. 421, 2022. https://doi.org/ 10.3390/en15020421

[3] Rainmaker Holland, "Rainmaker Holland, Affordable Production of Drinking Water," [Online]. Available: https://www.rainmakerholland.nl/. [Accessed 11 09 2024].

[4] SOLAq, "SOLAq. Water from thin air. Anywhere," [Online]. Available: https://solaq.nl/index. [Accessed 11 09 2024].

[5] R. P. S. Brochado and L. L. F. Agostinho, "Relatório Técnico: Estudos e Soluções Tecnológicas Visando o Aumento da Resiliência às Secas," NHL Stenden University of Applied Sciences, Leeuwarden, 2024.