Water Conservation Indexing The HVAC of Suranaree University of Technology Hospital Main Building Case

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Andreas Prasetyadi and Atit Koonsrisuk

Abstract

A water conservation indexing using availability and accessibility was proposed in order to have an index that is reliable, consistent, free of site character, and easy to interpret. A year simulation of the heating ventilating and air conditioning (HVAC) system of Suranaree University of Technology Hospital (SUTH) main building was conducted for the case using TRNSYS. Water availability was applied to show the total amount actually or potentially being harnessed during the process. Accessibility indicates the fitness of the available water. The results show that indexes of the water conservation of the system in 22, 24, and 26 °C temperatures setting are around 50%. It implies that there are amount of unused water. The higher the temperature setting is the less conserving the system becomes.

Keywords

Index of water conservation • Energy water nexus • HVAC

1 Introduction

Water conservation is a main issue and needs a metric to be measured (Prança and Ghisi 2010). Water conservation metrics tend to be biased of location due to uneven water distribution. It implies a difficulty in comparing the approaches in different locations.

Indexing water conservation as a mix of quantity and quality of the water at use was proposed as a metric. The index shows the system performance level in conserving water during its use process. The metric ability to be free of location bias with different water potential conditions is expected.

2 Methods

The water conservation index has two main important features. They are water availability showing all the water amounts that people can obtain from the process and water accessibility. The concepts are derived from the work of Georgescu-Roegen (1975) about thermoeconomics. Generally, both metrics show the ratio of the actual condition over the ideal one.

2.1 Water Availability, Capped Water Availability, and Water Accessibility

Water availability (W_{av}) is determined to show ratio of available water over utilized water at the point of use through Eq. (1). W_a and W_r are the available water and the water required for the process, respectively.

$$W_{av} = W_a / W_r \tag{1}$$

The capped water availability ($\hat{W}_{av}$) shows ratio of water usage over available water at the point of use with maximum condition of 1 and is defined in Eq. (2).

$$\hat{W}_{av} = \begin{cases} 1, & 1 < (W_a/W_r) \\ W_a/W_r, & 1 > (W_a/W_r) \end{cases} \tag{2}$$

Water accessibility (W_{ac}) shows the water provision fitness to the water requirement. It is determined by Eq. (3) with C_i is the water energy coefficient.

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$$W_{ac} = \sum_{i=1}^{n} C_i \hat{W}_{av,i} / \sum_{i=1}^{n} C_i \quad (3)$$

2.2 Water Conservation Level

The conservation level of water is defined as a score leveling system in conserving water amount and quality during the usage. It is calculated using Eq. (4), with W^*_{av} is determined by Eq. (5). WC is the water conservation level, and W^*_{av} is the availability factor.

$$WC = W_{ac} * W^*_{av} \quad (4)$$

$$W^*_{av} = \begin{cases} W_{av}, 1 \leq W_{av} \\ W^{-1}_{av}, 1 > W_{av} \end{cases} \quad (5)$$

2.3 SUTH Main Building HVAC Water

A year TRNYS simulation of the HVAC hospital system was conducted to find the HVAC water data as shown in author's former work (Prasetyadi and Koonsrisuk 2019). The procedure is shown in Fig. 1.

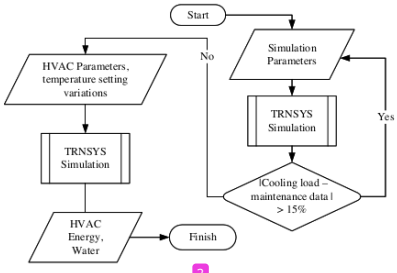

Fig. 1 Procedure of simulating the HVAC system of SUTH main building

3 Results and Discussion

The application of the coefficients to the water mentioned in Table 1 can provide the water availability, water accessibility, and water conservation level as shown in Table 2. The table shows that water accessibility of the system is 1 in various temperature settings. The table also reveals that the water need can be fulfilled in those temperature settings. The water conservation level is different for the temperature settings. The higher the temperature setting is the lower the water conservation level becomes.

Table 2 indicates that the system does not utilize water effectively. This is shown by the water availability score, being greater than 1 and was confirmed by the water accessibility score (1). If the water accessibility score is less than 1, but its availability score exceeds 1, the water conservation level is less than 1. The condition indicates that there is a water supply quality problem. In terms of amount, there is enough water, but it does not meet the requirement. If water availability and accessibility are less than 1, it shows that the system suffers from a shortage in the water supply.

The pattern relation of water availability and conservation level is shown in Fig. 2. When the water accessibility is less than 1, or the water quality does not match the requirement, water conservation becomes less than 1.

The water treatment and processing coefficients do not affect the index scale. Water accessibility is calculated using the energy for the water treatment and processing. The coefficient actually varies and depends on the site. However, Eq. (3) set shows that the maximum of accessibility becomes 1. This implies that the water conservation should not sacrifice the designed system capacity operation. Accordingly, the number is also free of the site character. Therefore, the water index conservation does not depend on the site.

4 Conclusion

A water conservation index using availability and accessibility was developed and applied to HVAC system of SUTH main building with score of 0.50. The index is free of the site treatment and processing coefficients. It has range of 0–1

Table 1 Type of water, daily water amount, and its coefficient

Water type	Amount of water in m^3 at temperature setting			Coefficient (Wakeel et al. 2016) (kWh/m^3)	Note
	22 °C	24 °C	26 °C		
Tap water	38.54	27.96	20.89	0.22	Main resource
Soften water	38.54	27.96	20.89	0.36	Water requirement
Brine	6.42	4.66	3.48	0.22	Alternative resource
Condensate	29.10	21.30	17.40	0.36	Alternative resource

Table 2 Water availability, accessibility, and conservation levels at various temperature settings

Temperature setting (°C)	Water availability	Water accessibility	Water conservation level
22	1.92	1	0.52
24	1.93	1	0.52
26	2.00	1	0.50

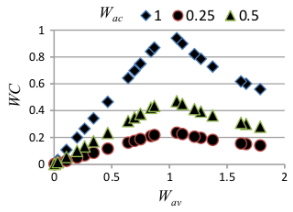

Fig. 2 Relation of water availability (W_{av}) and water conservation (WC). Water accessibility becomes the coefficient determining the maximum of water conservation, as well

with the higher score indicating a better condition of water usage. It shows the effect of temperature setting on the water conservation level. The higher the temperature setting is the lower the conservation level will be. The level of water conservation indicates the level of available water utilized by the system. The temperatures setting data show that alternative water resources are potentially harnessed to meet the energy need.

References

Georgescu-Roegen N.: Energy and economic myths south. Econ. J. (41), 347–381(1975)

Proença, L.C., Ghisi, E.: Water end-uses in Brazilian office buildings. Resour. Conserv. Recycl. **54**, 489–500 (2010)

Prasetyadi, A., Koonsrisuk, A.: Second law analysis of the centralized HVAC system of Suranaree University of Technology. In: Proceedings of 14th Conference on Energy, Heat and Mass Transfer in Thermal Equipments and Processes, Krabi, Thailand (2019)

Wakeel, M., Chen, B., Hayat. T., Alsaedi, A., Ahmad, B.: Appl. Energ. (178), 868–885 (2016)

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