Journal Renewable Energy 8[20]1-10: e20820110

Article

Using latent heat from a water purification system to improve the performance of an absorption heat transformer

Uso del calor latente de un sistema de purificación de agua para mejorar el desempeño de un transformador térmico por absorción

Morales, L.I.*[a], Siqueiros J.[b], Juárez-Romero D.[c] and Hernández-Soria, A. H.[d]

[a] Universidad Autónoma del Estado de Morelos • T-6933-2018 • 0000-0001-7500-6202 • 45697
[b] • LFU-6509-2024 • 0000-0002-2504-2632 • 2012
[c] Universidad Autónoma del Estado de Morelos • E-2056-2016 • 0000-0003-0942-9738 • 9643
[d] Universidad Autónoma del Estado de Morelos LFT-5450-2024 • 0000-0002-0126-0336 • 336706

CONAHCYT classification:

Area: Engineering
Field: Technological science
Discipline: Energy technology
Subdiscipline: Unconventional source of energy

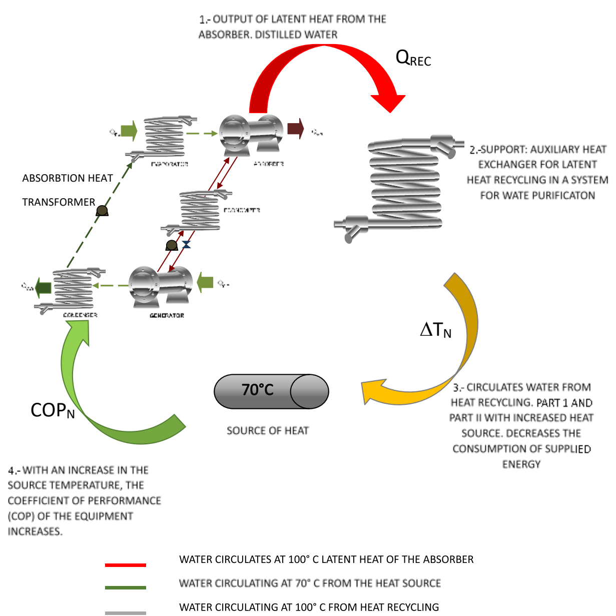
https://doi.org/10.35429/JRE.2024.8.20.2.10

Article History:
Received: January 12, 2024
Accepted: December 31, 2024

* ✉ [laura.morales@uaem.mx]

Abstract

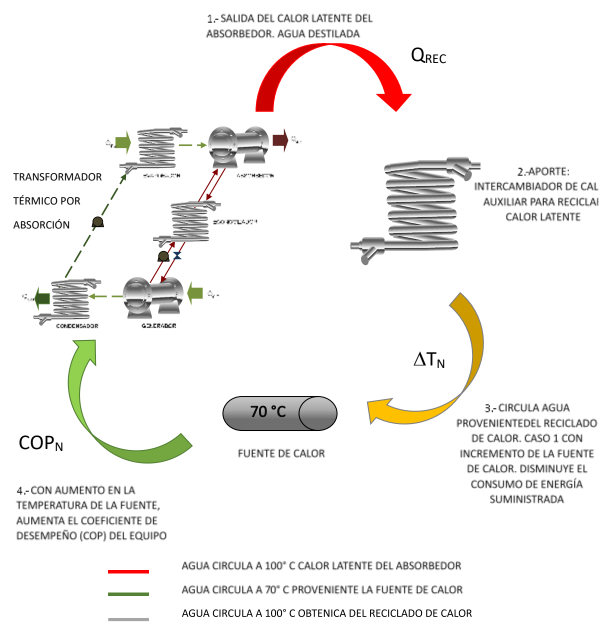
Absorption heat transformer for water purification (AHTWPs) are an option for utilizing energy from industrial or natural sources. Previous studies have demonstrated the feasibility of recycling the heat produced by the distillation of impure water, increasing the coefficient of performance (COP) values and reducing the energy requirements in the AHTWP. The present work presents a heat recovery proposal consisting in combining two cases: with source temperature increase (Case I) and without source temperature increase (Case II). The new configuration allows the fractionation of the available amount of heat (□ηQAB) between the two heat recovery cases. A simulation was carried out for different absorber operating conditions, using H2O-LiBr as the working mixture at different concentrations. The results show that it is possible to increase the initial COP values up to 74%.



Absorption, purification, combining configuration

Resumen

Los sistemas de transformador térmico por absorción para purificación de agua (TTAPA) son una opción para la recuperación de energía proveniente de fuentes industriales. Estudios anteriores han demostrado la viabilidad de reciclar el calor latente producto de la destilación simple del agua impura, incrementar los valores del coeficiente de operación (COP) y disminuir los requerimientos de energía primaria en el sistema de absorción. El presente trabajo presenta una propuesta para el reciclado de calor, que consiste en combinar las dos formas reportadas en la literatura: con incremento en la temperatura de la fuente (Caso I) y sin incremento de la temperatura de la fuente (Caso II). Se realizó una simulación para diferentes condiciones de operación del absorbedor, utilizando H2O-LiBr como mezcla de trabajo a diferentes concentraciones. Los resultados muestran que es posible incrementar los valores iniciales del COP hasta un 74%.



Absorción, purificación, configuración combinada

Citation: Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e20820110.

Introduction

Heat pump systems represent an alternative in energy savings because they can be coupled to industrial processes for heat recovery. The absorption heat transformer (AHT) is a type of heat pump that operates with waste heat that can come from an industrial source or a solar collector and raise its thermal level to be used in a secondary process [1]. AHT are used to boost energy from low thermal level heat sources [2]. AHT could supply the world's demand [3]. AHT is considered environmentally friendly and an excellent alternative to traditional systems. One of the most widely used working pairs is LiBr/H_2O [4]. The absorption system using LiBr/H_2O as the working fluid plays an increasingly important role in heating [5].

LiBr must operate near the ideal temperature and mass fraction to achieve its highest efficiency [6]. The main objective of the heat exchanger is to have the minimum heat transfer surface area for better performance, lower cost. The surface area is determined by the overall heat transfer coefficient. The correlation of heat transfer coefficient plays an important role in the optimization of the heat exchanger [7]. Several configurations of heat transformers have been proposed and studied. these configurations were designed to improve the coefficient of performance (COP) [8]. A AHT of 5000 kW capacity with a steam stream at 98°C coming from a plastics plant was used to heat water in a range of 95-110°C, the COP obtained was 0.47, with a GTL of 25°C and using H_2O-LiBr as working mixture [9]. At pilot scale a AHT was tested using a partially miscible mixture of n-heptane/N,N-dimethylformamido, the values of thermal efficiency obtained were between 30 and 40% and a maximum temperature difference of 8°C [10]. The feasibility of coupling a AHT to a textile plant for heat recovery at 92°C and heating process water up to 120°C with 50% heat recovery using H_2O-LiBr as the working mixture has been demonstrated [11]. In some countries absorption heat exchangers play an important role in district heating. [12]. Absorption heat transformer systems have also been studied as an alternative to conventional water desalination techniques. Experimentally, the results of a 1 kW water purification AHT are reported, the COP obtained was 0.228 with a distilled water flow rate of 448 mL/h, the working mixture H_2O-LiBr [13].

A water purification system by AHT with a capacity of 4.1 kg/h was operated and analyzed, the COP values were from 0.3 to 0.38 and the water obtained is considered within the limits to be drinking water [14]. Thermodynamic models of AHT for water purification have been reported in the literature. [15] designed a model of a water purification system integrated to a AHT using H_2O-(LiBr+LiI+LiNO_3+LiC1) as working mixture and showed that this mixture provides higher COP values than those obtained with the H_2O-LiBr mixture. Studies, simulations and experiments have been carried out on absorption technology, but more development and research on it is needed, because they are cost-effective, very energy efficient, compact in size and environmentally friendly [16].

Absorption systems have generated interest in industry and research in recent years. They consume less electricity, which is the main advantage over conventional systems [17]. [18,19] and [20] developed models using neural networks. AHT integrated water purification systems have also been analyzed from the point of view of the second law of thermodynamics [21,22]. It has been found that the main resistances for mass and heat transfer are those between the vapor and the interface [23]. In addition to the fact that the absorber is the most critical component in absorption systems, complex heat and mass transfer phenomena occur simultaneously in the absorber [24].

The absorber affects the efficiency of the absorption equipment. The mass transfer flux increases with increasing solution concentration at the inlet [25]. Understanding the heat and mass transfer between the solution and LiBr vapor is a crucial issue in absorption to intensify the transfer [26]. Investigations on mass and heat transfer behavior should be carried out under realistic operating conditions of adsorption cycling [27]. Heat recycling in water purification systems integrated to AHT is also reported in the literature [28,29,30]. Recent studies have evaluated heat recovery [31]. They propose models for the “maximum temperature rise” of a typical absorption heat transformer cycle [32]. The thermal energy by latent heat of casing and tubing not only improves the melting process of the phase change material, it also improves the overall performance of these systems [33].

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

Innovative strategies have been presented to simplify the latent heat migration steps in the heat recovery process, results indicate that the new heat recovery strategy exhibits higher growth rates in both flow and throughput ratio [34], these studies show that it is possible to reintroduce the latent heat from water distillation into the AHT and increase the COP values and the performance of the equipment.

Based on the literature review, no theoretical works were found that propose the combination of two forms of heat recycling in a water purification system integrated to an AHT. This work presents the results obtained by simulation using H_2O-LiBr as working mixture and different operating conditions. The results show that it is possible to increase the COP values by adding an auxiliary condenser to the conventional AHTWP scheme and obtained increased from 74% from original value.

This article shows the mathematical model and the analysis of results from the simulation, finally the conclusions of the present work.

Basic concepts

Figure 1 shows a schematic diagram of an absorption heat transformer (AHT). Absorption systems use working pairs, formed by a working fluid, circulating through the primary circuit, and an absorber located in a secondary circuit. The primary circuit begins in the condenser, where the working fluid condenses, releasing a quantity of useful heat (Q_{CO}), then passes to the evaporator, where it evaporates, exchanging energy with the heat source, at a P_{EV} pressure higher than the P_{CO} pressure and a T_{EV} temperature higher than the T_{CO} temperature. The vapour phase working fluid passes to the absorber, where it mixes with the absorber-rich solution (secondary circuit) and releases a quantity of useful heat (Q_{AB}) as a result of the exothermic reaction. The secondary circuit starts when the working mixture rich in working fluid leaves the absorber at a temperature T_{AB} and enters the economizer, where it gives up heat to the working mixture coming from the generator at a temperature T_{GE}.

As it enters the generator, part of the working fluid is separated as a result of the heat exchange between the working mixture and the heat source, while the working solution rich in absorbent passes to the economiser to re-enter the absorber.

Box 1

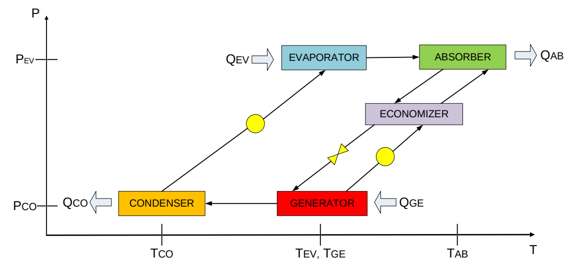


Figure 1
Schematic diagram of an absorption heat transforme
Source: [Own elaboration]

Figure 2 shows a schematic diagram of the water purification process by AHT, which consists of using the useful heat of the absorber (Q_{AB}) to bring the impure water to its saturation point and partially evaporate it, the saturated mixture passes to a phase separator where the saturated vapour is sent to an auxiliary condenser by the energy exchange provides a quantity of heat (ηQ_{AB}) to condense and obtain purified water. The quantity ηQ_{AB} [28] represents the heat that can be recycled to the AHT. The recycling of this heat can reduce the energy requirements of the system and enhance the COP values. Two configurations for recovering this useful heat are described in the literature.

Box 2

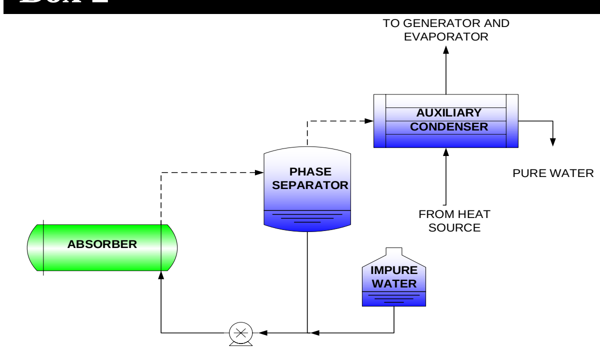


Figure 2
Water purification process using an absorption heat transformer
Source: [Own elaboration]

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

Figure 3 illustrates the initial form of heat recycling for an AHTWP system, as reported by Siqueiros and Romero [28]. In this configuration, the stream from the heat source is sent directly to an auxiliary condenser where it exchanges heat with the evaporated water from the phase separator. Upon leaving the condenser, the water's initial temperature increases by an amount ΔT, entering the generator and evaporator. The evaporated water then condenses, yielding an amount of heat (ηQ_{AB}), to produce purified water. This recycling method will be referred to as 'Case I' in the following discussion.

Box 3

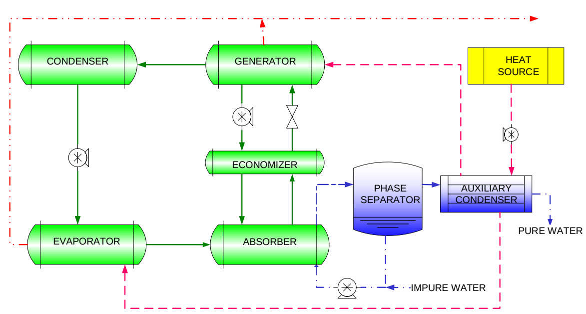


Figure 3

Heat recycling configuration increasing heat source temperature (Case I)

Source: [Own elaboration]

Figure 4 illustrates the second form of heat recycling for an AHT integrated with a water purification system, as reported by Romero et al. [29]. In this configuration, the useful heat (ηQ_{AB}) product of simple distillation is recycled to the system by heat exchange in the auxiliary condenser of the heat source streams leaving the evaporator and generator, as well as the vaporized water leaving the phase separator. The vaporized water releases heat as it condenses and purifies, while the heat source stream increases its initial temperature to re-enter the system. For the sake of clarity, we will refer to this form of recycling as 'Case II'.

Box 4

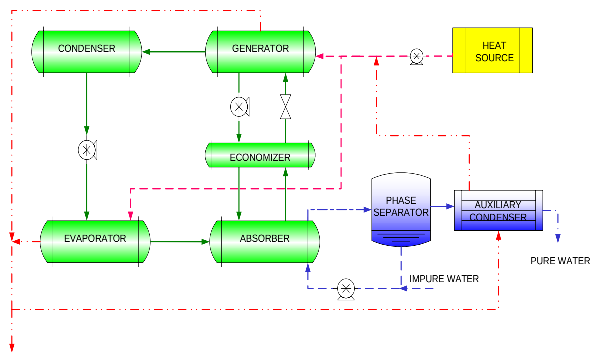


Figure 4

Heat recycling configuration without increasing heat source temperature (Case II)

Source: [Own elaboration]

Figure 5 shows the proposed heat recovery combination for an AHTWP. The useful heat obtained in the absorber (Q_{AB}) is used to raise the impure water to its saturation point and partially evaporate it. The saturated mixture then passes to a phase separator, where the liquid phase is reintroduced into the purification circuit, while the vapour phase is split and sent to auxiliary condensers I and II. In the auxiliary condenser I, the vapour is condensed by exchanging energy with the heat source stream, producing purified water. The heat source stream gains an amount of energy, which subsequently enters the evaporator and generator with an increase in its original temperature, ΔT (Case I) [28]. In the auxiliary condenser II, the purified water is vaporised and exchanges heat with the stream coming from the evaporator and generator. This stream is heated to a higher temperature and re-enters the system (Case II) [29]. By distributing the latent heat product of distillation (ηQAB) between the two forms of recycling, the energy requirements of the AHT are reduced and the COP values are increased.

Box 5

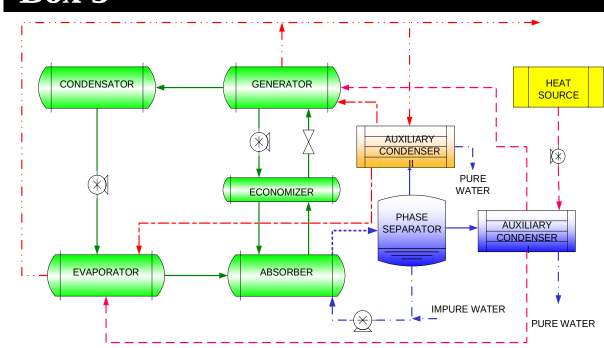


Figure 5

[Proposal heat recovery combination

Source: [Own elaboration]

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

Methodology

The mathematical equations used for simulating this system are based on thermodynamic models previously published by other authors [1][9]. This modelling approach has been tested and proven effective. The model was developed based on the following considerations:

- The entire system is in thermodynamic equilibrium.
- The analysis is carry out under steady-state conditions.
- A rectifier is not required since the absorbent does not evaporate under the operating temperature rang of the system.
- The solution that lives the generator and absorber is saturated; similarly, the working fluid leaving the condenser and the evaporator is also saturated.
- Heat losses and pressure drops in the tubing and the components are considered negligible.
- The flow through the valves is isenthalpic.
- The pumps are isentropic.
- Temperatures at the exit of the main components and the heat load in the evaporator (Q_{EV}) are known.
- The efficiency of economizer is well known.

1. Calculation of the COP for the proposal for combined heat recycling

The water purification system provides a finite amount of energy recycling to the AHT, which can be calculated by:

$$Q_{REC} = \eta Q_{AB} \quad [1]$$

Where η is defined as:

$$\eta = \frac{\Delta H_V}{\Delta H_V + \Delta H_S} \quad [2]$$

For water purification is considered an initial temperature of 25 °C for impure water and a boiling point of 100 °C at atmospheric pressure, so that the value of η is a constant with a value of 0.877 [14]. The Q_{REC} can be divided into two fractional components, which correspond to the two possibilities of energy recycling (case I and case II). The energy balance in the heat source can be estimated by:

$$Q_{HS} = m_{HS} Cp \Delta T_{HS} \quad [3]$$

In the case I of energy recycling, T_{EV} and T_{GE} temperatures can be increased in a quantity ΔT_N which is calculated by:

$$\Delta T_N = \eta COP_{ET} \Delta T_{HS} \quad [4]$$

However, should only a portion of this increase be allocated to case I, the new temperatures in the evaporator and generator can be calculated using the following equation.:

$$T_{EV,N} = T_{EV} + \alpha \Delta T_N \quad [4]$$

$$T_{GE,N} = T_{GE} + \alpha \Delta T_N \quad [5]$$

The value of α, which takes a range of 0 to 1, represents the fraction of heat that is sent to the Case I. To evaluate the effect of the Case I enthalpy-based COP definition for a heat transformer, we used the following methodology:

$$COP_H = \frac{Q_{AB}}{Q_{EV} + Q_{GE}} \quad [6]$$

Depending on the temperatures, $T_{EV,N}$ and $T_{GE,\ N}$.

The temperatures will affect the $T_{EV,\ N}$ and $T_{GE,\ N.}$ For Case II, we will use the definition of the COP_{WP} proposed by Romero *et al.* [14].

$$COP_{WP} = \frac{COP_{ET}}{1 - \eta COP_{ET}} \quad [7]$$

In this instance, the proportion of heat transferred to this category of energy recycling is represented by β. Consequently, the ultimate values of the COP, accounting for the impact of both Case I and Case II of energy recycling, can be determined using the following equation:

$$COP_N = \frac{COP_{ET}}{1 - \beta \eta COP_{ET}} \quad [8]$$

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

Results

The results of simulation are shown below. Three conditions of ΔT conditions are presented for the same absorber and condenser temperature T_{AB}=115°C, T_{CO}=30 °C. In this first condition of ΔT=5° C and T_{GE}=T_{EV}=70° C in Figure 6, it is observed that if the combination is not made, the COP_H value will be 0.29, but if the combination is made, the COP_N increases to a value of 0.42, which is closer to the theoretical value of 0.50. This is a consequence of increasing the concentration of the solution in the generator, which improves a better reaction in the absorber at constant pressure. With respect to the initial COP value, the COP_H value can be increased by up to 46%. This makes it possible to save more primary energy in the circuit of the absorption heat exchanger and to increase the outlet temperature in the absorber.

Box 6

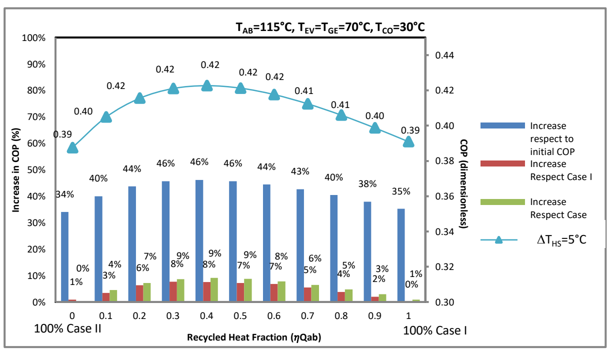


Figure 6

Increases of COP_H in function of ηQ_{AB} with ΔT_{HS}=5°C

Source: [Own elaboration]

Figure 7 presents the COP behaviour when a recycle heat increment of ΔT=10 ° C is available. It is possible to increase the COP_H value up to a maximum value of 0.47 which represents an increase of the initial COP of 62%. So if the combination is carried out, it is possible to increase the original COP_H value from 0.29 to 0.47, which represents an amount of heat that can be recovered very close to the theoretical value. And if you compare the percentage increase of the COP_N of the combination with Case I and Case II, it is convenient to make the combination because the increase is higher, the values goes to 0.34 to 0.47. These increases are the result of the increase the latent heat in auxiliary condenser II and in conclusion increase the vapor in evaporator promoting a better reaction in absorber.

Box 7

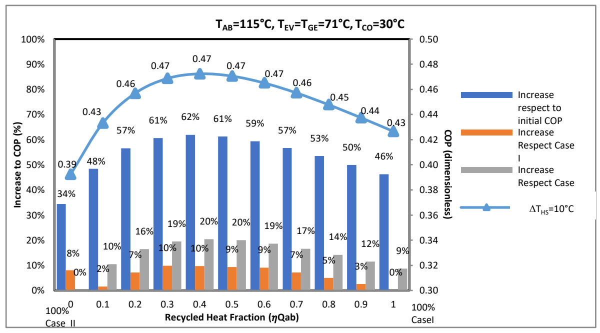


Figure 7

Increases of COP_H in function of ηQ_{AB} with ΔT_{HS}=10°C

Source: [Own elaboration]

In Figure 8 shows the behavior of the COP when increasing ΔT=15° C. Increasing the latent heat ΔT also increases the steam production at the outlet of the evaporator and facilitates a higher useful heat in the absorber, increasing its power, because a strong exothermic reaction takes place, reducing the concentration of the working solution going to the generator, also increasing the pressure, which increases the power of the generator to satisfy the energy balance. Under these conditions, it is possible to increase the COP_H values up to 0.51, which represents an increase of 74%, using the combination, in other cases, using Case I or Case II alone, an increase 53% and 39% respectively is possible.

Box 8

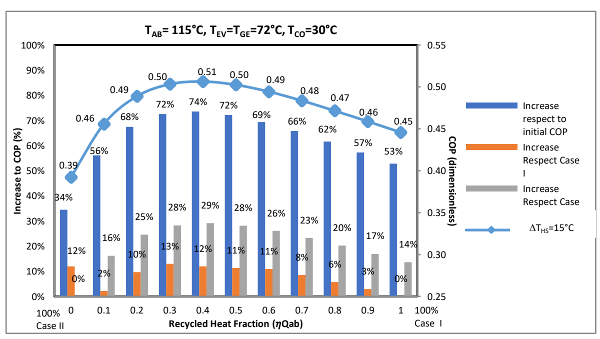


Figure 8

Increases of COP_H in function of ηQ_{AB} with ΔT_{HS}=15°C

Source: [Own elaboration]

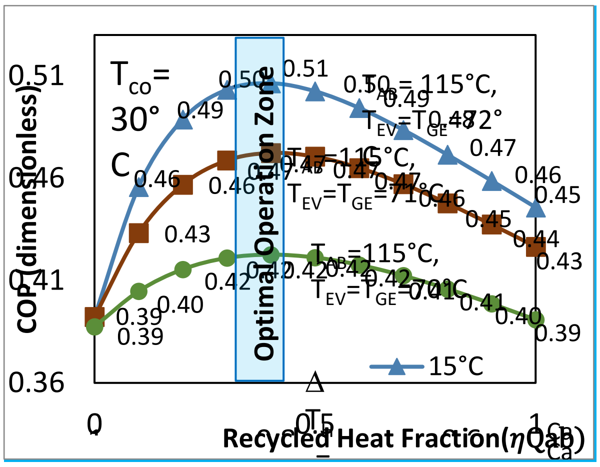
Figure 9 shows the three conditions previously discussed, demonstrating an optimal operational range for the combined utilization of the two forms of heat recycling. The most effective method for achieving an increase in COP is to combine Case I with a 40% increase and Case II with a 60% increase.

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

This results in an overall COP_H increase of up to 74% through the utilization of the latent heat of the purified water.

Box 9



Graphic 4

Comparison of COP increase for three different ΔT_{HS} conditions

Source: [Own elaboration]

Conclusions

In conclusion, adding an auxiliary condenser II to the water purification circuit integrated to a thermal transformer increases the COP_H values. The COP_{WP} increases with the latent heat of the purified water, which depends on the quality of the impure water and the atmospheric pressure. When heat is recycled, COP increases from 46% to 74%. This work shows that combining 40% to Case I and 60% to Case II is the best option.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

L.I Morales: was responsible for developing the initial concept, creating the model and analyzing the resulting data.

J. Siqueiros provided valuable input to the project, offering insights on the concept, data analysis and conclusions.

D. Juárez-Romero: Provided input to the analysis of results and conclusions.

A.H. Hernández: contributed to the literature review, data analysis and conclusions.

Availability of data and materials

Communication with the principal autor laura.morales@uaem.mx

Funding

No received any finance.

Acknowledgements

The authors would like to thank the Centro de Investigación en Ingeniería y Ciencias Aplicadas, CIICAp- UAEM for the facilities provided for this work.

Abbreviations

AHT	Absorption heat transformer
COP	Coefficient of Performance (Dimensionless)
H	Enthalpy (kJ/kg)
Q	Heat flux (kW)
Cp	Heat Capacity (kJ/kg°C)
m	Mass flow rate (kg/s)
T	Temperature (°C)

Sub-index

AB	Absorber
CO	Condenser
EV	Evaporator
GE	Generator
HS	Heat Source
H	Enthalpy
N	New
REC	Recycled
S	Sensitive
V	Vaporization
WP	Water purification

Greek-symbols

η	Fraction of available heat
β	Fraction of heat sent to Case II
α	Fraction of heat sent to Case I
ε	Efficiency.

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

References

[1] Holland F. A., Siqueiros, J., Santoyo, S., Heard, C. L. y Santoyo, E. R. Water purification using heat pumps. E & FN Spon. Taylor & Francis Group. London (1999) ISBN0203983564, 9780203983560

[2] Salehi, S., Yari, M., Mahmoudi, S. M. S., & Farshi, L. G. (2019). Investigation of crystallization risk in different types of absorption LiBr/H_2O heat transformers. Thermal Science and Engineering Progress, 10, 48-58. https://doi.org/10.1016/j.tsep.2019.01.013

[3] Amaris C, Vall`es M, Bourouis M. Vapour absorption enhancement using passive techniques for absorption cooling/heating technologies: a review. Applied Energy 2018; 231:826–53 https://doi.org/10.1016/j.apenergy.2018.09.071

[4] Zhang L, Fu Z, Liu Y, Jin L, Zhang Q, Hu W. Experimental study on enhancement of falling film absorption process by adding various nanoparticles. Int Commun Heat Mass Tran 2018; 92:100–6.https://doi.org/10.1016/j.icheatmasstransfer.2018.02.011

[5] Yi Y, Hu T, Xie X, Jiang Y. The influence of a vertical chevron corrugated plate on wetting and thermal performance of a detachable plate-type falling film absorber. Appl Therm Eng 2020; 179:115704.https://doi.org/10.1016/j.applthermaleng.2020.115704

[6] Labra, L., Juarez-Romero, D., Siqueiros, J., Coronas, A., & Salavera, D. (2017). Measurement of properties of a lithium bromide aqueous solution for the determination of the concentration for a prototype absorption machine. Applied Thermal Engineering, 114, 1186-1192.https://doi.org/10.1016/j.applthermaleng.2016.10.162

[7] Ramesh R, Murugesan SN, Narendran C, Saravanan R. Experimental investigations on shell and helical coil solution heat exchanger in NH 3 -H 2 O vapour absorption refrigeration system (VAR). Int Commun Heat Mass Tran 2017; 87:6–13https://doi.org/10.1016/j.icheatmasstransfer.2017.06.010

[8] Balderas-Sánchez, I. N., Rivera, W., & Jiménez-García, J. C. Thermodynamic analysis of a novel absorption heat transformer (2019). Applied Thermal Engineering, 162, 114268. https://doi.org/10.1016/j.applthermaleng.2019.114268

[9] Ma X., Chen J., Li S., Sha Q., Liang A., Li W., Zhang J., Zheng G., Feng Z. Application of absorption heat transformer to recover waste heat from a synthetic rubber plant. Applied Thermal Engineering, 2003, 23:797-806. https://doi.org/10.1016/S1359-4311(03)00011-5

[10] Alonso D., Cachot T., Hornut J. M. Experimental study of an innovative absorption heat transformer using partially miscible working mixtures, International Journal of Thermal Sciences, 42, 2003, 42: 631-638.https://doi.org/10.1016/S1290-0729(03)00028-0

[11] Horus I., Kurt B., Absorption heat transformers and an industrial application. Renewable Energy, 2010, 35:2175-2181.https://doi.org/10.1016/j.renene.2010.02.025

[12] Yi Y, Hu T, Xie X, Jiang Y. Experimental assessment of a detachable plate falling film heat and mass exchanger couple using lithium bromide and water as working fluids. Int J Refrig 2020; 113:219–27. https://doi.org/10.1016/j.ijrefrig.2020.02.001

[13] Huicochea A., Siqueiros J., Romero R. J. Portable water purification system integrated to a heat transformer, Desalination, 2004, 165:385-391. https://doi.org/10.1016/j.desal.2004.06.044

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

Morales, L.I., Siqueiros J., Juárez-Romero D. and Hernández-Soria, A. H.. [2024]. Using latent heat from a water purification system to improve the performance of an absorption heat transformer. Journal Renewable Energy. 8[20]-1-10: e10820110.
DOI: https://doi.org/10.35429/JRE.2024.8.20.2.10

[14] Sekar S., Saravanan R., Experimental studies on absorption heat transformer coupled distillation system. Desalination, 2011, 274:292-301. https://doi.org/10.1016/j.desal.2011.01.064

[15] Bourouis M., Coronas A., Romero R. J., Siqueiros J. Purification of seawater using absorption heat transformers with water-(LiBr+LiI+LiNO3+LiCl) and low temperature heat sources, Desalination, 2004, 166:209-214. https://doi.org/10.1016/j.desal.2004.06.075

[16] Abed, A. M., Alghoul, M. A., Sopian, K., Majdi, H. S., Al-Shamani, A. N., & Muftah, A. F. (2017). Enhancement aspects of single stage absorption cooling cycle: A detailed review. Renewable and Sustainable Energy Reviews, 77, 1010-1045. https://doi.org/10.1016/j.rser.2016.11.231

[17] Lima AAS, Ochoa AAV. Da Costa JAP, Henríquez JR. CFD simulation of heat and mass transfer in an absorber that uses the pair ammonia/water as a working fluid. Int J Refrig 2019; 98:514–25. https://doi.org/10.1016/j.ijrefrig.2018.11.010

[18] Hernández J.A., Juárez-Romero D., Morales L.I., Siqueiros J. COP prediction for the integration of a water purification process in a heat transformer: with and without energy recycling. Desalination, 2008, 219:66-80. https://doi.org/10.1016/j.desal.2007.05.008

[19] Hernández J.A., Bassam A., Siqueiros J., Juárez-Romero D., Optimum operating conditions for a water purification process integrated to a heat transformer with energy recycling using neural network inverse. Renewable Energy, 2009, 34:1084-1091. https://doi.org/10.1016/j.renene.2008.07.004

[20] El Hamzaoui Y., Hernandez J.A., Gonzalez R.A., Rodriguez R.A., ANN and ANFIS Models for COP prediction of a water purification process integrated to a heat transformer with energy recycling. Chemical Product and Process Modeling, 2012, Volumen 7: Iss. 1, Article 7. https://doi.org/10.1515/1934-2659.1616

[21] Rivera W., Huicochea A., Martínez H., Siqueiros J., Juárez D., Cadenas E. Exergy analysis of an experimental heat transformer for water purification. Energy, 2011, 36:320-327. https://doi.org/10.1016/j.energy.2010.10.036

[22] Gomri R. Energy and exergy analyses of seawater desalination system integrated in a solar heat transformer. Desalination, 2009, 249:188-196. https://doi.org/10.1016/j.desal.2009.01.021

[23] Aminyavari, M., Aprile, M., Toppi, T., Garone, S., & Motta, M. (2017). A detailed study on simultaneous heat and mass transfer in an in-tube vertical falling film absorber. International journal of refrigeration, 80, 37-51. https://doi.org/10.1016/j.ijrefrig.2017.04.029

[24] García-Rivera E, Castro J, Farnos ´ J, Oliva A. Numerical and experimental investigation of a vertical LiBr falling film absorber considering wave regimes and in presence of mist flow. Int J Therm Sci 2016; 109:342–61.https://doi.org/10.1016/j.ijthermalsci.2016.05.029

[25] Gao H, Mao F, Song Y, Hong J, Yan Y. Effect of adding copper oxide nanoparticles on the mass/heat transfer in falling film absorption. Appl Therm Eng 2020;181: 115937.https://doi.org/10.1016/j.applthermaleng.2020.115937

[26] Chen, T., Yin, Y., Zhang, Y., & Zhang, X. (2019). Model evaluation of lithium bromide aqueous solution and characteristics of water transport behaviors in liquid–vapor systems by molecular dynamics. International Journal of Refrigeration, 107, 165-173.https://doi.org/10.1016/j.ijrefrig.2019.08.001

[27] Narváez-Romo B, Chhay M, Zavaleta-Aguilar EW, Simoes-Moreira ˜ JR. A critical review of heat and mass transfer correlations for LiBr-H 2 O and NH 3 -H 2 O absorption refrigeration machines using falling liquid film technology. Appl Therm Eng 2017; 123:1079–95n https://doi.org/10.1016/j.applthermaleng.2017.05.092

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902

[28] Siqueiros J., Romero R.J., Increase of COP for water purification systems. Part I: increase heat source temperature. Applied Thermal Engineering, 2007, 27:1043-1053.https://doi.org/10.1016/j.applthermaleng.2006.07.042

[29] R.J. Romero, J. Siqueiros, A. Huicochea. Increase COP for heat transformer in water purification systems. Part II: Without increasing heat source temperature. Applied Thermal Engineering, 2007, 27:1054-1061. https://doi.org/10.1016/j.applthermaleng.2006.07.041

[30] Huicochea A. y Siqueiros J. Improved efficiency of energy use of a heat transformer using a water purification system. Desalination, 2010, 257:8-15. https://doi.org/10.1016/j.desal.2010.02.040

[31] Armando, H., López-Pérez, L. A., Juárez Romero, D., Torres Díaz, T., Delgado Gonzaga, J., & Carbajal Carbajal, J. Experimental Evaluation of an Absorption Heat Transformer with Carrol/H_2O to Obtain Freshwater. Available at SSRN 4805910. https://dx.doi.org/10.2139/ssrn.4805910

[32] Saren, S., Mitra, S., Miksik, F., Miyazaki, T., Ng, K. C., & Thu, K. (2024). Investigating maximum temperature lift potential of the adsorption heat transformer cycle using IUPAC classified isotherms. International Journal of Heat and Mass Transfer, 225, 125384.https://doi.org/10.1016/j.ijheatmasstransfer.2024.125384

[33] Ali, A. M., Bagdanavicius, A., Barbour, E. R., Pottie, D. L., Garvey, S., Rouse, J., & Baniamerian, Z. (2024). Improving the performance of a shell and tube latent heat thermal energy storage through modifications of heat transfer pipes: A comprehensive investigation on various configurations. Journal of Energy Storage, 96, 112678. https://doi.org/10.1016/j.est.2024.112678

[34] Liu, Z., Lu, X., Wu, C., Gu, J., & Wu, Q. (2024). Exploiting the potential of a novel “in-situ latent heat recovery” in hollow-fiber vacuum membrane distillation process for simultaneously improved water production and energy efficiency. Water Research, 256, 121586. https://doi.org/10.1016/j.watres.2024.121586

References Classification

Antecedents:

[1], [2], [3], [16]

Basics:

[4], [5], [6], [7], [17], [24], [25], [26], [27]

Support:

[8], [9], [13], [14], [21], [22], [23], [28], [29], [30], [31], [32], [33], [34]

Differences:

[10], [11], [12], [15]

Discussion:

[18], [19], [20]

ISSN: 2523-6881
RENIECYT-CONAHCYT: 1702902