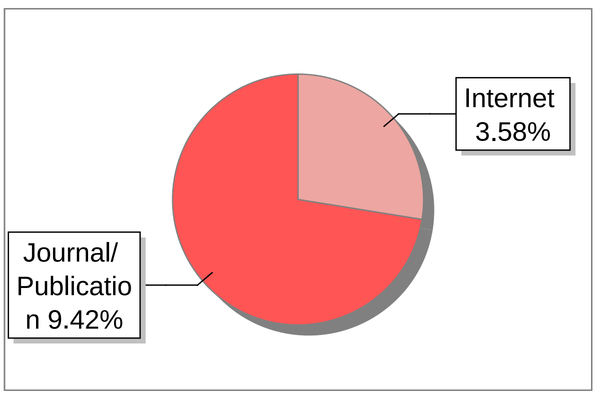
The Report is Generated by DrillBit Plagiarism Detection Software

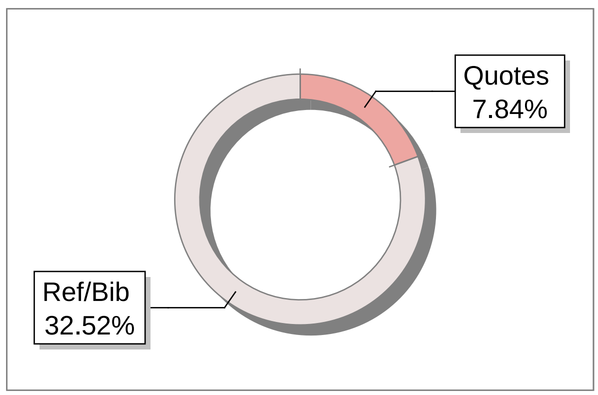
Submission Information

Author Name	Totok Eka Suharto
Title	Utilization-Heat-Combustion-AdiP-IJAAS
Paper/Submission ID	1544967
Submitted by	tunggal.pribadi@staff.uad.ac.id
Submission Date	2024-03-19 07:52:54
Total Pages	7
Document type	Article

Result Information

Similarity **13 %**





Exclude Information

Quotes	Excluded
References/Bibliography	Excluded
Sources: Less than 14 Words %	Not Excluded
Excluded Source	**59 %**
Excluded Phrases	Not Excluded

Database Selection

Language	English
Student Papers	Yes
Journals & publishers	Yes
Internet or Web	Yes
Institution Repository	Yes

A Unique QR Code use to View/Download/Share Pdf File

DrillBit Similarity Report

13	24	B	A-Satisfactory (0-10%) B-Upgrade (11-40%) C-Poor (41-60%) D-Unacceptable (61-100%)
SIMILARITY %	MATCHED SOURCES	GRADE	

LOCATION	MATCHED DOMAIN	%	SOURCE TYPE
2	A Robust Controller for A 3-DOF Flexible Robot with a Time Variant Payload by Feliu-2012	1	Publication
7	inba.info	1	Internet Data
13	repository.up.ac.za	5	Publication
14	Assisting the diagnosis of Cushing syndrome by pattern recognition me, by Kudo, Masataka Sat- 2014	1	Publication
15	bradscholars.brad.ac.uk	<1	Internet Data
16	www.dx.doi.org	<1	Publication
17	www.ijert.org	1	Publication
18	coek.info	<1	Internet Data
19	www.ijeat.org	<1	Publication
20	Dayalbagh Educational Institute Student Thesis Published in inflibnet - www.inflibnet.ac.in	<1	Publication
21	mdpi.com	<1	Internet Data
22	Screening and identification indigenous yeast from neera Siwalan for bioethanol by Widyaningrum-2019	<1	Publication

23	civilejournal.org	<1	Internet Data
24	How E are Arab Municipalities An Evaluation of Arab Capital Municipal Web Sit by Al-Nuaim-2009	<1	Publication
25	www.dx.doi.org	<1	Publication
26	journal.unair.ac.id	<1	Internet Data
27	A Special Breed A Longitudinal and Cross-Sectional Study of Norwegian Budgetin by To-2012	<1	Publication
28	www.researchgate.net	<1	Internet Data
29	ejournal.radenintan.ac.id	<1	Publication
30	moam.info	<1	Internet Data
31	uad.ac.id	<1	Internet Data
32	academicjournals.org	<1	Publication
33	eprints.uad.ac.id	<1	Publication
34	springeropen.com	<1	Internet Data

EXCLUDED SOURCES

1	ijaas.iaescore.com	59	Publication

Utilization of the heat from combustion of water for the heating process in water desalination

Adi Permadi[1], Arief Syamsuddin[2], Trianik Widyaningrum[3], Ibdal Satar[4], Totok Eka Suharto[1], Joko Pitoyo[1]

[1]Department of Chemical Engineering, Faculty of Industrial Technology, Ahmad Dahlan University, Yogyakarta, Indonesia
[2]Department of Automotive Technology Vocational Education, Faculty of Teacher Training and Education, Ahmad Dahlan University, Yogyakarta, Indonesia
[3]Department of Biology Education, Faculty of Teacher Training and Education, Ahmad Dahlan University, Yogyakarta, Indonesia
[4]Department of Food Technology, Faculty of Industrial Technology, Ahmad Dahlan University, Yogyakarta, Indonesia

Article Info

Article history:

Received Jun 9, 2023
Revised Sep 15, 2023
Accepted Dec 9, 2023

Keywords:

Heating
Rubbish
Salt
Sea water
Water desalination

ABSTRACT

The volume of municipal waste has become a national problem so far, so a solution is needed to reduce the waste problem. One solution to reduce the volume of municipal waste is to burn waste. However, the combustion needs to be designed to take advantage of the heat generated by combustion. In this study, the process of burning waste with various types of waste materials was carried out. The heat of burning waste is used to evaporate 1 liter of seawater and the seawater vapor is cooled to produce distilled water. The volume of distilled water and the precipitated salt were weighed. The results of the research from the variation of 6 types of waste materials obtained that the type of clothing waste material gave the fastest time, which was 43.75 minutes, the amount of distilled water was 931 ml, and salt deposited as much as 30 grams. The test results on distilled water showed that almost all parameters met the requirements of drinking water and obtained a salt content of 84%. Further processing by adjusting the hardness is needed to process distilled water into clean water and the addition of iodine can be considered to produce iodized salt.

Corresponding Author:

Adi Permadi
Department of Chemical Engineering, Faculty of Industrial Technology, Ahmad Dahlan University
Ahmad Yani street, Tamanan, Banguntapan, Bantul, Yogyakarta 55166, Indonesia
Email: adi.permadi@che.uad.ac.id

1. INTRODUCTION

Industrialization, urbanization, and economic growth have all contributed to a sharp rise in the world's waste production [1]. According to World Bank statistics, municipal solid waste (MSW) produced worldwide reached 2.01 billion tonnes in 2016 and this is predicted to increase above 3.4 billion tonnes per year by 2050. The increasing volume of waste is due to two things, namely population growth and human behavior such as culture, lifestyle, and quality economy [2]. A dense population in an area has an impact on increasingly heterogeneous people's lives, which means there will be a diversity of lifestyles and different economic qualities. This also has an impact on the increasing volume of waste in an area [3]. The government's role in managing national waste has been stated in presidential regulation no. 97 of 2017 concerning national policy and strategy for the management of household waste and household-like waste. in the regulation, it is stated that the target in 2025 is a reduction of 30% and recycle 70% from the predetermined data [4]. One method of processing waste by burning waste is considered more effective than just stacking it. This is a method commonly used in developing countries [5].

In addition to problems with waste management, there are also concerns about a clean water crisis. The water crisis is a global problem that is expected to worsen in the coming years. More than two billion people do not have access to clean water [6]. The biggest problem with the clean water crisis is climate change and pollution [7]. The supply of clean water can be supplemented by utilizing seawater, the percentage of the seawater on earth reaches 97% [8]. Another factor that increases water scarcity is the growth of urbanization and the depletion of freshwater resources [9]. The importance of utilizing alternative energy such as sea water to meet water needs by exploring technological development. Abundant sea water still contains complexes and large amounts of dissolved salts, so it needs to be treated through desalination [10]. Over the past 50 years, desalination has been the most frequently used technology to meet the demand for clean water supply. Desalination technology aims to be able to separate the salt content from sea water and clean water products that can be used for drinking water, industry, and agriculture so that research and development continue to be carried out to produce technologies that are more cost-effective and efficient.

The separation process with desalination technology can use a phase change process (thermal) through a continuous process of evaporation and condensation [11]. Distillation is the oldest and most commonly used desalination method [12]. Distillation is a separation method by heating sea water to produce water vapor, which is then condensed to produce clean water. The desalination process with the distillation method certainly requires thermal energy. Renewable energy is a solution as an energy source [13]. Previous research has reviewed several aspects of saving energy by replacing the use of fossil fuel energy in the desalination process using renewable energy that is integrated with the desalination process [14]. Even though several industries have taken steps towards implementing renewable energy in the desalination process, difficulties are still encountered due to the high energy demand which results in the high production capacity required. The selection of the factory location has also not found the best place because it needs to be installed with a renewable energy system [15]. The desalination process unit requires depreciation, maintenance, operations, employees, energy, chemicals, and insurance costs [16]. In addition, there will be additional costs if pre-treatment and post-treatment are carried out so that product costs can be estimated. The cost of desalination energy is calculated from the cost of processing steam and electricity determined from the power generation unit [17].

Utilization of waste as fuel in the process of heating sea water is a solution to reduce the accumulation of waste and the use of fossil energy. Plastic waste is better utilized as fuel than having to be stockpiled or disposed of into the sea which will certainly have a negative impact on marine ecosystems [18]. Non-organic waste is also a problem that causes environmental damage and takes a very long time to decompose [19]. The effectiveness of burning waste in reducing waste reaches 80-90% [20]. In this research, several types of waste were burned to evaporate sea water to obtain distilled water and salt. The need for each type of waste material and the duration of desalination to evaporate 1 liter of sea water can be known from this research.

2. RESEARCH METHOD

2.1. Time and place of research

The research was conducted from 18 July 2022 to 12 August 2022 at the Faculty of Industrial Technology, Ahmad Dahlan University. Tests for the content of sea water, distillate water, and mineral water were carried out by the UPT Health Laboratory in the city of Yogyakarta, located on Sisingamangaraja Street no. 21 Brontokusuman, Mergangsan, Yogyakarta. While testing for salt content was carried out by the DIY Health Office located in Ngadinegaran MJ III/62 Yogyakarta.

2.2. Research tools and materials

This study used sea water from Parangtritis Beach in Yogyakarta and various types of waste from the Sleman area of Yogyakarta as research materials. The varied waste consists of charcoal, plastic, leaves, twigs, cloth, and paper. The tools used in the seawater desalination process consist of a furnace, presto, aluminum pipes, buckets, hoses, thermometers, static, fans, scales, measuring cups, used bottles, stopwatches, spoons, and plastic.

2.3. Research procedure

The seawater desalination process begins with preparing the tools and materials to be used during the experiment. After the tools and materials are ready, the experimental equipment is assembled as shown in Figure 1. Before burning, the variable waste to be burned is weighed first, and then 1 liter of sea water is prepared which is then put into the presto. The burning process begins after the presto is placed on the stove. The stopwatch is run to determine the burning time until the sea water has completely evaporated. The steam resulting from condensation on the aluminum pipe is cooled by contacting it by convection with cooling water. The cooling water temperature is maintained at 30 °C and the temperature is controlled by changing the water in the bucket. When the aluminum pipe has no water dripping anymore, this shows that the water in Presto has all evaporated, then the desalination process. Then the weight of the salt in the presto and the volume of condensed water in the bottle are weighed. Furthermore, the content of sea water, distillate water, mineral water, and salt is tested.

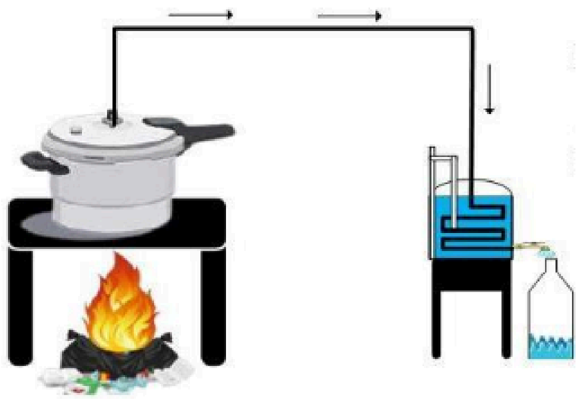


Figure 1. Desalination process equipment

3. RESULTS AND DISCUSSION

3.1. Comparison of evaporation time with the amount of water and salt based on various types of waste burned

Desalination process of 1 liter of seawater using a variety of organic and non-organic waste. The desalination process is carried out by utilizing heat from burning waste. The experiment was carried out 3 times for each type of waste. Research data on various types of waste can be seen in Tables 1 and 2.

Table 1. Research results on various types of charcoal, plastic, and leaf waste

No	Parameter	Charcoal			Plastic			Leaf		
		1	2	3	1	2	3	1	2	3
1	Evaporation time (minutes)	136	131	143	50.8667	53.05	57.1667	101	117	108
2	Waste weight (kg)	2	2	2	0.89	0.818	0.849	1.9	1.7	2
3	Distilled water volume (ml)	872	920	976	915	965	974	965	895	930
4	Distillate water weight (g)	869	918	943	879	933	941	935	865	897
5	Salt weight (g)	26	29	28	26	28	31	29	31	30

Table 2. Research results on variations in the types of twigs, cloth, and paper waste

No	Parameter	Twigs			Clothes			Paper		
		1	2	3	1	2	3	1	2	3
1	Evaporation time (minutes)	49.9833	46.6167	46.9	43.75	43.85	45.0667	55.5667	58.15	59.9167
2	Waste weight (kg)	2	2	2	1	1	1	1,4	1,5	1,8
3	Distilled water volume (ml)	935	970	918	931	824	956	940	929	951
4	Distillate water weight (g)	894	924	877	895	790	923	904	895	914
5	Salt weight (g)	28	28	29	30	30	31	30	32	28

Based on the data in Tables 1 and 2, it can be concluded that the type of waste that can vaporize 1 liter of seawater in the fastest time is fabric-type waste in 43.75 minutes, the volume of distillate water is 931 ml and salt deposits are as much as 30 grams. The use of cloth-type waste for evaporation of seawater is more effective than charcoal, leaves, twigs, and paper because only 1 kg of waste can carry out the fastest evaporation process. This also correlates with the results of the average calculation in Table 3. It is known that the fastest average evaporation time is using a type of cloth waste with a time of 44.2222 minutes. In addition, it can also be seen that the weight of the salt produced from the desalination process is in the range of 26 to 32 grams. The highest gain of salt content occurred in the type of paper waste with a weight of 32 grams. Based on the calculation of the average research results, it is known that the evaporation time sequence starts from the fastest, namely cloth (44.2222 minutes), twigs (47.8333 minutes), plastic (53.6945 minutes), paper (57.8778 minutes), leaves (108.6667 minutes), and charcoal (136.6667 minutes).

Table 3. Average of research results

No	Parameter	Charcoal	Plastic	Leaf	Twigs	Clothes	Paper
1	Evaporation time (minutes)	136.6667	53.6945	108.6667	47.8333	44.2222	57.8778
2	Waste weight (kg)	2.2333	0.8523	1.8667	2	1	1.5667
3	Distilled water volume (ml)	922.6667	951.3333	930	941	903.6667	940
4	Distillate water weight (g)	910	918	899	898	869	904
5	Salt weight (g)	27.6667	28.3333	30	28	30	30

3.2. Sea water content test results, distillate water, and mineral water

The water content test is carried out to determine the quality of water in the initial sea water content before the desalination process, distillate water, and mineral bottled water on the market according to quality standards. The composition of sea water before the desalination process presented in Table 4 has a major difference from the composition of distillate water presented in Table 5. The significant decrease in the mineral content of iron (Fe), manganese (Mn), fluoride (F), chloride (Cl), nitrate (NO_3-), nitrite (NO_2-), and total hardness before and after the desalination process can be observed in Tables 4 and 5.

Table 4. Seawater content test results

Parameter	Results	Unit	Quality standard	Method
Smell	smelly	-	smelly	Organoleptic
pH	7.5	mg/l	6.5-9.0	Potentiometry
Iron	0.029	mg/l	1.0	SNI 06-4138-1966
Mangan	0.019	mg/l	0.5	SNI 06-6855-2002
Fluoride	1.475	mg/l	1.5	SNI 06-6989.29-2005
Nitrate (NO_3-N)	2.690	mg/l	10	APHA 2017. Section 4500-NO3 B
Nitrite (NO_2-N)	0.003	mg/l	1.0	SNI 06-6989.9-2004
Total Hardness	61480*	mg/l	500	SNI 06-6989.12-2004
Chloride	20635.75*	mg/l	600	SNI 6989.19-2009
Flavor	Tastes salty	-	Tasteless	Organoleptic
Turbidity	11.6*	NTU	5	SNI 06-6989.25-2005
Temperature	23.3	°C	Air temperature ±3 °C	SNI 06-6989.23-2005
Color	5	TCU	15	Photometry

Table 5. Distillate water content test results

Parameter	Results	Unit	Quality standards	Method
Smell	smelly	-	smelly	Organoleptic
pH	6.7	mg/l	6.5-9.0	Potentiometry
Iron	<0.009	mg/l	1.0	SNI 06-4138-1966
Mangan	0.078	mg/l	0.5	SNI 06-6855-2002
Fluoride	<0.001	mg/l	1.5	SNI 06-6989.29-2005
Nitrate (NO3-N)	4.454	mg/l	10	APHA 2017. Section 4500-NO3 B
Nitrite (NO2-N)	0.006	mg/l	1,0	SNI 06-6989.9-2004
Total Hardness	1127.84*	mg/l	500	SNI 06-6989.12-2004
Chloride	108.35	mg/l	600	SNI 6989.19-2009
Flavor	Tastes salty	-	Tasteless	Organoleptic
Turbidity	13.5*	NTU	5	SNI 06-6989.25-2005
Temperature	23,3	°C	Air temperature ±3 °C	SNI 06-6989.23-2005
Color	30*	TCU	15	Photometry

The test results on distillate water showed that almost all of the parameters met the requirements for mineral water (Table 6). Hardness that has not yet reached the quality standard caused by the presence of carbonate ions can be overcome by increasing the potential of hydrogen (pH) through the conversion of bicarbonate ions to carbonate which has a neutral pH (+7). Chemical compounds that can be added to overcome problems with the hardness parameter are Na_2CO_3 or K_2CO_3 [21]–[23].

Table 6. Mineral water content test results

Parameter	Results	Unit	Quality standards	Method
Smell	-	-	-	Organoleptic
Flavor	Tasteless	-	Tasteless	Organoleptic
Color	0	TCU	15	Photometry
Turbidity	1.13	NTU	5	SNI 06-6989.25-2005
Temperature	23.4	°C	Air temperature ±3 °C	SNI 06-6989.23-2005
Iron	<0,009	mg/l	0.3	SNI 06-4138-1996
Fluoride	<0.001	mg/l	1.5	SNI 06-6989.29-2005
Total Hardness	86.92	mg/l	500	SNI 06-6989.12-2004
Chloride	12.31	mg/l	250	SNI 6989.19-2009
Mangan	0.021	mg/l	0.4	SNI 06-6855-2002
Nitrate (NO3-)	7.095	mg/l	50	APHA 2017. Section 4500-NO3 B
Nitrite (NO2-)	<0,006	mg/l	30	SNI 06-6989.9-2004
pH	6.8	-	6.8-8.5	Potentiometry

3.3. Comparison of levels of iodine salt and distillate salt

The results of the research from the desalination process, it was found that the salt was left behind in the presto during the separation process. The data for iodized salt in Table 7 is obtained from the salt that is commonly produced and consumed by the public. Based on Table 7 it is known that the yield of distillate salt has a content of 84.89%, so it is recommended to add iodine to produce iodized salt. Adding iodine to salt is effective in meeting the needs of iodine in the human body [24], [25]. The desalination process has a significant effect, but there are still drawbacks, namely hardness, turbidity, and color which are higher than the quality standards, and the purity of the salt produced is still low. High hardness is caused by the presence of bicarbonate ions which can be overcome by increasing the pH through the conversion of bicarbonate ions to carbonate which has a neutral pH (+7). In addition, chemical compounds can also be added to overcome problems in the hardness parameter, namely Na^2CO_3 or K_2CO_3. The turbidity and color values in distilled water that have not reached quality standards can be overcome by advanced processes such as using membrane filtration and adsorbents.

Table 7. Salt content test results

Parameter	Unit	Result	Method specifications
Iodine salt	%	98.94	Titrimetry
Distillate salt	%	84.89	Titrimetry

4. CONCLUSION

We provide solutions for handling the volume of municipal waste by utilizing the burning of the waste to distill sea water. Waste that is obtained free of charge and used for the sea water desalination process provides many benefits such as producing fresh and salt water that the community needs. The salt obtained can be further processed into food salt or pharmaceutical salt. Apart from that, sea water desalination efforts can be a solution to the reduced availability of groundwater. According to our research, clothing material is the type of waste with the fastest time to evaporate 1 liter of sea water (43.75 minutes). The result of the distillate salt has a content of 84.89%. Further research is needed to improve the purity of the salt obtained and the addition of iodine to obtain the iodized salt needed by the community. Another thing is handling combustion smoke so that air pollution due to smoke can be minimized as much as possible

ACKNOWLEDGEMENTS

We express our deepest gratitude to LPPM UAD for funding this seawater desalination research. We also thank you for the contribution of Chemical Engineering students from Ahmad Dahlan University in this research.

REFERENCES

[1] A. Kaur, R. Bharti, and R. Sharma, "Municipal solid waste as a source of energy," *Materials Today: Proceedings*, vol. 81, pp. 904–915, 2023, doi: 10.1016/j.matpr.2021.04.286.
[2] S. Kaza, S. Shrikanth, and S. Chaudhary, *More growth, less garbage*. World Bank, 2021. doi: 10.1596/35998.
[3] M. Rezaei, B. Ghobadian, S. H. Samadi, and S. Karimi, "Electric power generation from municipal solid waste: a techno-economical assessment under different scenarios in Iran," *Energy*, vol. 152, pp. 46–56, Jun. 2018, doi: 10.1016/j.energy.2017.10.109.
[4] Presidential Regulation, *National and Regional Policy and Strategy for the management of household and household-like waste*

(JAKSTRANAS). no. 97, Indonesia, 2017. [Online]. Available: https://faolex.fao.org/docs/pdf/INS210536.pdf

[5] Z. J. Yong, M. J. K. Bashir, C. A. Ng, S. Sethupathi, J. W. Lim, and P. L. Show, "Sustainable waste-to-energy development in Malaysia: appraisal of environmental, financial, and public issues related with energy recovery from municipal solid waste," *Processes*, vol. 7, no. 10, p. 676, Oct. 2019, doi: 10.3390/pr7100676.

[6] F. E. Ahmed, A. Khalil, and N. Hilal, "Emerging desalination technologies: current status, challenges and future trends," *Desalination*, vol. 517, p. 115183, Dec. 2021, doi: 10.1016/j.desal.2021.115183.

[7] E. J. Okampo and N. Nwulu, "Optimisation of renewable energy powered reverse osmosis desalination systems: a state-of-the-art review," *Renewable and Sustainable Energy Reviews*, vol. 140, p. 110712, Apr. 2021, doi: 10.1016/j.rser.2021.110712.

[8] H. Zhang and X. Xie, "Evaluating the seawater desalination potential of an air-seawater system: through thermodynamic analysis and simulation of an indirect evaporative cooling desalination system," *Applied Thermal Engineering*, vol. 238, p. 121950, Feb. 2024, doi: 10.1016/j.applthermaleng.2023.121950.

[9] F. E. Ahmed, R. Hashaikeh, and N. Hilal, "Hybrid technologies: The future of energy efficient desalination – a review," *Desalination*, vol. 495, p. 114659, Dec. 2020, doi: 10.1016/j.desal.2020.114659.

[10] A. A. Monjezi *et al.*, "Development of an off-grid solar energy powered reverse osmosis desalination system for continuous production of freshwater with integrated photovoltaic thermal (PVT) cooling," *Desalination*, vol. 495, p. 114679, Dec. 2020, doi: 10.1016/j.desal.2020.114679.

[11] R. H. Hailemariam, Y. C. Woo, M. M. Damtie, B. C. Kim, K.-D. Park, and J.-S. Choi, "Reverse osmosis membrane fabrication and modification technologies and future trends: A review," *Advances in Colloid and Interface Science*, vol. 276, p. 102100, Feb. 2020, doi: 10.1016/j.cis.2019.102100.

[12] O. M. A. Al-hotmani, M. A. Al-Obaidi, G. Filippini, F. Manenti, R. Patel, and I. M. Mujtaba, "Optimisation of multi effect distillation based desalination system for minimum production cost for freshwater via repetitive simulation," *Computers & Chemical Engineering*, vol. 135, p. 106710, Apr. 2020, doi: 10.1016/j.compchemeng.2019.106710.

[13] A. Mollahosseini, A. Abdelrasoul, S. Sheibany, M. Amini, and S. K. Salestan, "Renewable energy-driven desalination opportunities – a case study," *Journal of Environmental Management*, vol. 239, pp. 187–197, Jun. 2019, doi: 10.1016/j.jenvman.2019.03.044.

[14] M. Ahmed, R. Kumar, B. Garudachari, and J. P. Thomas, "Performance evaluation of a thermoresponsive polyelectrolyte draw solution in a pilot scale forward osmosis seawater desalination system," *Desalination*, vol. 452, pp. 132–140, Feb. 2019, doi: 10.1016/j.desal.2018.11.013.

[15] D. Zarzo and D. Prats, "Desalination and energy consumption. What can we expect in the near future?," *Desalination*, vol. 427, pp. 1–9, Feb. 2018, doi: 10.1016/j.desal.2017.10.046.

[16] N. Emamdoost, A. Jafarian, and R. Kouhikamali, "Implementing multiple-effect distillation and reverse osmosis thermal coupling to improve desalination process performance in combined water and power plants," *Energy Conversion and Management*, vol. 221, p. 113176, Oct. 2020, doi: 10.1016/j.enconman.2020.113176.

[17] E. Ali *et al.*, "Cost analysis of multiple effect evaporation and membrane distillation hybrid desalination system," *Desalination*, vol. 517, p. 115258, Dec. 2021, doi: 10.1016/j.desal.2021.115258.

[18] S. K. Tulashie *et al.*, "Recycling of plastic wastes into alternative fuels towards a circular economy in Ghana," *Cleaner Chemical Engineering*, vol. 4, p. 100064, Dec. 2022, doi: 10.1016/j.clce.2022.100064.

[19] A. Ratnasari, A. Syafiuddin, M. A. Mehmood, and R. Boopathy, "A review of the vermicomposting process of organic and inorganic waste in soils: Additives effects, bioconversion process, and recommendations," *Bioresource Technology Reports*, vol. 21, p. 101332, Feb. 2023, doi: 10.1016/j.biteb.2023.101332.

[20] Y. Wang *et al.*, "Investigating impact of waste reuse on the sustainability of municipal solid waste (MSW) incineration industry using emergy approach: a case study from Sichuan province, China," *Waste Management*, vol. 77, pp. 252–267, Jul. 2018, doi: 10.1016/j.wasman.2018.04.003.

[21] E. Chibowski, L. Hołysz, A. Szcześ, and M. Chibowski, "Precipitation of calcium carbonate from magnetically treated sodium carbonate solution," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, vol. 225, no. 1–3, pp. 63–73, Sep. 2003, doi: 10.1016/S0927-7757(03)00133-X.

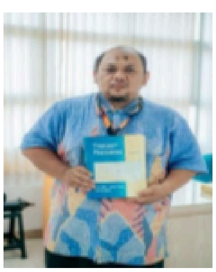
[22] N. I. Prakoso, N. V. Nugroho, and D. Rubiyanto, "Comparative study of the effectiveness of Na2CO3 and K2CO3 as base in methylation reaction on eugenol using dimethylcarbonate," in *3rd International Seminar on Chemical Education: Trends, Applications, Changes in Chemical Education for the 4.0 Industrial Revolution*, 2020, p. 030001. doi: 10.1063/5.0002543.

[23] X. Liu, J. Gan, S. Nirasawa, E. Tatsumi, L. Yin, and Y. Cheng, "Effects of sodium carbonate and potassium carbonate on colloidal properties and molecular characteristics of konjac glucomannan hydrogels," *International Journal of Biological Macromolecules*, vol. 117, pp. 863–869, Oct. 2018, doi: 10.1016/j.ijbiomac.2018.05.176.

[24] H. L. Johannesen, S. Andersen, P. Weihe, M. S. Petersen, M. Strøm, and A. S. Veyhe, "The iodine content of Faroese food items to support iodine nutrition in the North Atlantic," *International Journal of Circumpolar Health*, vol. 82, no. 1, Dec. 2023, doi: 10.1080/22423982.2023.2233145.

[25] M. N. Wu *et al.*, "Association between iodized salt intake and cognitive function in older adults in China," *The journal of nutrition, health & aging*, vol. 27, no. 11, pp. 1005–1011, Oct. 2023, doi: 10.1007/s12603-023-1997-7.

BIOGRAPHIES OF AUTHORS



Adi Permadi is currently a lecturer and researcher with a master's degree in Chemical Engineering from Universitas Ahmad Dahlan (UAD) since 2020. His research interests include nanomaterials, food, and pharmaceutical technology. He received a bachelor's degree in chemical engineering from Universitas Gadjah Mada (UGM), in 2007, then a master's degree in chemical engineering from Institut Teknologi Bandung (ITB), in 2010, and a doctor of chemical engineering (Ph.D.) from National Taiwan University of Science and Technology (NTUST), in 2017. During his career as a lecturer, he also received a master's degree in Pharmacy from Universitas Ahmad Dahlan and a professional engineering degree (Ir) from Universitas Muslim Indonesia (UMI). He can be contacted at email: adi.permadi@che.uad.ac.id.

Arief Syamsuddin graduated with a bachelor's degree in mechanical engineering vocational education (2009-2012) and a master's degree in management education from Universitas Negeri Yogyakarta (2013-2018). Now he is a lecturer in automotive engineering vocational education at Universitas Ahmad Dahlan. He can be contacted at email: arief.syamsuddin@pvto.uad.ac.id.

Trianik Widyaningrum is currently a lecturer and researcher with a bachelor's degree in Biology Education at Universitas Ahmad Dahlan (UAD) since 1997. Her research interests include the microbiology industry and bioethanol production. She received a bachelor's degree in Biology Faculty from Universitas Gadjah Mada (UGM), in 1994, then a master's degree in Biology Faculty from Universitas Gadjah Mada (UGM), in 2001, and a doctor of biology from Universitas Brawijaya (UB), in 2021. She can be contacted at email: trianik.widyaningrum@pbio.uad.ac.id.

Ibdal Satar has been active as a lecturer and researcher in the Department of Food Technology, Faculty of Industrial Technology Universitas Ahmad Dahlan (UAD) Yogyakarta. He received a Ph.D. degree in fuel cell engineering, from Universiti Kebangsaan Malaysia. During his Ph.D. journey, he received a scholarship and a research grant from UKM via the CRIM research center. His expertise is related to biodiesel production, biohydrogen generation from organic waste, food waste treatment, and food technology. He has some papers that have been published in the indexed national and international journals. Currently, He received a research grant from the Indonesian Government through the HIBAH DIKTI and he made a research group that conducted the waste to energy and waste to product. He can be contacted at email: ibdal@tp.uad.ac.id.

Totok Eka Suharto is currently an associate professor in the Department of Chemical Engineering, Faculty of Industrial Technology, Universitas Ahmad Dahlan (UAD) Yogyakarta. His research interests include heterogeneous catalysis, nanomaterials, bioenergy, and environmental chemistry. He received a bachelor's degree in chemistry from Universitas Negeri Yogyakarta (UNY) in 1984, then a master's degree in chemistry from Universitas Gadjah Mada (UGM) in 1989, and a doctor rerum naturalium (Dr.rer.nat.) in chemistry from Johannes Gutenberg University Mainz Germany in 1997. He can be contacted at email: totok.suharto@che.uad.ac.id.

Joko Pitoyo graduated with a bachelor's degree in chemical engineering from Universitas Gadjah Mada (2004-2009) and a master's degree in chemical engineering from Universitas Ahmad Dahlan Yogyakarta (2021-2023). His research research includes renewable energy, pyrolysis, and optimization. He can be contacted at email: jokopitoyo85@gmail.com.