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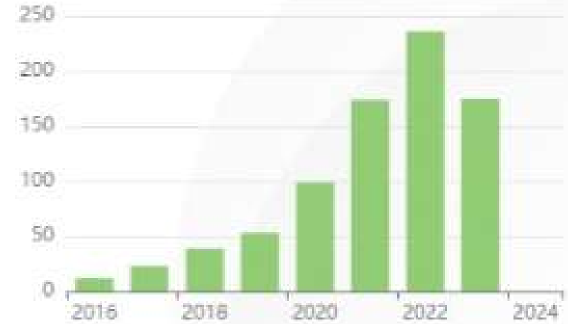

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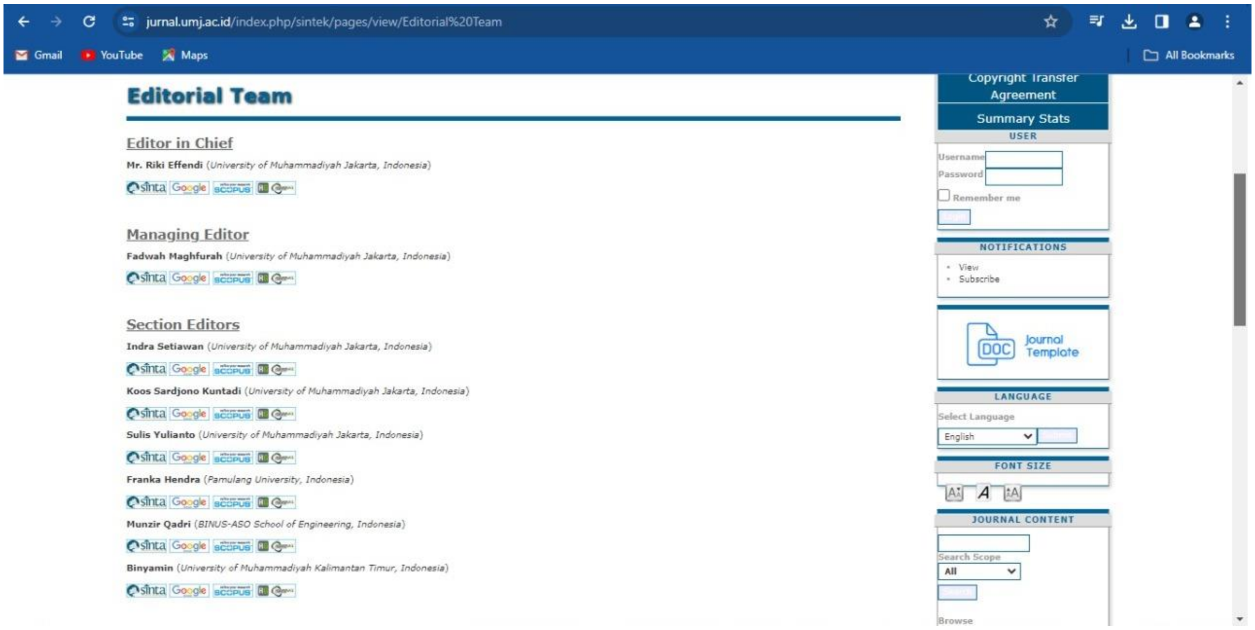

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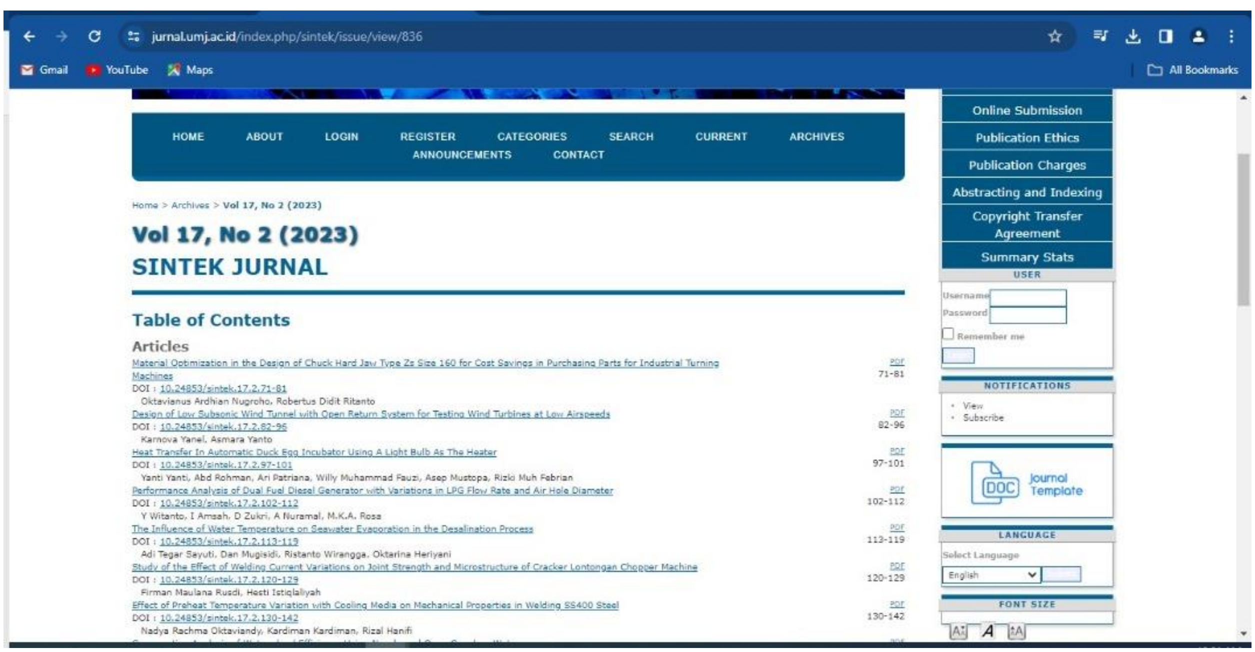

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THE INFLUENCE OF WATER TEMPERATURE ON SEAWATER EVAPORATION IN THE DESALINATION PROCESS

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ABSTRAK

Peningkatan populasi di suatu daerah berdampak pada meningkatnya permintaan akan air bersih. Meskipun air melimpah, sekitar 97% air di Bumi berupa air laut yang tidak dapat dikonsumsi secara langsung karena mengandung zat berbahaya. Proses desalinasi digunakan untuk mengubah air laut menjadi air minum dengan memanfaatkan panas dan kecepatan angin. Penelitian ini mengeksplorasi suhu 30℃, 45℃, 60℃, dan 70℃ dengan kecepatan angin sebesar 2,6 m/s. Pengumpulan data dilakukan untuk setiap variasi suhu selama 2 jam dengan catatan setiap 15 menit, bertujuan untuk mengevaluasi efektivitas evaporasi dan kondensasi dalam proses desalinasi. Hasil penelitian menunjukkan bahwa suhu 70℃ menghasilkan penguapan tertinggi (800 gram), meskipun dengan tingkat kondensasi sebesar 26,25%. Pengukuran kondensat menunjukkan pH sebesar 7,2 dan pembacaan meter TDS berkisar antara 125 hingga 138 ppm.

Kata kunci: *desalinasi; konversi air laut; efektivitas penguapan; laju kondensasi.*

ABSTRACT

Population An increase in population in an area results in an increased demand for clean water. Although water is abundant, about 97% of the water on Earth is seawater, which cannot be consumed directly because it contains harmful substances. Desalination process is used to convert seawater into drinking water by utilizing heat and wind speed. This research explores temperatures of 30℃, 45℃, 60℃, and 70℃ with a wind speed of 2.6 m/s. Data was collected for each temperature variation for 2 hours with records every 15 minutes, aiming to evaluate the effectiveness of evaporation and condensation in the desalination process. The results showed that 70℃ resulted in the highest evaporation (800 grams), although with a condensation rate of 26.25%. Condensate measurements showed a pH of 7.2 and TDS meter readings ranged from 125 to 138 ppm.

Keywords*: desalination; seawater conversion; evaporation effectiveness; condensation rate.*

1. PENDAHULUAN

Pertumbuhan penduduk di suatu daerah [1-3] menyebabkan kebutuhan air juga bertambah. Ketersediaan air bersih terbatas [4-6] tetapi sangat penting untuk menopang kehidupan yang layak bagi manusia ataupun makhluk hidup lainnya [7] karena air merupakan sumber [8] atau elemen penting [9] bagi kehidupan makhluk di muka bumi termasuk di dalamnya manusia. Banyak sekali kegiatan manusia [10] yang menjadikan air sebagai sumber utama seperti minum, mencuci, memasak dan kegiatan-kegiatan lainnya. Air kerap kali mudah untuk ditemukan dikarenakan sumber air tersebut dapat diperoleh dari tanah, mata air, air sungai, danau dan air laut. Namun tidak semua air dapat dikonsumsi dikarenakan ada beberapa kandungan zat-zat berbahaya [11,12] yang ada di dalam air tersebut Selain itu 97% air di muka bumi[13,14] merupakan air laut yang tidak dapat digunakan oleh manusia secara langsung. Terbatasnya air yang tersedia mendorong banyaknya penelitian untuk mengubah air laut menjadi air tawar [15,16] dengan cara proses distilasi [17-26]. Proses destilasi ini mengubah air laut menjadi air tawar dengan menggunakan panas dengan menggunakan tenaga matahari [27-39] sehingga air menjadi layak dikonsumsi [40].

Mengkonsumsi air bersih yang berasal dari air laut sudah dilakukan di pesisir pantai [41] dan beberapa peneliti juga sudah menguji hasil destilasi air laut [42]. Karena panas yang dihasilkan matahari tidak dapat dikendalikan beberapa peneliti lain menggunakan pemanas [43-46]. Panas akan meningkatkan temperatur air yang juga meningkatkan tekanannya sampai akhirnya terjadi penguapan. Penguapan pada dasarnya terjadi karena adanya perbedaan tekanan antara permukaan air dengan ruang di atasnya [47] sehingga aliran udara yang bergerak di atas air juga akan mempengaruhi laju penguapan, meskipun dengan temperatur yang tetap [48].

Sejauh ini belum ada penelitian yang menggunakan variasi temperatur dengan kecepatan angin tertentu dan mengukur penguapannya. Oleh karena itu penelitian ini bertujuan menentukan pengaruh temperatur terhadap efektivitas pengolahan air laut menjadi air tawar dengan kecepatan angin yang tetap.

2. METODE PENELITIAN

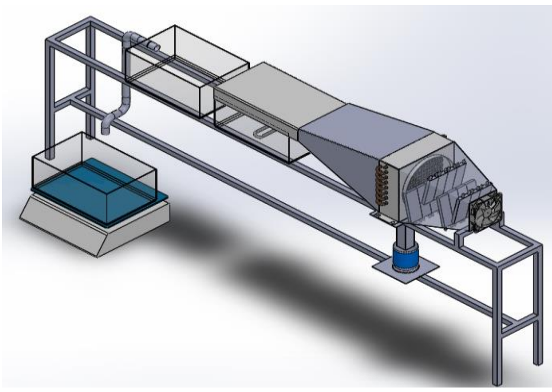
Jenis penelitian ini merupakan penelitian eksperimental menggunakan prototipe destilasi air laut [49]. Pada penelitian ini air laut dinaikkan temperaturnya menggunakan pemanas dengan kecepatan angin 2.6 m/s. Temperatur yang digunakan ialah 30℃, 45℃, 60℃, 70℃.

Data diambil setiap per-15 menit selama jangka waktu 2 jam untuk setiap variasi suhu yang digunakan. Panas yang dihasilkan berasal dari elemen heater yang dikendalikan temperaturnya dengan menggunakan pengontrol temperatur. Aliran angin dihasilkan oleh kipas yang menarik uap air hasil penguapan di ruang penguapan. Untuk mengukur tingkat kelembaban udara, temperatur dan kecepatan angin maka digunakan alat alat pada tabel 1.

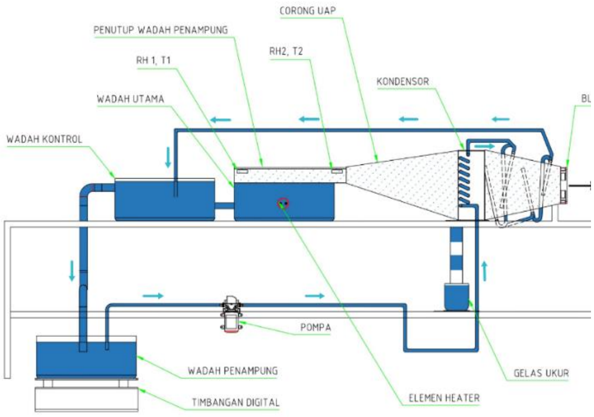
Tabel 1. Alat Penelitian

No	Alat	Spesifikasi
1	Thermostat XH-W3001	Rentang -50℃ - 110℃, 0.1℃
2	Anemometer GM816	Rentang 0 – 30 m/s, 0,1 m/s,
3	Thermometer digital	Rentang -50℃ - 110℃, ±0.1℃
4	Hygrometer digital	Range 10% - 99%, ±1%
5	Timbangan digital 40 kg	Beban maksimum 40 kg, resolusi 0.005 kg
6	Timbangan digital 5 kg	Beban maksimum 5 kg, resolusi 1 gr

Penelitian ini menggunakan alat seperti yang ditampilkan pada gambar 1 dan Skema yang ditampilkan pada gambar 2**.** Penelitian dilaksanakan di Laboratorium Konversi Energi, Fakultas Teknologi Industri dan Informatika Universitas Muhammadiyah Prof. Dr Hamka, Jakarta.



Gambar 1. Desain Alat Destilasi



Gambar 2. Skema Alat Destilasi

Penelitian dilakukan dengan mengalirkan air laut dari wadah penampung seperti ditampilkan pada gambar 3. Air laut dialirkan menuju wadah utama melalui kondensor dan dipanaskan menggunakan heater yang diatur dengan thermostat dengan 4 variasi suhu yaitu; 30^{o}C, 45^{o}C, 60^{o}C dan 70^{o}C dengan kecepatan angin tetap 2,6 m/s.

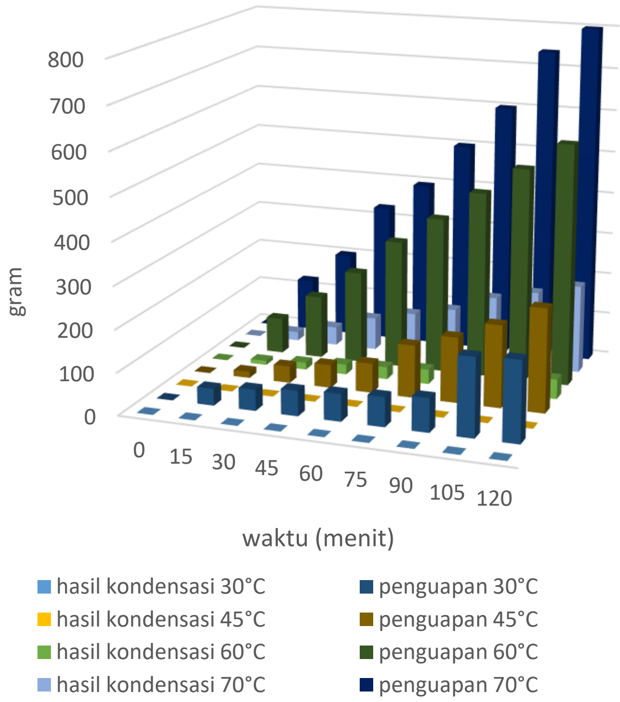
Gambar 3. Alat Destilasi

Berdasarkan hasil uji coba, peralatan yang digunakan bekerja dengan baik termasuk juga pemeriksaan kebocoran dan retak pada sambungan.

3. HASIL DAN PEMBAHASAN

Untuk mempermudah melakukan analisa maka data hasil pengujian dan perhitungan digambarkan dalam bentuk grafik [50]. Pengumpulan data dilakukan dengan variasi temperatur heater 30^{o}C, 45^{o}C, 60^{o}C dan 70^{o}C. Lalu, waktu pengambilan data ini diambil per-15 menit sekali selama dalam kurun waktu 2 jam tiap varian suhu panas yang dihasilkan oleh heater.

Sensor kelembaban dan temperatur digunakan untuk mengetahui temperatur dan kandungan uap air di udara yang terjadi karena proses penguapan [51]. Hasil pengujian ditampilkan menggunakan grafik pada Gambar 4.



Gambar 4. Grafik Penguapan dan Kondensasi pada variasi suhu yang diujikan

Dari gambar 4 terlihat terjadinya kondensasi dipengaruhi oleh energi panas [52,53] yang dihasilkan oleh heater untuk membuat air laut menguap. Berdasarkan hasil pengukuran menggunakan timbangan bahwa penguapan terjadi mulai dari temperatur 30^{o}C hingga temperatur yang tertinggi 70^{o}C. Meskipun semua variasi temperatur yang diujikan terjadi proses penguapan, hanya beberapa dari variasi temperatur yang diujikan menghasilkan kondensasi. Panas yang dikandung oleh uap air dilepaskan pada dinding kondensor [54]. Meskipun demikian energi panas yang dibawa oleh uap air tidak seluruhnya dapat dilepaskan di kondensor karena adanya aliran udara. Kondensasi total yang terjadi hanya 8,25% dari penguapannya untuk temperatur 60^{o}C dan 26,25% pada temperatur 70^{o}C. Hasil tersebut menunjukkan bahwa sebagian besar uap air yang dihasilkan tidak berhasil dikondensasikan oleh kondensor yang digunakan karena penampang kondensor yang cukup luas memungkinkan uap air tidak bersentuhan dengan dinding sehingga temperatur uap tidak turun di bawah temperatur embunnya. Oleh karena itu desain kondenser perlu diperbaiki dan ditingkatkan performanya.

Selama 2 jam eksperimen dilakukan pada berbagai suhu (30°C, 45°C, 60°C, dan 70°C), semuanya menghasilkan penguapan. Namun, hanya suhu 60°C dan 70°C yang mengalami kondensasi, hasilnya ditunjukkan pada tabel 2.

Tabel 2. Hasil dari Tekanan Air dan Tekanan Udara di atas Air

Air		Udara	
Temperatur °C	Tekanan (p_a)	Temperatur °C	Tekanan (p_a)
30°C	22,67	30°C	4241,52
45°C	24,85	45°C	4813,44
60°C	26,83	60°C	5796,56
70°C	28,05	70°C	6544,78

Pengujian kandungan [55] pada air laut dan hasil kondensasi perlu dilakukan untuk mengetahui isi dari kandungan air laut [56] sebelum mengalami proses desalinasi dan setelahnya. Dari hasil pengukuran pH meter dan TDS meter diketahui air laut sendiri memiliki nilai pH 8 dan TDS meter 30320 PPM, sedangkan pada pengukuran sampel lainnya terkait pH dan nilai TDS meter ialah pada sampel 1 didapati pH 7.2/ TDS meter 125 PPM, sampel 2 didapati pH 7.2/ TDS meter 138 PPM. Dari hasil pengukuran pH meter dan TDS meter di atas menunjukkan bahwa sampel 1 dan sampel 2 dapat dikatakan sebagai air yang memenuhi syarat air bersih.

4. KESIMPULAN

Hasil eksperimen menyatakan selama 2 jam hasil pengujian di tiap variasi temperatur 30^{o}C, 45^{o}C, 60^{o}C, dan 70^{o}C semua menghasilkan penguapan. Tetapi hanya temperatur 60^{o}C dan 70^{o}C sajalah yang menghasilkan kondensasi. Berdasarkan tujuan penelitian ini yaitu mengetahui tingkat keefektifitan untuk menghasilkan penguapan dan kondensasi, dapat dipastikan temperatur 70^{o}C menjadi temperatur yang paling efektif dalam menghasilkan penguapan dan kondensasi.

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DAFTAR PUSTAKA

[1] A. Sakka, R. Musa, and H. Ashad, "Kajian Ketersediaan Air pada Daerah Irigasi Palakka Kabupaten Bone Provinsi Sulawesi Selatan," Jurnal Konstruksi: Teknik, Infrastruktur dan Sains, vol. 01, no. 05, pp. 29–39, 2022.

[2] A. Liponi, C. Wieland, and A. Baccioli, "Multi-effect distillation plants for small-scale seawater desalination: thermodynamic and economic improvement," *Energy Convers Manag*, vol. 205, no. September 2019, p. 112337, 2020, doi: 10.1016/j.enconman.2019.112337.

[3] C. Kenigsberg, S. Abramovich, and O. Hyams-Kaphzan, "The effect of long-term brine discharge from desalination plants on benthic foraminifera," *PLoS One*, vol. 15, no. 1, pp. 1–20, 2020, doi: 10.1371/journal.pone.0227589.

[4] V. Noperissa and R. S. B. Waspodo, "Analisis Kebutuhan dan Ketersediaan Air Domestik Menggunakan Metode Regresi di Kota Bogor," *Jurnal Teknik Sipil dan Lingkungan*, vol. 3, no. 3, pp. 121–132, 2018, doi: 10.29244/jsil.3.3.121-132.

[5] S. Lin *et al.*, "Seawater desalination technology and engineering in China: A review," *Desalination*, vol. 498, no. May 2020, p. 114728, 2021, doi: 10.1016/j.desal.2020.114728.

[6] A. Amirfakhraei, T. Zarei, and J. Khorshidi, "Performance improvement of adsorption desalination system by applying mass and heat recovery processes," *Thermal Science and*

Engineering Progress, vol. 18, p. 100516, 2020, doi: 10.1016/j.tsep.2020.100516.
[7] D. Mugisidi and O. Heriyani, "Study of Utilization under Sea-water Hydrostatic Pressure as Hydro Power Generation," *E3S Web of Conferences*, vol. 73, pp. 2–4, 2018, doi: 10.1051/e3sconf/20187301020.
[8] W. Bunganaen, N. S. Karbeka, and E. E. Hangge, "Analisis Ketersediaan Air Terhadap Pola Tanam dan Luas Areal Irigasi Daerah Irigasi Siafu," *Jurnal Teknik Sipil*, vol. IX, no. 1, pp. 15–26, 2020.
[9] M. Z. Lubis *et al.*, "Pemberian Mini House (Destilator) Air laut kepada masyarakat Pantai Setokok, Batam, Guna membantu dalam penyediaan stok air bersih (Air Tawar), dan mendukung Parawisata," *Jurnal Pengabdian kepada Masyarakat Politeknik Negeri Batam*, vol. 2, no. 2, pp. 112–120, 2021, doi: 10.30871/abdimaspolibatam.v2i2.2601.
[10] F. Saputra, "Analisis Ketersediaan Air Irigasi Untuk Pertanian Padi di Kecamtan Padang Ganting Kabupaten Tanah Datar," *JURNAL BUANA*, vol. 2, no. 2, p. 584, 2018, doi: 10.24036/student.v2i2.113.
[11] S. Stein *et al.*, "The effects of long-term saline groundwater pumping for desalination on the fresh–saline water interface: Field observations and numerical modeling," *Science of the Total Environment*, vol. 732, p. 139249, 2020, doi: 10.1016/j.scitotenv.2020.139249.
[12] T. E. Storage, "Pengembangan Alat Desalinasi Air Laut dengan Teknologi Thermal Energy Storage Development of Seawater Desalination Equipment with Technology," vol. 5, pp. 171–178, 2023.
[13] Y. Januardi, M. Rosi, and I. P. Handayani, "Sistem Desalinasi Air Laut Menggunakan Prinsip Capacitive Deionization (Cdi) Berbasis Karbon Aktif Sea Water Desalination System Using Carbon Based Capacitive Deoinization (Cdi)," *e-Proceeding of Engineering*, vol. 3, no. 2, pp. 2047–2053, 2016.
[14] M. M. Armendáriz-Ontiveros *et al.*, "Effect of Temperature on Energy Consumption and Polarization in Reverse Osmosis Desalination Using a Spray-Cooled Photovoltaic System," *Energies (Basel)*, vol. 15, no. 20, 2022, doi: 10.3390/en15207787.
[15] Z. Xu, X. Yan, Z. Du, J. Li, and F. Cheng, "Effect of oxygenic groups on desalination performance improvement of graphene oxide-based membrane in membrane distillation," *Sep Purif Technol*, vol. 251, no. June, p. 117304, 2020, doi: 10.1016/j.seppur.2020.117304.
[16] A. Pratama and F. Rahmadianto, "Analisa Perancangan Desalinasi Air Laut Dengan Variasi Filter Tempurung Kelapa Dan Variasi Temperatur Pemanasan," *Jurnal Flywheel*, vol. 12, no. 2, pp. 21–29, 2021, doi: 10.36040/flywheel.v12i2.4279.
[17] D. Mugisidi, B. Fajar, T. Utomo, and Syaiful, "The Effect of Water Surface Level in sensible heat material on Yield of Single Basin Solar Still: Experimental Study," *J Phys Conf Ser*, vol. 1373, no. 1, 2019, doi: 10.1088/1742-6596/1373/1/012014.
[18] D. Mugisidi, A. Rahman, O. Heriyani, and P. H. Gunawan, "Determination of the convective heat transfer constant (c and n) in a solar still," *Jurnal Teknosains*, vol. 11, no. 1, p. 1, 2021, doi: 10.22146/teknosains.50908.
[19] D. Mugisidi *et al.*, "Iron sand as a heat absorber to enhance performance of a single-basin solar still," *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, vol. 70, no. 1, pp. 125–135, 2020, doi: 10.37934/ARFMTS.70.1.125135.
[20] T. Arunkumar and A. E. Kabeel, "Effect of phase change material on concentric circular tubular solar still-Integration meets enhancement," *Desalination*, vol. 414, pp. 46–50, 2017, doi: 10.1016/j.desal.2017.03.035.
[21] M. Feilizadeh, M. R. Karimi Estahbanati, A. Ahsan, K. Jafarpur, and A. Mersaghian, "Effects of water and basin depths in single basin solar stills: An experimental and theoretical study," *Energy Convers Manag*, vol. 122, pp. 174–181, 2016, doi: 10.1016/j.enconman.2016.05.048.
[22] A. Awasthi, K. Kumari, H. Panchal, and R. Sathyamurthy, "Passive solar still: recent advancements in design and related performance," *Environmental Technology Reviews*, vol. 7, no. 1, pp. 235–261, 2018, doi: 10.1080/21622515.2018.1499364.
[23] Z. M. Omara and A. E. Kabeel, "The performance of different sand beds solar stills," *Int J Green Energy*, vol. 11, no. 3, pp. 240–254, 2014, doi: 10.1080/15435075.2013.769881.
[24] D. Mugisidi, R. S. Cahyani, O. Heriyani, D. Agusman, and Rifky, "Effect of Iron Sand in Single Basin Solar Still: Experimental Study," *IOP Conf Ser Earth Environ Sci*, vol. 268, no. 1, 2019, doi: 10.1088/1755-1315/268/1/012158.
[25] C. P. Koutsou, E. Kritikos, A. J. Karabelas, and M. Kostoglou, "Analysis of temperature effects on the specific energy consumption in reverse osmosis desalination processes," *Desalination*, vol. 476, no. October 2019, p. 114213, 2020, doi: 10.1016/j.desal.2019.114213.

[26] H. Rostamzadeh, H. Ghiasirad, M. Amidpour, and Y. Amidpour, "Performance enhancement of a conventional multi-effect desalination (MED) system by heat pump cycles," *Desalination*, vol. 477, no. November 2019, p. 114261, 2020, doi: 10.1016/j.desal.2019.114261.

[27] A. Mukaddim, M. Wirawan, and I. B. Alit, "Analisa Pengaruh Variasi Bentuk Absorber Pada Alat Destilasi Air Laut Terhadap Kenaikan Suhu Air Dalam Ruang Pemanas Dan Jumlah Penguapan Air Yang Dihasilkan," *Dinamika Teknik Mesin*, vol. 3, no. 2, pp. 127–135, 2013, doi: 10.29303/d.v3i2.79.

[28] M. Mulyanef, B. Burmawi, and K. Muslimin, "Pengolahan Air Laut Menjadi Air Bersih Dan Garam Dengan Destilasi Tenaga Surya," *Jurnal Teknik Mesin ISSN …*, vol. 4, no. 1, pp. 25–29, 2015.

[29] R. Adhitya Putra, G. Ahmad Pauzi, and A. Surtono, "Rancang Bangun Alat Destilasi Air Laut dengan Metode Ketinggian Permukaan Air Selalu Sama Menggunakan Energi Matahari," *Jurnal Teori dan Aplikasi Fisika*, vol. 06, no. 01, pp. 101–107, 2018.

[30] H. Haryadi, I. Rosyadi, and N. K. Caturwati, "Rancang Bangun Alat Destilasi Air Laut Menjadi Air Tawar Menggunakan Tenaga Surya," *Teknika: Jurnal Sains dan Teknologi*, vol. 12, no. 2, p. 431, 2016, doi: 10.36055/tjst.v12i2.6608.

[31] D. Purwadianto and F. A. R. Sambada, "Unjuk Kerja Destilasi Air Energi Surya Menggunakan Kondenser Pasif," *Jurnal Penelitian*, vol. 5, no. 1, pp. 34–41, 2013.

[32] G. Djoyowasito, A. M. Ahmad, M. Lutfi, and A. Anggra, "Rancang Bangun Model Penghasil Air Tawar dan Garam dari Air Laut Berbasis Efek Rumah Kaca Tipe Penutup Limas," *Jurnal Keteknikan Pertanian Tropis dan Biosistem*, vol. 6, no. 2, pp. 107–119, 2018.

[33] Mulyanef, Sari M, Mario W, and Nasution H, "Kaji Eksperimental Untuk Meningkatkan Performasi Destilasi Surya Basin Tiga Tingkat Menggunakan Beberapa Bahan Penyimpan Panas," *Jurnal Teknik Mesin*, vol. 2, no. 1, pp. 7–12, 2012.

[34] S. A. Kalogirou, "Seawater desalination using renewable energy sources," *Prog Energy Combust Sci*, vol. 31, no. 3, pp. 242–281, 2005, doi: 10.1016/j.pecs.2005.03.001.

[35] S. Al-Kharabsheh and D. Y. Goswami, "Theoretical analysis of a water desalination system using low grade solar heat," *Journal of Solar Energy Engineering, Transactions of the ASME*, vol. 126, no. 2, pp. 774–780, 2004, doi: 10.1115/1.1669450.

[36] G. N. Tiwari and L. Sahota, "Review on the energy and economic efficiencies of passive and active solar distillation systems," *Desalination*, vol. 401, pp. 151–179, 2017, doi: 10.1016/j.desal.2016.08.023.

[37] M. R. Qtaishat *et al.*, "Desalination at ambient temperature and pressure by a novel class of biporous anisotropic membrane," *Sci Rep*, vol. 12, no. 1, pp. 1–8, 2022, doi: 10.1038/s41598-022-17876-8.

[38] A. R. F. Gani, N. A. Putri, S. S. Habibi, and ..., "Desalinasi Dengan Metode Evaporasi Sebagai Penyedia Air Bersih Di Desa Kurandak," *Jurnal Pasopati …*, vol. 4, no. 4, pp. 226–230, 2022.

[39] A. W. Krisdiarto, A. Ferhat, A. W. Krisdiarto, and M. P. Bimantio, "Penyediaan Air Bagi Masyarakat Pesisir Terdampak Kekeringan dengan Teknologi Desalinasi Air Laut Sederhana," *DIKEMAS (Jurnal Pengabdian Kepada Masyarakat)*, vol. 4, no. 2, pp. 25–31, 2020, doi: 10.32486/jd.v4i2.532.

[40] J. Ely, "Kualitas Air Hasil Desalinasi Menggunakan Sistim Destilasi Sederhana," *Global Health Science*, vol. 4, no. 3, pp. 2662–1055, 2019.

[41] B. Hamuna, R. H. R. Tanjung, S. Suwito, H. K. Maury, and A. Alianto, "Kajian Kualitas Air Laut dan Indeks Pencemaran Berdasarkan Parameter Fisika-Kimia di Perairan Distrik Depapre, Jayapura," *Jurnal Ilmu Lingkungan*, vol. 16, no. 1, p. 35, 2018, doi: 10.14710/jil.16.1.35-43.

[42] A. T. S. Haji, R. Wirosoedarmo, and M. W. Tyas, "Analysis of Temperature Nomography, Evaporation Rate and Air Pressure for Solar-Driven Desalination System Design With Vacuum Setting," no. March, pp. 1–7, 2018.

[43] R. Natawisastra, R. Bramawanto, M. Ma'muri, L. Alfaris, and S. Suhernalis, "Rancang Bangun Alat Destilasi Air Laut yang Dilengkapi Pemanas Air Sederhana," *Jurnal Kelautan Nasional*, vol. 17, no. 2, p. 161, 2022, doi: 10.15578/jkn.v17i2.11382.

[44] M. I. Mowaviq, "Kendali Alat Destilasi Air Laut Elektrik Berbasis Mikrokontroler," *Kilat*, vol. 10, no. 2, pp. 280–286, 2021, doi: 10.33322/kilat.v10i2.1316.

[45] B. B. Taqwa, R. Rosalina, and H. Ramza, "Perancangan Alat Proses Distilasi Air Laut menggunakan Pemanas Elektrik," *Prosiding Seminar Nasional Teknoka*, vol. 5, no. 2502, pp. 204–214, 2020, doi: 10.22236/teknoka.v5i.327.

[46] N. P. Arif, "Rancang Bangun Destilasi Air Laut Menjadi Air Minum Menggunakan Solar PV Dengan Metode MPPT P&O," *Suara Teknik : Jurnal Ilmiah*, vol. 11, no. 2, p. 14, 2020, doi: 10.29406/stek.v11i2.2058.

[47] M. Ali, M. Lazim, A. Muin, and I. Badil, “Penyulingan Air Laut Menjadi Air Tawar,” *Desiminasi Teknologi*, vol. 7, no. 2, pp. 138–142, 2019.

[48] R. Wirangga, D. Mugisidi, A. T. Sayuti, and O. Heriyani, “The Impact of Wind Speed on the Rate of Water Evaporation in a Desalination Chamber,” vol. 1, no. 1, pp. 39–50, 2023.

[49] S. Ali and K. Waliden, “Alat Destilasi Air Laut Berbasis Energi Surya Dan Energi Elektrik Sebagai Alternatif Penyediaan Air Bersih Dan Garam,” *SENSISTEK: Riset Sains dan Teknologi …*, vol. 1, no. 1, pp. 42–46, 2019.

[50] K. Astawa, M. Sucipta, I. P. Gede, and A. Negara, “Analisa Performansi Destilasi Air Laut Tenaga Surya Menggunakan Penyerap Radiasi Surya Tipe Bergelombang Berbahan Dasar Beton,” *Jurnal Energi Dan Manufaktur*, vol. 5, no. 1, pp. 7–13, 2012.

[51] F. Irawan, “Troublshooting dan analisa kelembaban udara pada trainer ac split aux di laboratorium refrigerasi politeknik sekayu,” vol. 7, no. 2, pp. 45–56, 2020.

[52] F. I. Pasaribu, A. K. Hasibuan, N. Evalina, and E. S. Nasution, “Analisa Penggunaan Surya Panel Phollycristal 240 WP Sebagai Kinerja Destilator Air Laut,” *RELE (Rekayasa Elektrikal dan Energi) : Jurnal Teknik Elektro*, vol. 4, no. 2, pp. 90–99, 2022, doi: 10.30596/rele.v4i2.9530.

[53] N. P. Soelaiman, Sofyan, “Analisa prestasi kerja turbin uap pada beban yang bervariasi,” *Turbin Heat Rate*, pp. 1–12, 2009.

[54] E. Y. Setyawan and D. Suhendra, “Analisis Perhitungan Evaporator dan Kondensor yang Digunakan pada Alat Desalinasi Air Laut Sistem Vakum Alami Menggunakan Energi Surya,” *Flywheel*, vol. 9, no. 1, pp. 22–29, 2018.

[55] D. Mugisidi and O. Heriyani, “Sea Water Characterization at Ujung Kulon Coastal Depth as Raw Water Source for Desalination and Potential Energy,” *E3S Web of Conferences*, vol. 31, pp. 18–21, 2018, doi: 10.1051/e3sconf/20183102005.

[56] S. Y. Wulandari, M. Yusuf, and M. Muslim, “Kajian Konsentrasi Dan Sebaran Parameter Kualitas Air Di Perairan Pantai Genuk, Semarang,” *Buletin Oseanografi Marina*, vol. 3, no. 1, p. 9, 2014, doi: 10.14710/buloma.v3i1.11213.

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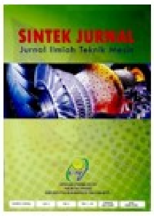

THE INFLUENCE OF NOZZLE INJECTION PRESSURE ON SEAWATER EVAPORATION INSIDE AN EVAPORATOR TUBE

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ABSTRACT

Indonesia, the largest archipelagic country in the world, possesses a vast marine area. Despite being surrounded by the sea, many coastal communities in Indonesia lack access to clean water. Seawater distillation presents a viable solution to this scarcity. This process involves separating salt from seawater to produce fresh water. This study aims to analyze the effect of nozzle spray pressure on the evaporation process of seawater to optimize fresh water production. Experiments were conducted using a fogging nozzle with a diameter of 0.3 mm, varying the nozzle pressure at 40 psi, 70 psi, and 100 psi. The data were statistically analyzed to determine the impact of nozzle pressure on seawater evaporation. The results indicate that the highest evaporation occurred at a nozzle pressure of 40 psi, yielding 10 g of condensed seawater, whereas the lowest evaporation was observed at 100 psi, producing 4 g.

Keywords: Seawater; Distillation; Evaporation; Pressure.

ABSTRAK

Indonesia sebagai negara kepulauan terbesar di dunia mempunyai wilayah laut yang sangat luas. Meski dikelilingi laut, banyak masyarakat pesisir di Indonesia yang kekurangan akses terhadap air bersih. Distilasi air laut memberikan solusi yang tepat untuk mengatasi kelangkaan ini. Proses ini melibatkan pemisahan garam dari air laut untuk menghasilkan air tawar. Penelitian ini bertujuan untuk menganalisis pengaruh tekanan semprotan nozzle terhadap proses penguapan air laut untuk mengoptimalkan produksi air tawar. Percobaan dilakukan dengan menggunakan nozzle fogging berdiameter 0,3 mm, tekanan nozzle divariasikan pada 40 psi, 70 psi, dan 100 psi. Data dianalisis secara statistik untuk mengetahui dampak tekanan nosel terhadap penguapan air laut. Hasil penelitian menunjukkan bahwa penguapan tertinggi terjadi pada tekanan nosel 40 psi, menghasilkan 10 g air laut yang terkondensasi, sedangkan penguapan terendah diamati pada 100 psi, menghasilkan 4 g.

***Kata Kunci**: Air Laut; Distilasi; Evaporasi; Tekanan.*

1. Introduction

Indonesia, the largest archipelagic country in the world, boasts an extensive maritime territory [1]. With 17,499 islands, 81,000 km of coastline, and 2.7 million km of inland waters, Indonesia also possesses an exclusive economic zone extending 3.1 million km, culminating in a total sea area of 5.8 million km [2]. Despite its vast maritime resources, many communities in Indonesia still face challenges in accessing clean water. This scarcity, particularly pronounced on small islands, constitutes a significant social issue [3], as clean water is an essential need for the population [4]. Consequently, the provision of clean water remains a substantial challenge [5], especially in regions experiencing a clean water crisis, notably coastal areas. Coastal communities are especially vulnerable to saline water contamination [6], which they often use for daily activities such as bathing, washing, and consumption.

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Prolonged use of saline water can lead to health issues such as hypertension, kidney disease, and skin ailments[7,8], given that clean water standards require a salt content of no more than 0.5% [9]. Seawater distillation presents a viable solution to the clean water scarcity problem [10], recognized as a promising technology[11,12].

Distillation involves heating seawater to produce steam, which is then condensed into fresh water [13]. In this study, seawater evaporation occurs within an evaporator tube [14]. Seawater is injected into the evaporator tube through a nozzle [15] and sprayed onto a heating plate [16]. The jet of seawater hitting the heating plate surface undergoes evaporation [17], which occurs when the vapor pressure of water is lower than the liquid's saturation pressure [18,19]. Additionally, evaporation is driven by the vapor pressure differential between the evaporator and the condenser due to temperature differences [20]. Water vapor moves from the evaporation chamber above the water surface in the evaporator to the low-pressure condenser, resulting in a drop in vapor pressure above the water level [21,22]. The water vapor is then condensed in the cooling pipe within the evaporator tube, forming water droplets that coalesce into fresh water [23]. Various studies have examined evaporation, including the impact of nozzle pressure on the evaporation process[24-29] and the influence of sunlight on evaporation [30-35]. However, no research has specifically investigated the effect of nozzle pressure on seawater evaporation with pressure variations of 40 psi, 70 psi, and 100 psi. Therefore, this study aims to analyze how nozzle pressure affects seawater evaporation and determine the effectiveness of each pressure variation in producing fresh water.

2. Methods

This research is field-based and conducted experimentally using a seawater distillation prototype [36]. The study employs a fogging nozzle with a diameter of 0.3 mm, which is injected into the evaporator tube. Seawater is distributed into the evaporator tube through the nozzle by spraying, and the nozzle pressure is controlled by an adjustable pump. Nozzle pressures of 40 psi, 70 psi, and 100 psi were used to compare the efficiency of the distillation process at different pressures. It is necessary to vary the pressures to observe their influence on the seawater evaporation process. Higher nozzle pressure can increase the rate of evaporation; however, selecting the correct nozzle pressure is crucial to avoid imperfect evaporation rates [37]. Therefore, varying nozzle pressures can help identify optimal conditions to maximize the rate of seawater evaporation. The following tools were used to measure the data in this study:

Table 1. Research Tools

No	Tool	Specifications
1	Thermostat XH-W3001	Range -50 ºC - 110 ºC, ± 0.1 ºC
2	Heater Plate	Range -50 °C – 300 °C
3	Thermometer digital	Range -50 ⁰C - 110 °C, ± 0.1°C
4	Pompa Sprayer	DC 12V 100 psi
5	40 kg digital scale	Maximum load 40 kg, resolution 0.005 kg
6	5 kg digital scale	Maximum load 5 kg, resolution 1 gr

This study utilized the tools illustrated in Figure 2 and the schematic diagram shown in Figure 1. The research was conducted at the Mechanical Engineering Laboratory, Faculty of Industrial and Information Technology, Universitas Muhammadiyah Prof. Dr. HAMKA.

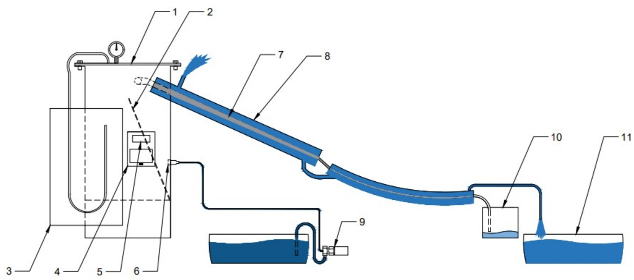

Figure 1. Distillation Device Scheme 1. Evaporator tube, 2. Heating plate, 3. PG, 4. Thermostat, 5. SH1, 6. Nozzle, 7. Steam flow, 8. Cooling water flow, 9. Pumps, 10. Freshwater reservoirs, 11. Reservoir of the outgoing cooling water flow.

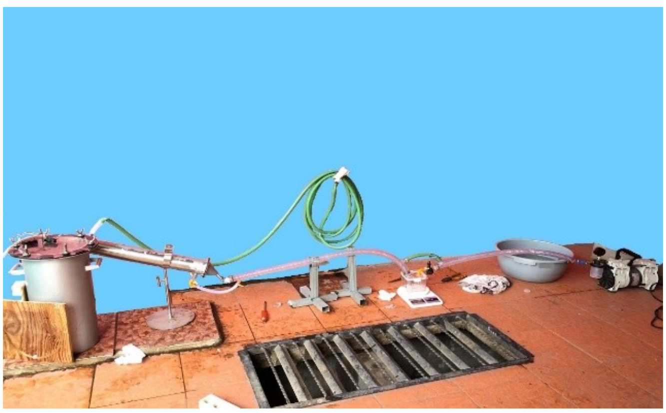

Figure 2. Distillation Tools

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Figure 2 illustrates the distillation device used in this study. Seawater, amounting to 5000 g, is distributed from the main container into the evaporator tube through a nozzle with a diameter of 0.3 mm, utilizing nozzle pressure variations of 40 psi, 70 psi, and 100 psi. The seawater is sprayed onto a heating plate maintained at 100°C by a thermostat. Data collection was conducted over 30 minutes at 5-minute intervals, recording the mass of water on a digital scale to determine the amount of seawater evaporated.

In Figure 2 data retrieval is performed on PG, SH1, AT1, SAL1 and SAL2.

Information:

PG : Evaporation pressure in the tube

SH 1 : Heating plate temperature

AT1 : Fresh water produced

SAL1 : Remaining seawater

SAL2 : Non-evaporating seawater

Based on the results of the trial, the equipment used worked well including checking for leaks in the joints.

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3. Results and Discussion

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To make it easier to do the analysis, the test result data is presented in the form of tables and graphs. In this study using nozzle pressure variations, namely 40 psi, 70 psi, and 100 psi. Sampling is carried out for 30 minutes with a time interval of 5 minutes. The data obtained include the evaporation pressure on the tube, the temperature of the heating plate, the container for holding fresh water, the remaining seawater, and the remaining seawater that does not evaporate in the tube. The following are the results of data collection which can be seen in the form of tables and graphs below.

Table 2. Nozzle Pressure 40 psi

13 14

t (Minutes)	p (Pa)	T (°C)	m (g)	SAL1 (g)	SAL2 (g)
5	20	81.2	5	4900	855
10	120	82	6	4760	
15	220	82.2	7	4625	
20	270	82.7	8	4480	
25	300	84.6	8	4370	
30	320	86.1	10	4135	

Table 3. Nozzle Pressure 70 psi

t (Minutes)	p (Pa)	T (°C)	m (g)	SAL1 (g)	SAL2 (g)
5	60	57.3	1	4750	1050
10	130	58.1	2	4525	
15	140	59.4	4	4470	
20	155	60	6	4300	
25	170	60.9	8	4150	
30	185	60.9	9	3935	

Table 4. Nozzle Pressure 100 psi

t (Minutes)	p (Pa)	T (°C)	m (g)	SAL1 (g)	SAL2 (g)
5	10	55.4	1	4650	1345
10	20	57.1	2	4360	
15	40	57.9	3	3980	
20	70	58.2	3	3670	
25	110	58.2	4	3370	
30	160	59.7	4	3100	

Based on the results of the study, data were obtained on the evaporation of seawater at various variations in nozzle pressure for 30 minutes. The results showed that the higher the nozzle spray pressure against the heating plate, the lower the evaporation pressure in the tube. This is because if the nozzle spray against the heating plate is higher, the seawater droplets that are in direct contact with the heating plate become few and only condense so that the seawater does not experience evaporation. At a burst pressure of 40 psi, the highest evaporation pressure in the tube is 320 Pa, resulting in 10 g of fresh water. At a burst pressure of 70 psi, the highest evaporation pressure in the tube is 185 Pa, resulting in 9 g of fresh water. At a burst pressure of 100 psi, the highest evaporation pressure in the tube is 160 Pa, producing 4 g of fresh water.

Figure 3 shows the difference in evaporation pressure and the amount of fresh water produced at each variation in burst pressure. The factor of mass flow rate also affects the difference in evaporation pressure at each variation in burst pressure. The mass flow rate can be obtained using the following equation:

$$\dot{m} = \rho . A . v \quad (1)$$

2

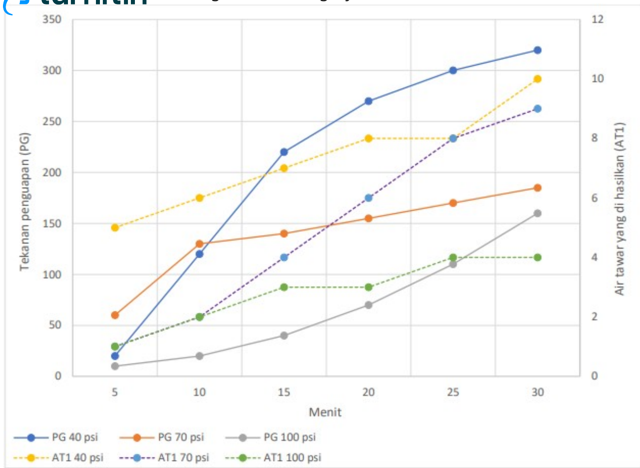

Figure 3. Evaporation Pressure Graphics (p), Nozzle Spray Pressure (Psi), Produced Fresh Water (m)

The results of the calculation show that at a burst pressure of 40 psi, a mass flow rate of 0.375 kg / s, an evaporation pressure in the tube of 320 Pa and produces fresh water as much as 10 g. At a burst pressure of 70 psi, a mass flow rate of 0.488 kg/s, an evaporation pressure in the tube of 185 Pa and produces 9 g of fresh water. At a burst pressure of 100 psi, a mass flow rate of 0.579 kg/s, an evaporation pressure in the tube of 160 Pa and produces 4 g of fresh water.

4. Conclusion

The results of testing, observation, and analysis in this study revealed a comparison of each pressure variation 40 psi, 70 psi, and 100 psi. Over a 30-minute period, the highest evaporation occurred at a nozzle pressure of 40 psi, producing 10 g of fresh water. Conversely, the lowest evaporation was observed at a nozzle pressure of 100 psi, yielding 4 g of fresh water. Based on the study's objective to analyze the effect of nozzle pressure on seawater evaporation and determine the effectiveness of each pressure variation in producing fresh water, it can be concluded that a pressure of 40 psi is the most effective for fresh water production.

Acknowledgments

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References

[1] G. P. Bonita, A. C. Heksa, S. Nurkhamidah, and Y. Rahmawati, “Pra Desain Pabrik Garam Farmasi dari Air Laut dengan Metode Reverse Osmosis,” J. Tek. ITS, vol. 11, no. 3, pp. 93–98, 2022, doi: 10.12962/j23373539.v11i3.97466.

[2] M. Taufik, E. Khairina, R. Hidayat, R. Kalalinggi, and M. I. Fadhlurrohman, “Study of Government’s Strategy on Clean Water Availability in Indonesia,” J. Kesehat. Lingkung. Indones., vol. 21, no. 1, pp. 111–121, 2022, doi: 10.14710/jkli.21.1.111-121.

[3] F. X. H. Kusumartono and A. Rizal, “An integrated assessment of vulnerability to water scarcity measurement in small islands of Indonesia,” An Int. Sci. J., vol. 24, no. April, pp. 117–133, 2019, [Online]. Available: www.worldnewsnaturalsciences.com.

[4] D. Mugisidi and O. Heriyani, “Sea Water Characterization at Ujung Kulon Coastal Depth as Raw Water Source for Desalination and Potential Energy,” E3S Web Conf., vol. 31, pp. 18–21, 2018, doi: 10.1051/e3sconf/20183102005.

[5] S. Maryati and Y. T. Febriani, “Status and challenges of water governance in facing the water crisis disaster in Blora Regency, Indonesia,” IOP Conf. Ser. Earth Environ. Sci., vol. 683, no. 1, 2021, doi: 10.1088/1755-1315/683/1/012145.

[6] M. A. Rakib, J. Sasaki, H. Matsuda, and M. Fukunaga, “Severe salinity contamination in drinking water and associated human health hazards increase migration risk in the southwestern coastal part of Bangladesh,” J. Environ. Manage., vol. 240, no. November 2018, pp. 238–248, 2019, doi: 10.1016/j.jenvman.2019.03.101.

[7] M. Shammi, M. M. Rahman, S. E. Bondad, and M. Bodrud-Doza, “Impacts of salinity intrusion in community health: A review of experiences on drinking water sodium from coastal areas of Bangladesh,” Healthc., vol. 7, no. 1, 2019, doi: 10.3390/healthcare7010050.

[8] M. A. Abedin, A. E. Collins, U. Habiba, and R. Shaw, “Climate Change, Water Scarcity, and Health Adaptation in Southwestern Coastal Bangladesh,” Int. J. Disaster Risk Sci., vol. 10, no. 1, pp. 28–42, 2019, doi: 10.1007/s13753-018-0211-8.

[9] D. Chen, C. Zhang, H. Rong, C. Wei, and S. Gou, “Experimental study on seawater desalination through supercooled water dynamic ice making,” Desalination, vol. 476, no. September 2019, p. 114233, 2020, doi: 10.1016/j.desal.2019.114233.

[10] A. Abotaleb and A. Mabrouk, “The impact of vapor box location on the performance of the multiple effect distillation for seawater desalination technology,” Desalin. Water Treat., vol. 216, pp. 1–13, 2021, doi: 10.5004/dwt.2021.26821.

[11] Z. Liu, B. Wu, B. Zhu, Z. Chen, M. Zhu, and X. Liu, “Continuously Producing Watersteam and Concentrated Brine from Seawater by Hanging Photothermal Fabrics under Sunlight,” Adv. Funct. Mater., vol. 29, no. 43, pp. 1–11, 2019, doi: 10.1002/adfm.201905485.

[12] B. Zhu et al., “Flexible and Washable CNT-Embedded PAN Nonwoven Fabrics for Solar-Enabled Evaporation and Desalination of Seawater,” ACS Appl. Mater. Interfaces, vol. 11, pp. 35005–35014, 2019, doi: 10.1021/acsami.9b12806.

[13] D. Sumardiyanto, S. E. Susilowati, F. Hidayat, “Penyuluhan Destilasi dan Filtrasi Air Laut Menjadi Air Bersih Untuk Masyarakat Sekitar Jakarta Utara,” BERDIKARI, vol. 4, no. 2, pp. 1–9, 2021, [Online]. Available:

http://journal.uta45jakarta.ac.id/index.php/berdikari/article/view/4999.
[14] S. Aly, J. Jawad, H. Manzoor, S. Simson, J. Lawler, and A. N. Mabrouk, "Pilot testing of a novel integrated Multi Effect Distillation - Absorber compressor (MED-AB) technology for high performance seawater desalination," Desalination, vol. 521, no. July 2021, p. 115388, 2022, doi: 10.1016/j.desal.2021.115388.
[15] W. Gao, Q. Qi, J. Zhang, G. Chen, and D. Wu, "An experimental study on explosive boiling of superheated droplets in vacuum spray flash evaporation," Int. J. Heat Mass Transf., vol. 144, p. 118552, 2019, doi: 10.1016/j.ijheatmasstransfer.2019.118552.
[16] M. H. Amirkalaei, A. Khoshgard, H. Ahmadi-Danesh-Ashtiani, and R. Fazaeli, "Evaporation rate of sprayed seawater droplets in upward and downward direction and analyzing the effect of the injection pressure and nozzle type in solar water desalination systems," Energy Sources, Part A Recover. Util. Environ. Eff., vol. 00, no. 00, pp. 1–14, 2020, doi: 10.1080/15567036.2020.1850929.
[17] H. Raach and J. Mitrovic, "Simulation of heat and mass transfer in a multi-effect distillation plant for seawater desalination," Desalination, vol. 204, no. 1-3 SPEC. ISS., pp. 416–422, 2007, doi: 10.1016/j.desal.2006.04.037.
[18] C. Elango, N. Gunasekaran, and K. Sampathkumar, "Thermal models of solar still - A comprehensive review," Renew. Sustain. Energy Rev., vol. 47, pp. 856–911, 2015, doi: 10.1016/j.rser.2015.03.054.
[19] M. I. Ahmed, M. Hrairi, and A. F. Ismail, "On the characteristics of multistage evacuated solar distillation," Renew. Energy, vol. 34, no. 6, pp. 1471–1478, 2009, doi: 10.1016/j.renene.2008.10.029.
[20] W. Wang et al., "Solar Seawater Distillation by Flexible and Fully Passive Multistage Membrane Distillation," Nano Lett., vol. 21, no. 12, pp. 5068–5074, 2021, doi: 10.1021/acs.nanolett.1c00910.
[21] H. E. S. Fath and S. M. Elsherbiny, "Effect of adding a passive condenser on solar still performance," Int. J. Sol. Energy, vol. 11, no. 1–2, pp. 73–89, 1992, doi: 10.1080/01425919208909731.
[22] E. Diniardi, "Analisa Perencanaan Desalination Plant 4167 Ton / Jam," Sintek J. J. Ilm. Tek. Mesin, pp. 22–31, 2009.
[23] M. Fujiwara, K. Takahashi, and K. Takagi, "Improvement of condensation step of water vapor in solar desalination of seawater and the development of three-ply membrane system," Desalination, vol. 508, no. January, p. 115051, 2021, doi: 10.1016/j.desal.2021.115051.
[24] M. H. Amirkalaei, A. Khoshgard, H. Ahmadi-Daneshashtiani, and R. Fazaeli, "Investigation of the parameters influencing the evaporation rate of downward sprayed sea water in solar water desalination," Desalin. Water Treat., vol. 191, pp. 64–71, 2020, doi: 10.5004/dwt.2020.25469.
[25] S. D. Waluyo, Y. H. Providensia, N. Kartika, and L. Suprianti, "Pengaruh Diameter Nozzle Sprayer Terhadap Kadar Effect of Sprayer Nozzle Diameter on Salt Content of," pp. 2018–2022, 2022.
[26] C. Chen, Y. Kuang, and L. Hu, "Challenges and Opportunities for Solar Evaporation," Joule, vol. 3, no. 3, pp. 683–718, 2019, doi: 10.1016/j.joule.2018.12.023.
[27] R. Alrowais, C. Qian, M. Burhan, D. Ybyraiymkul, M. W. Shahzad, and K. C. Ng, "A greener seawater desalination method by direct-contact spray evaporation and condensation (DCSEC): Experiments," Appl. Therm. Eng., vol. 179, no. June, p. 115629, 2020, doi: 10.1016/j.applthermaleng.2020.115629.
[28] B. Cai et al., "Mathematical study of spray flash evaporation in a spray-assisted seawater desalination chamber," Desalination, vol. 465, no. December 2018, pp. 25–37, 2019, doi: 10.1016/j.desal.2019.03.007.
[29] F. Fathinia, M. Khiadani, Y. M. Al-Abdeli, and A. Shafieian, "Performance improvement of spray flash evaporation desalination systems using multiple nozzle arrangement," Appl. Therm. Eng., vol. 163, no. June, 2019, doi: 10.1016/j.applthermaleng.2019.114385.
[30] A. S. Abdullah, M. M. Younes, Z. M. Omara, and F. A. Essa, "New design of trays solar still with enhanced evaporation methods – Comprehensive study," Sol. Energy, vol. 203, no. February, pp. 164–174, 2020, doi: 10.1016/j.solener.2020.04.039.
[31] A. M. Manokar, D. P. Winston, A. E. Kabeel, R. Sathyamurthy, and T. Arunkumar, "Different parameter and technique affecting the rate of evaporation on active solar still -a review," Heat Mass Transf. und Stoffuebertragung, vol. 54, no. 3, pp. 593–630, 2018, doi: 10.1007/s00231-017-2170-9.
[32] A. S. Abdullah et al., "Rotating-drum solar still with enhanced evaporation and condensation techniques: Comprehensive study," Energy Convers. Manag., vol. 199, no. June, p. 112024, 2019, doi: 10.1016/j.enconman.2019.112024.
[33] O. Mahian, A. Kianifar, S. Z. Heris, D. Wen, A. Z. Sahin, and S. Wongwises, "Nanofluids effects on the evaporation rate in a solar still equipped with a heat exchanger," Nano Energy, vol. 36, no. February, pp. 134–155, 2017, doi: 10.1016/j.nanoen.2017.04.025.
[34] A. Muthu Manokar, K. Kalidasa Murugavel, and G. Esakkimuthu, "Different parameters affecting the rate of evaporation and condensation on passive solar still - A review," Renew. Sustain. Energy Rev., vol. 38, pp. 309–322, 2014, doi: 10.1016/j.rser.2014.05.092.
[35] S. Shoeibi, N. Rahbar, A. Abedini Esfahlani, and H. Kargarsharifabad, "A review of techniques for simultaneous enhancement of evaporation and condensation rates in solar stills," Sol. Energy, vol. 225, no. July, pp. 666–693, 2021, doi: 10.1016/j.solener.2021.07.028.
[36] A. Yani, "Study experimental alat destilasi air laut terhadap kuantitas dan kualitas air tawar yang dihasilkan dengan menggunakan energi matahari," Turbo J. Progr. Stud. Tek. Mesin, vol. 10, no. 2, 2021, doi: 10.24127/trb.v10i2.1744.
[37] H. Guo, J. Wang, J. Wu, and X. Du, "Study on spray evaporation treatment of desulfurization wastewater," Coatings, vol. 11, no. 4, pp. 1–19, 2021, doi: 10.3390/coatings11040418.

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