International Journal of Engineering Materials and Manufacture (2026) 11(2) 40-48
https://doi.org/10.26776/ijemm.11.02.2026.01

Exergetic Analysis of Boiler Feed Water System with Deaerator in Steam Power Plant

Nurul Hoda Sanid, Mohammad Zoynal Abedin and Samsul Islam

Received: 03 November 2025
Accepted: 15 February 2026
Published: 30 April 2026
Publisher: Deer Hill Publications

ABSTRACT

The thermodynamic analysis of the steam power plant is of great importance from a practical point of view. The present research aims to investigate the exergetic analysis of a boiler feed water system with a deaerator in a steam power plant with a design capacity of 210 MW in Bangladesh. The water parameters, including temperature, pressure, and mass flow rate, are measured and analyzed in the present study. The experimental results are compared and validated with the existing observations of the combined-cycle power plant. The highest and lowest water temperatures at the deaerator outlet signify the operating regimes as Initial Regime 1 and Final Regime 4, respectively, whereas the two intermediate water temperatures at the deaerator indicate Regime 2 and Regime 3, respectively. The results reveal that the highest exergy destruction, at 3.2 MW, occurs at an ambient temperature of 30°C in Regime 1. Furthermore, lower exergy destruction is observed at lower ambient temperatures. Conversely, the highest exergy efficiency of 84% is achieved in Regime 4 at an ambient temperature of 15°C. This is because a low water outlet temperature from the deaerator ensures higher exergy efficiency through less exergy destruction, and vice versa.

Keywords: Exergy, Boiler Feed Water, Deaerator, Steam Power Plant, Efficiency, Destruction.

NOMENCLATURE

$\dot{E}$	Energy of a fluid flow, kW
h	Specific enthalpy, kJ/kg
$\dot{m}$	Mass flow rate, kg/s
ρ	Pressure, bar
P	Power, kW
$\dot{Q}$	Heat transfer, kW
S	Specific entropy, kJ/kg·K
T	Temperature, K or °C
X_{heat}	Exergy transfer by heat, kW
ε	Specific exergy, kJ/kg
η	Efficiency, %
0	Ambient state
D	Destruction (loss)
ex	Exergy
in	Inlet/ Input
out	Outlet/ Output

1 INTRODUCTION

Bangladesh, as a developing nation, heavily depends on electricity for its economic growth [1]. The country hosts numerous large and small industries, including garment factories, steel plants, cement factories, ceramic factories, polymer factories, plastic factories, paper mills, jute mills, and various food processing facilities, all of which rely heavily on electricity. Hence, there is a pressing need to boost electricity generation, which can be achieved through

---

Nurul Hoda Sanid, Mohammad Zoynal Abedin ✉ and Samsul Islam
Department of Mechanical Engineering
Dhaka University of Engineering and Technology, Gazipur-1707, Bangladesh
E-mail: abedin.mzoynal@duet.ac.bd,

Reference: Sanid et al. (2026). Exergetic Analysis of Boiler Feed Water System with Deaerator in Steam Power Plant. *International Journal of Engineering Materials and Manufacture*, 11(2), 40-48.

the establishment of various types of power plants [2]. Steam power plants are crucial for power generation. During operation, it is essential to ensure the quality of water and steam, maintain the cleanliness of components, and safeguard the boiler against accidents. Steam power plants utilize regenerative condensate and feedwater heating systems to preheat the condensate and feedwater before reintroducing them to the steam generator [3]. Heating the condensate and feed water helps to save fuel in the boiler, leading to increased efficiency of the steam power plant [4]. This heating system comprises several components, including a low-pressure (LP) heater, a Phase 100, a Phase 50, an ejector, and others [5].

Moreover, the deaerator, an integral part of the feed water and condensate heating system, serves two purposes. It helps prevent the erosion of heat exchangers, pipelines, steam generator parts, and other components by removing dissolved gases, such as oxygen and carbon dioxide, and other substances from the condensate and feed water [6]. The presence of high levels of dissolved oxygen in the feed water is a common cause of boiler corrosion. Deaerators are specifically designed to decrease the concentrations of carbon dioxide and oxygen to levels not exceeding 7 parts per billion by weight [7]. When dissolved in water, carbon dioxide forms carbonic acid, which can contribute to further corrosion. Deaerators also play a role in heating the condensate and feed water. Typically, the deaerator is a key component of the entire regenerative heating system, with the high-pressure section positioned between the deaerator and the steam generator, and the low-pressure section located between the deaerator and the steam condenser [8]. In a supercritical thermal power plant operating at constant load conditions under pure sliding pressure, exergy analyses are frequently performed [9]. A steam turbine power plant consists of a boiler, steam turbine, deaerator, generator, and additional auxiliaries. Steam is produced by the boiler at high pressure and temperature. The thermal energy of the steam is then converted into mechanical energy and subsequently into electric power [10].

These days, the supply of electricity is being stabilized, and its adverse environmental consequences will be reduced by a few very efficient and environmentally friendly power plants [11]. The application of advanced technologies helps reduce environmental impact. At standard air pressure (0.101MPa), water boils at 100°C. When the temperature reaches 374°C, and the pressure is increased to 22.12 MPa, water immediately converts into steam rather than boiling [12]. The critical point is the pressure above which water converts to steam; this pressure is referred to as supercritical pressure. Supercritical pressure at 593°C or above is referred to as ultra-supercritical pressure. Figure 1 shows the steam flow schematic of a power plant [13]. The study by Mrzliak et al. examined the effectiveness of plants and various parameters [14]. A condenser, a heat-transfer unit, is utilized to cool a gaseous substance and transform it into a liquid state, releasing its latent heat in the process. The released heat is then transferred to the condenser coolant, with many condensers using ambient air or cooling water as the coolant. The main purpose of a condenser is to gather and condense the exhaust steam from a steam engine or turbine, thereby utilizing energy that would have otherwise been wasted [15]. Steam is typically condensed by a steam condenser to a pressure significantly below atmospheric pressure.

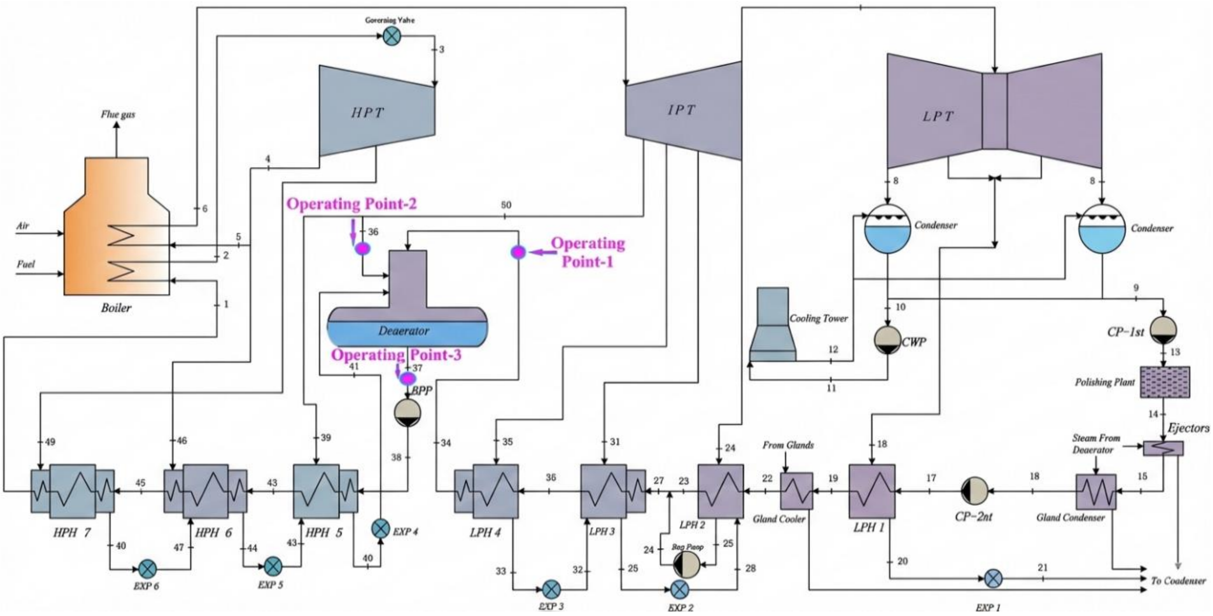

Figure 1: 210 MW Steam Power Plant's steam flow diagram [16].

The energy and exergy analysis of the deaerator from the combined cycle power plant was analyzed in the thermal power plants based on the Rankine cycle [17]. In the study, the saturated liquid water (feed water) is converted into steam, the working fluid of a simple Rankine cycle. This saturated steam passes through the turbine, which converts its internal energy into mechanical energy to drive an electricity-generating machine. However, the system cannot utilize all of the steam's energy due to losses caused by blade bending, viscosity, and friction [18]. In the steam condenser, the majority of the heat energy is rejected. Condensed water is returned to the boiler through the feed water. A washbasin releases the heat that is rejected when steam condenses in the condenser [19]. When steam exits the turbine, its temperature and pressure are significantly lower than those of the turbine entry because a large portion of its thermal energy is converted into mechanical energy or work. The Rankine cycle is depicted in Figure 1 [20]. As illustrated in Figure 1, the low-pressure steam that exits the turbine at state 2 is essentially condensed to a liquid at state 3, pressurized in a pump to state 4, and then ready for its subsequent pass through the steam generator to state 1 [21]. This process repeats itself around the Rankine cycle. The steam generator and condenser both operate as heat exchangers. Both hot and cold fluids travel through a well-designed heat exchanger with minimal pressure loss [22].

When fluids operate without experiencing a pressure change, it is best to consider steam generators and condensers as having minimal pressure loss. The Rankine cycle operates between the fixed pressure levels in the steam generator and the condenser [23]. A turbine provides the controlled pressure drop between these levels, while a pump provides the pressure increase. The Rankine cycle uses the turbine's rotation to convert the steam's thermal energy into mechanical energy, which then powers the generator to produce electrical energy [24]. Numerous studies with diverse results have been conducted in the fields of energy, power plants, thermodynamics, and Rankine cycles [25]. These studies explore the fundamental concepts of thermodynamic exergy analysis in generalized power plants, contributing uniquely to their respective areas [26]. Vedran et al. [27] performed an exergetic analysis of the deaerator in a combined cycle power plant. However, the exergetic analysis of a boiler feedwater system with a deaerator in a steam power plant under various ambient conditions, such as those in Bangladesh, has not yet been addressed. Therefore, this study focuses on the boiler feedwater system with a deaerator at the Ghorashal power station to identify loss areas and explore ways to reduce them to enhance system performance.

2 EXPERIMENTAL METHODS

The current trial operations are being carried out with official sanction at the Ghorashal 210 MW steam power plant owned by the Bangladesh Power Development Board, as shown in Figure 2. The study's usage of the following technical terms demonstrates how the steam power plant's deaerator preserves the purity of the steam.

Figure 2: Ghorashal 210 MW steam power plant (a) Interior view of turbine–generator hall, (b) Exterior view of the boiler, deaerator, and main steam/feedwater piping system [28].

2.1 Experimental Setup

In this analysis, we examined the hot water/steam deaerator system of a steam cycle power plant, which is commonly used in steam turbine power plants. The general deaerator method and the operational points required for the analysis are shown in Figure 1. To transfer condensate from the main steam condenser to the deaerator under analysis, three condensate pumps, operational point 1, as shown in Figures 1 and 3 are employed. Another input into the deaerator under analysis is steam extracted from the intermediate-pressure steam turbine (operating point 2, Figures 1 and 3). Additionally, steam or hot water from the low-pressure heater (LPH-1) at operating point 2, shown in Figures 1 and 3, serves as another input to the deaerator under analysis. A portion of the steam collected from the turbine is used for deaeration, while the remaining steam is utilized to heat the water, as illustrated in Figure 3.

The system with a deaerator is analyzed under four operating regimes for three operating points across various ambient conditions. When the water temperature at the deaerator outlet is at its maximum, it indicates the first operating regime (Regime 1). When it is at its lowest, it corresponds to the fourth and final operating regime (Regime 4). The other two intermediate water temperatures in the deaerator represent Regime 2 and Regime 3. Regarding the three operating points in Figure 3, point 1 represents the outlet of condensed steam from the condenser, point 2 indicates the outlet of steam from the steam turbine, and point 3 indicates the outlet of water from the deaerator.

The deaerating process releases a stream of dissolved gases, but its low mass flow rate compared to other deaerator fluid streams allows it to be disregarded in the deaerator energy and exergy calculations. In our experimental analysis, we utilize various meters to identify different types of data. The feed water system transfers water from the condenser to the deaerator and from the feed water pump to the boiler. Within the system, we gauge deaerator pressure, temperature of demineralized water or condensate water, and condensate water flow using a variety of measuring devices such as a deaerator pressure meter, a condensate flow meter, a steam flow meter, a deaerator level meter, a feed water flow meter, a load meter, and a deaerator condensate temperature meter.

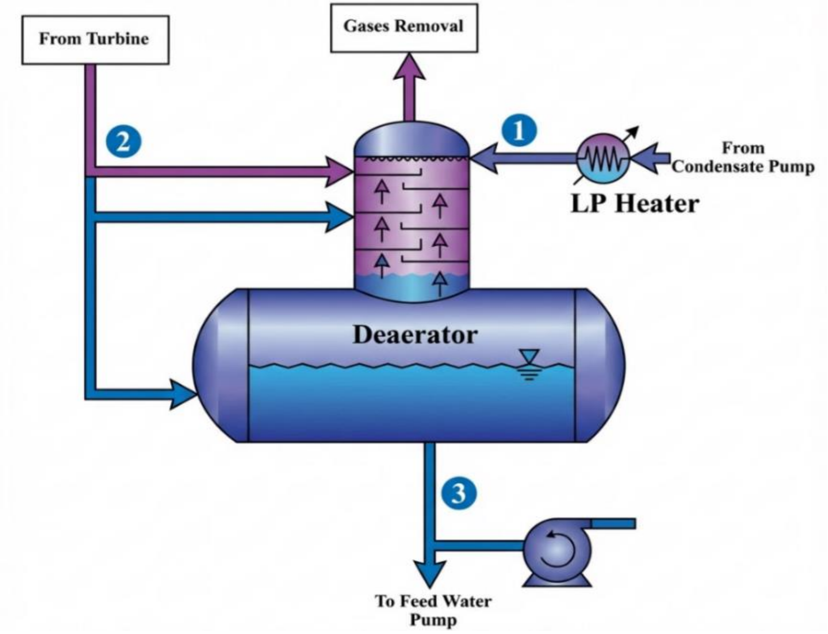

Figure 3: Main design and necessary operating points of the deaerator under analysis [27].

2.2 Experimental Data for Ambient Temperature of 15°C

The measured data are analyzed and compared with existing observations. In Bangladesh, the ambient temperature ranges from 15°C to 30°C under different weather conditions, measured using a bimetallic thermometer. Data at 15°C were recorded during the winter season, while data at 30°C were recorded during the summer season. The data collection process lasted 10 minutes.

Table 1: The analyzed deaerator's steam or water characteristics, operating regime 1, ambient temperature of 15°C.

Operating point	Temperature (^{0}K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	427	5	85.67	648.88	1.8826	39.592
2	705	5	7.37	3112.9	9.7775	298.641
3	430	5	90.25	661.82	1.9128	31.295

Table 2: The analyzed deaerator's steam or water characteristics, operating regime 2, ambient temperature of 15°C.

Operating Point	Temperature (^{0}K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	423	5	84.12	631.66	1.8421	46.406
2	700	5	7.74	3112.9	9.6979	321.566
3	425	5	84.14	640.26	1.712	113.279

Table 3: The analyzed deaerator's steam or water characteristics, operating regime 3, ambient temperature of 15°C.

Operating Point	Temperature (^{0}K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	422	5	61.24	627.37	1.9129	56.596
2	719	5	7.47	3112.9	9.7448	308.058
3	425	5	72.13	640.26	1.9329	130.006

Table 4: The analyzed deaerator's steam or water characteristics, operating regime 4, ambient temperature of 15°C.

Operating Point	Temperature (^{0}K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	421	5	84.47	623.07	1.8217	39.231
2	693	5	7.302	3112.9	9.6681	330.148
3	423	5	89.22	631.66	1.8421	74.276

2.3 Experimental Data for Ambient Temperature of 30°C

Table 5: The analyzed deaerator's steam or water characteristics, operating regime 1, ambient temperature of 30°C.

Operating Point	Temperature (°K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	429	5	83.69	657.51	1.8926	38.534
2	706	5	7.37	3112.9	9.7775	298.641
3	432	5	87.27	670.79	1.9428	31.358

Table 6: The analyzed deaerator's steam or water characteristics, operating regime 2, ambient temperature of 30°C.

Operating Point	Temperature (°K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	425	5	80.14	640.26	1.8824	51.402
2	701	5	7.74	3112.9	9.6979	321.566
3	427	5	87.76	648.88	1.763	113.879

Table 7: The analyzed deaerator's steam or water characteristics, operating regime 3, ambient temperature of 30°C.

Operating Point	Temperature (°K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	424	5	64.23	635.97	1.9129	46.506
2	720	5	7.47	3112.9	9.7448	308.058
3	426	5	74.15	648.88	1.9629	130.236

Table 8: The analyzed deaerator's steam or water characteristics, operating regime 4, ambient temperature of 30°C.

Operating Point	Temperature (°K)	Pressure (Bar)	Mass Flow Rate (kg/s)	Specific Enthalpy (kJ/kg)	Specific Entropy (kJ/kg.K)	Specific Exergy (kJ/Kg)
1	423	5	85.48	631.66	1.8617	39.982
2	694	5	7.302	3112.9	9.6681	330.148
3	425	5	89.24	640.26	1.823	74.773

2.4 Exergetic Analysis

Defines the control volume exergy balance. Potential and kinetic energy can be ignored, just like in the case of the control volume exergy balance [29]:

$$\sum m_{in} \cdot \varepsilon_{in} + \mathrm{X}_{heat} = \sum m_{out} \cdot \varepsilon_{out} + P + E_{ex,D} \tag{1}$$

Two parts of the Eqn (1), the first is known as specific exergy, and it is described as follows by [30]:

$$\varepsilon = (h - h_0) - T_0(S - S_0) \tag{2}$$

The net exergy transfer ($\dot{X}_{heat}$) by heat at the temperature T is defined as:

$$\dot{X}_{heat} = \sum\left(1 - \frac{T_0}{T}\right) \cdot \dot{Q} \tag{3}$$

For every fluid flow, the exergy transfer is:

$$\dot{E}_{ex} = \dot{m}.\varepsilon = \dot{m}[(h - h_0) - T_o.(S - S_o)] \tag{4}$$

Deaerator exergy power input:

$$\dot{E}_{ex,in} = \dot{m}_1.\varepsilon_1 + \dot{m}_2\varepsilon_2 \tag{5}$$

Deaerator exergy power output:

$$\dot{E}_{ex,out} = \dot{m}_3.\varepsilon_3 \tag{6}$$

Deaerator exergy destruction:

$$\dot{E}_{ex.D} = \dot{E}_{ex,in} - \dot{E}_{ex,out} = \dot{m}_1.\varepsilon_1 + \dot{m}_2.\varepsilon_2 - \dot{m}_3.\varepsilon_3 \tag{7}$$

Deaerator exergy efficiency: The exergy efficiency of the control volume is as follows:

$$\eta_{ex} = \frac{Exergy\ output}{Exergy\ input}$$

$$\eta_{ex} = \frac{\dot{E}_{ex.out}}{\dot{E}_{ex,in}} = \frac{\dot{m}_3.\varepsilon_3}{\dot{m}_1.\varepsilon_1 + \dot{m}_2.\varepsilon_2} \tag{8}$$

3 RESULTS AND DISCUSSIONS

The experimental study recognizes the necessity of the deaerator to enhance the deaerator system's efficiency. This study highlights the importance of deaerators in the boiler feed water system of a steam power plant by demonstrating their role in preventing corrosion in the steam line.

3.1 Data Validation

The exergy efficiency of the deaerator is displayed against the operating regime in Figure 4. The exergy efficiency is the ratio of the exergy output to the exergy input of the deaerator, which is expressed as a percentage. The system with a deaerator is analyzed in four operating regimes at three operating points with various ambient conditions. The three ambient temperatures, such as 15°C and 10°C, are used in the present experiment in analogy with the experiment of Vedran et al. [27]. As seen in Figure 4, the deaerator exergy efficiency increases steadily for a temperature of 15°C and for each of the three regimes from 50.49% in Regime 1 to 76.91% in Regime 3. Similarly, the deaerator exergy efficiency grows steadily from 53.93% in regime 1 to 83.4% in regime 3, at an ambient temperature of 10°C and regimes 1 through 3. From Figure 4, it is observed that for both ambient temperatures, the exergy efficiency is lowest in Regime 1 due to the highest exergy destruction in the deaerator. Additionally, for Regimes 1, 2, and 3, the exergy efficiency increases as exergy destruction decreases in those regimes, respectively. Furthermore, in Regime 3, the exergy efficiency is highest due to the lowest exergy destruction in the deaerator.

Figure 4 further demonstrates that the current experimental investigation aligns well with the observations of Vedran et al. [27], showing that the deaerator's energy efficiency increases steadily from 72.35% in operating Regime 1 to 78.21% in operating Regime 3, thereby confirming the validity of the investigation. As illustrated in Figure 4, the deaerator's exergy efficiency increases steadily from 13.82% in operating Regime 1 to 41.41% in operating Regime 3 at an ambient temperature of 15°C, consistent with Vedran et al. [27]. As illustrated in Figure 4, the deaerator's exergy efficiency increases steadily from 17.33% in operating Regime 1 to 43.73% in operating Regime 3, with the ambient temperature being 10°C. Operating Regime 3 has the maximum exergy efficiency and the lowest exergy loss, while Regime 1 has the lowest exergy efficiency and the biggest exergy destruction (loss) of the deaerator. The other two operating regimes at the deaerator are that exergy efficiency is increased and deaerator destruction (loss) is decreased, respectively. Our current experiment closely aligns with the experiments of Vedran et al. [27], despite different ambient temperatures. At an ambient temperature of 15°C, the percentage differences in exergy efficiency between the present experiment and Vedran et al. [27] for Regimes 1, 2, and 3 are 2.11%, 0.73%, and 0.91%, respectively. At an ambient temperature of 10°C, these differences are 2.67%, 0.68%, and 0.85%, respectively.

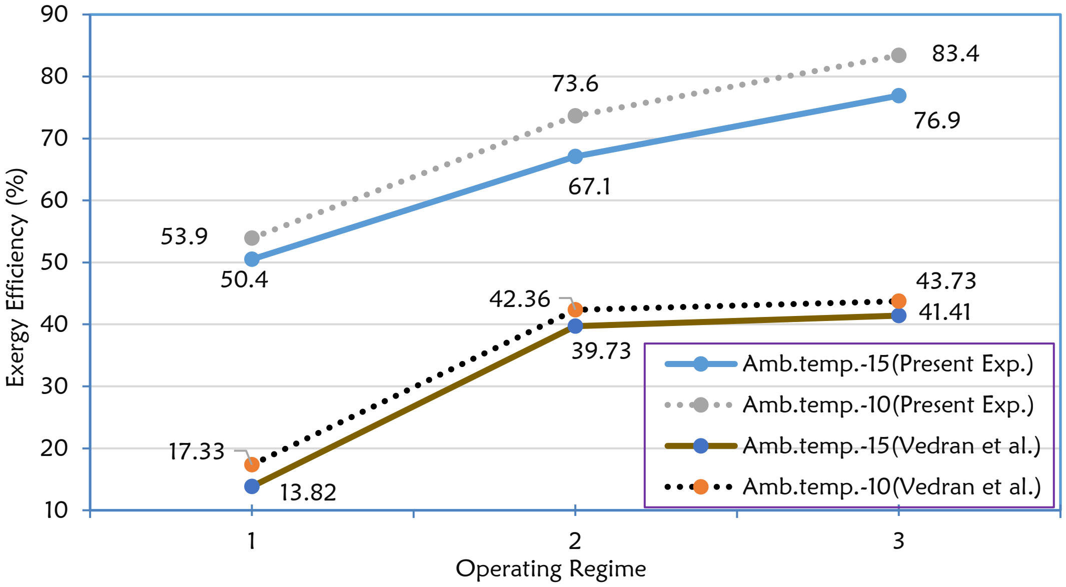

Figure 4: Comparison of changes in exergy efficiency in the present experiment with Vedran et al. [27].

3.2 Exergy Destruction

The exergy destruction of the deaerator is displayed against the operating regime in Figure 5 for both ambient temperatures. The exergy destruction of the deaerator output is subtracted from the deaerator input. The two ambient temperatures are 15°C and 30°C. From the ambient temperature of 15°C, it is observed that the deaerator's exergy destruction consistently decreases from 2.969 MW to 0.901 MW between operating regimes 1 and 4. Parallel to this, the deaerator's exergy destruction gradually decreases from 1.118 MW to 2.783 MW at 30°C and operating regimes 1 through 4. The ambient temperatures of 15°C and 30°C are nearly the same, with variations across the regimes.

3.3 Exergy Efficiency

The exergy efficiency of the deaerator is displayed against the operating regime in Figure 6. The ratio of the exergy output to the exergy input of the deaerator, expressed as a percentage, is known as exergy efficiency. The two ambient temperatures are 15°C and 30°C. From the ambient temperature of 15°C, as demonstrated in Figure 6, the deaerator energy efficiency increases steadily from operating Regime 1 to operating Regime 4, going from 50.49% in operating Regime 1 to 84.61% in operating Regime 4. Comparably, the deaerator's exergy efficiency grows steadily from 49.52% in Regime 1 to 83.74% in Regime 4 at an ambient temperature of 30°C. Here, the exergy efficiency trends at ambient temperatures of 15°C and 30°C are nearly identical, differing only across the regimes.

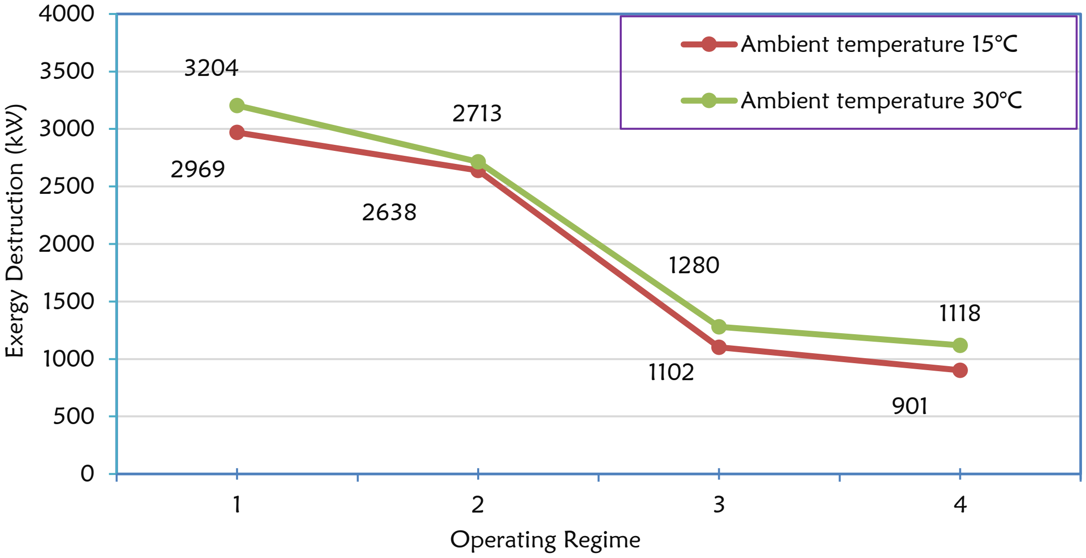

Figure 5: Variation in the deaerator's energy destruction in the operation regimes at 15°C and 30°C ambient temperatures.

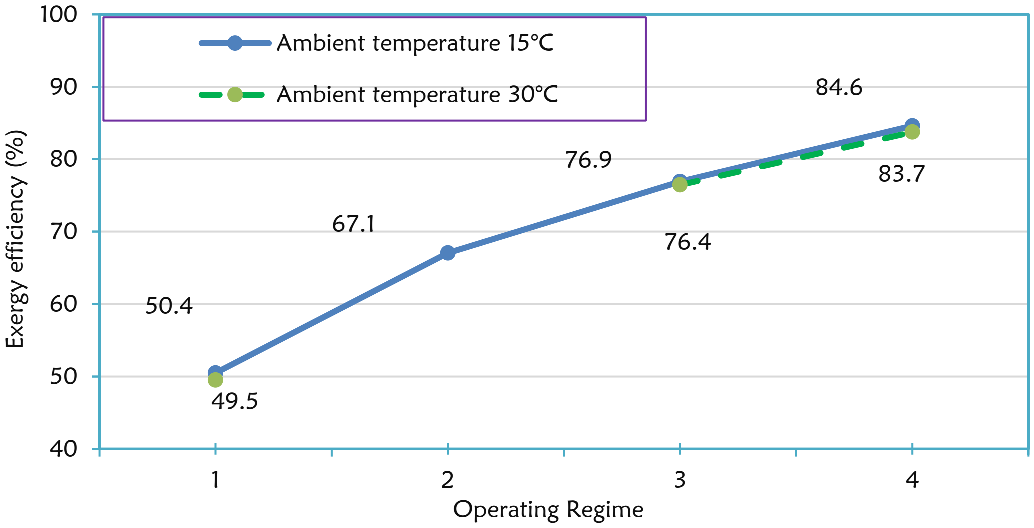

Figure 6: Variation in the deaerator's energy efficiency at ambient temperatures of 15°C and 30°C in the preceding operating regimes.

4 CONCLUSIONS

This analysis describes the exergy efficiency and exergy destruction of the deaerator in a 210 MW steam turbine power plant for four distinct ambient temperatures and four deaerator operating regimes. In this analysis, water parameters, including temperature, pressure, and mass flow rate, are measured and analyzed. The measured data and the statistics from the steam power plant's current observation are closely compared and validated. The findings of the current analysis can be expressed as follows:

1. The exergy destruction at an ambient temperature of 15°C is approximately 3 MW in Regime 1 and about 901.94 kW in Regime 4. Furthermore, the exergy destruction at an ambient temperature of 30°C is approximately 3.31 MW in Regime 1 and about 1,118.94 kW in Regime 4.
2. The exergy efficiency for an ambient temperature of 15°C is approximately 84% at Regime 4 and about 50% at Regime 1. This is because the deaerator guarantees high energy efficiency by reducing exergy destruction at low water output temperatures (Regime 4) and vice versa. Furthermore, at an ambient temperature of 30°C, the exergy efficiency is nearly 83% in Regime 4 and approximately 49% in Regime 1.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Engr. Md. Forizzaman, Superintending Engineer, Ghorashal Power Station, Bangladesh Power Development Board, for the cooperation in conducting the experimental works of the present research.

REFERENCES

[1] P. Ahmadi, M. Ameri, H. Armita. "Energy, exergy and exert- go economic analysis of a steam power plant: a case study. Int J Energy Res 2009.
[2] C. Uysal, H. Kurt, H.-Y. Kwak., "Exergetic and thermos economic analyses of a coal-fired power plant," International Journal of Thermal Sciences Vol- 117, p. 106-120, 2017.
[3] A. Kostyuk, V. Frolov: "Steam and gas turbines", Mir Publishers, Moscow, 1988.
[4] https://en.wikipedia.org/wiki/Deaerator. [Accessed on 08 January 2026]
[5] S. Adibhatla, S. C. Kaushik, "Energy and exergy analysis of a supercritical thermal power plant at various load conditions under constant and pure sliding pressure operation," Applied Thermal Engineering Vol- 73, p. 49-63, 2014.
[6] Nasrazadani SH, Ahmadidanesh H. "Energy and exergy analysis of Isfahan refinery steam power plan," Int J Sustain Energy 2012.
[7] Mrzljak, V., Poljak, I., Medica-Viola, V. "Dual fuel consumption and efficiency of marine steam generators for the propulsion of LNG carrier," Applied Thermal Engineering 119, p. 331–346, 2017.
[8] Lorencin, I., Anđelić, N., Mrzljak, V., Car, Z. "Exergy analysis of marine steam turbine labyrinth (gland) seals," Scientific Journal of Maritime Research 33 (1), p. 76-83, 2019.
[9] Dincer, I., Midilli, A., Kucuk, H. "Progress in Exergy, Energy and the Environment," Springer International Publishing, 2014.
[10] G. R. Ahmadi, D. Toghraie, "Energy and exergy analysis of Montazeri Steam Power Plant in Iran," Renewable and Sustainable Energy Reviews, Vol.56, p. 454–463, 2016.
[11] Roni, M. A. R., Abedin, M. Z., Islam, S., Miah, M. A. H., Ahsan, Z. (2024). Thermodynamic Analysis and Performance Improvement in Biomass Power Plant: A Comprehensive Review. American Journal of Mechanical and Materials Engineering, 8(1), 1-14. https://doi.org/10.11648/j.ajmme.20240801.11
[12] Kaushik SC, Reddy V Siva, Tyagi SK. "Energy and exergy analyses of thermal power plants:" a review. Renew Sustain Energy Rev 2011.
[13] Mrzljak, V., Prpić-Oršić, J., Senčić, T. "Change in Steam Generators Main and Auxiliary Energy Flow Streams During the Load Increase of LNG Carrier Steam Propulsion System," Scientific Journal of Maritime Research 32 (1), p. 121-131, 2018
[14] V. Mrzljak, I. Poljak, V. Medica-Viola, "Thermodynamically analysis of high-pressure feed water heater in steam propulsion system during exploitation," Shipbuilding, Vol-68, No-2, p.45-61, 2017.
[15] F. Hafdhi, T. Khir, A. Ben Yahyia, A. Ben Brahim, "Energetic and exergetic analysis of a steam turbine power plant in an existing phosphoric acid factory," Energy Convers. Manage. 106 ,2015.
[16] Manual Book, Ghorashal Steam Power Plant,210 MW, Bangladesh Power Development Board, Bangladesh.
[17] Abdolsaeid G, Hassan B, Mohammad NM, Jaafar TML. "Exergo environmental optimization of Heat Recovery Steam Generators in combined cycle power plant through energy and exergy analysis" Energy Convers Manag 2013.
[18] Koroglu, T., Sogut, O. S. "Conventional and Advanced Exergy Analyses of a Marine Steam Power Plant," Energy 163, p. 392-403,2018.
[19] Y. Haseli, I. Dincer, G.F. Naterer, "Optimum temperatures in a shell and tube condenser with respect to exergy," Int. J. Heat Mass Transf. 51, 2008.
[20] P. Ahmadi, M. Ameri, H. Armita. "Energy, exergy and exert- go economic analysis of a steam power plant: a case study. Int J Energy Res 2009.

[21] Blažević, S., Mrzljak, V., Anđelić, N., Car, Z. “Comparison of energy flow stream and isentropic method for steam turbine energy analysis,” Acta Polytechnica 59 (2), p. 109-125, 2019.

[22] Lemmon, E.W., Huber, M.L., McLinden, M.O. “NIST reference fluid thermodynamic and transport properties-REFPROP,” version 9.0, User’s guide, Colorado, 2010.

[23] V.Amir. “Improving steam power plant efficiency through exergy analysis: ambient temperature,” In Proceedings of the 2nd international conference on mechanical production and automobile eengineering.30;2012.

[24] Can Gulen S, Smith WSR, Second law efficiency of the Rankine bottoming cycle of a combined cycle power plant” Int J Eng Gas Turbines Power Plants 2010.

[25] Baldi, F., Ahlgren, F., Van Nguyen, T., Thern, M., Andersson, K.” Energy and Exergy Analysis of a Cruise Ship,” Energies 2018.

[26] Aljundi Isam H. “Energy and exergy analysis of a steam power plant in Jordan,” Appl Therm Eng 2009.

[27] Vedran Mrzljak, J. Musulin, J. P. Orsic, D. Stifanic, “Energy and exergy analysis of deaerator from combined cycle power plant,” At: Borovrts, Bulgaria, Volume:1,2020.

[28] https://mustafachowdhury.net/ghorashal-thernal-power-plant-station/ [Accessed on 26 January 2026]

[29] Mrzljak, V., Poljak, I., Prpić-Oršić, J. “Exergy analysis of the main propulsion steam turbine from marine propulsion plant,” Shipbuilding 70 (1), p. 59-77, 2019.

[30] Tan, H., Shan, S., Nie, Y., Zhao, Q. “A new boil-off gas re-liquefaction system for LNG carriers based on dual mixed refrigerant cycle,” Cryogenics 92, p. 84–92, 2018.