Design and Construction Fish Cool Box Using Combined Aluminum and Ethylene Vinyl Acetate (EVA) Materials

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Abstract— Innovation in this research development is related to the design and materials of fish storage (cool box). The most frequently used materials for making cool boxes of fish storage materials are polyethylene (PE), polyurethane (PU), Styrofoam, plastic fiber, and coconut fiber, which are used as heat insulators. Those materials have proven effective as heat insulators, but the problem is that they cannot decrease the temperature quickly. The Fish storage or Cool Box requires a rapid decrease in temperature to prevent putrefactive bacteria growth, and long-lasting low temperature actually. Aluminum material is one alternative that can be used to improve the quality of insulation and can also drop the temperature to the lowest degree in a cool box. Aluminum material has good thermal conductivity properties. Therefore, researchers tried to add aluminum material to the fish cool box design research. Using aluminum material for a fish cooler box is a novelty of this research. The objective of this research (1) determines lowest cool box temperature and performance temperature profile between the standard cool box and the Innovation cool box. (2) determines the cooling durability of the cool box and calculates the efficiency of ice usage between the standard and innovative fish cool box. The research method used is an experimental design, by comparing materials test, a standard cool box made of PE and PU, and an innovative cool box using aluminum, EVA sponge, and fiber for 48 Hours. Data analysis with T-test: two-sample assuming equal variances. The research results show Innovative Cool box can decrease the temperature to (-3 °C) within 45 minutes, which is faster and lower than the standard cool box, which takes 75 minutes to reach (-1 °C). The temperature cooling performance of 24 and 48 hours shows that the innovative cool box is more stable and lasts longer to maintain the temperature below (-5 °C), which is the standard used for storing fresh fish, but the efficiency of the standard cool box is 4.64% better than the innovative cool box. The Innovation Cool box's overall cooling performance and thermal stability were superior than standard cool box.

Keywords— *cool box innovation; fish handling; thermal performance; ice efficiency; aluminum–EVA insulation; post-harvest fisheries.*

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I. INTRODUCTION

Indonesia possesses abundant natural resources, with particularly significant potential in the marine and fisheries sectors. At present, Indonesia is the third-largest global exporter of fresh and frozen fish after China and India. In 2020, the total volume of Indonesian exports of fresh and frozen fish reached 57,694.3 tons [1]. Indonesian fishery export production contributes substantially to global fish consumption; however, this high production volume contrasts with relatively low export prices. The low selling price of exported fish from Indonesia is largely attributable to the suboptimal quality of fish landed by domestic fishers. Export value is strongly dependent on product quality, whereby higher fish quality is associated with increased market value [2].

Although capture fisheries production has continued to increase, improvements in catch quality have not progressed at a comparable rate. Fish stored for prolonged periods in vessel holds after capture typically undergo a decline in freshness and overall quality [3]. Fish constitute nutrient-dense animal protein sources; however, they are highly perishable commodities that deteriorate rapidly post-harvest [4]. Quality degradation is primarily induced by microbial contamination, which is exacerbated by inappropriate handling practices [5]. Among various post-harvest handling techniques, low-temperature preservation is the most widely applied method to maintain freshness. The application of low temperatures effectively suppresses the growth of spoilage bacteria [6] and slows biochemical processes within fish tissue that lead to quality deterioration [7].

Currently, most small-scale fishers employ relatively simple storage systems such as wooden boxes, Styrofoam containers, or fish holds cooled with block ice [8],[9]. These storage systems often lack adequate insulation capacity, resulting in unstable storage temperatures and accelerated quality loss. In addition, Styrofoam containers are easily damaged and may pose safety and environmental concerns when used as food-contact materials [10]. The poor insulation capacity of Styrofoam boxes also leads to rapid ice melt, thereby reducing cooling efficiency [8].

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Given these constraints, the development of innovative storage technologies is required, particularly through the modification of fish cool boxes employing lamination techniques and food-grade, thermally efficient materials. Aluminum foil and aluminum plate represent safe materials for food applications, while EVA foam materials function as an effective insulating layer capable of reducing heat transfer and solar exposure. The use of such materials is expected to maintain optimal storage temperatures, preserve product quality, enhance export value, and reduce ice consumption. Therefore, a comprehensive investigation into cool box design integrating aluminum foil, aluminum plate, and EVA foam, alongside an assessment of ice-use efficiency, is warranted to optimize post-harvest handling and storage of capture fishery products.

II. METHOD

A. Research Methodology

This study was conducted using an experimental design method, namely by developing a construction design of a cool box using aluminum and Styrofoam materials, which was then compared with the cool boxes currently used by fishers through comparative statistical testing. The research was carried out over a period of four months, from June 2025 to September 2025. The study site was the Laboratory of the Capture Fisheries Study Program, Lampung State Polytechnic.

The tools and materials used in this study are as follows:

TABLE 1.
RESEARCH INSTRUMENTS

Instrument	Quantity	Specification	Function
Cool box	9	200-liter capacity	Test material
Thermometer	3	Digital thermometer	Measure temperature
Scale	3	Digital	Measure ice weight
Hammer	3	Small hammer	Crush ice
Vernier caliper	3	Vernier caliper	Measure material thickness
Ruler	1	Steel ruler	Measure test material
Saw	1	Wood saw	Cutting tool

TABLE 2.
RESEARCH MATERIALS

Material	Volume	Specification	Function
Block ice	50 kg	Block	Main material for cool box testing
Salt	5 kg	Industrial/PDAM salt	Cooling mixture for fish
Aluminum foil	2 rolls	Bubble type	Cool box material
Aluminum plate	6 sheets	2 mm thick, premium	Cool box material
EVA foam 3 cm	6 sheets	3 cm thickness (hard)	Cool box material
Resin	10 kg	Acrylic resin	Mold material
Catalyst	5 kg	Liquid catalyst	Resin mixture
Fiberglass	20 kg	Fiberglass	Lamination material
Compound	10 kg	Resin compound	Mold surface finisher

B. Equipment Fabrication Procedure

The fabrication process commenced with a preparatory stage involving the collection and organization of all tools and materials, as listed in Tables 1 and 2. Upon completion of the preparation phase, the cool box was constructed with dimensions of 70 cm in length, 40 cm in width, and 40 cm in height. The cool box was designed with a three-layer structure: the outer layer was composed of fiberglass, the middle layer utilized EVA foam, and the inner layer was fabricated from an aluminum plate.

The lid of the cool box was constructed using the same multilayer configuration, consisting of fiberglass as the external layer, EVA foam as the intermediate layer, and an aluminum plate combined with aluminum foil as the internal layer. An aperture was created in the lid to facilitate the installation of a thermometer, in which the thermometer probe was positioned within the inner layer, and the temperature indicator was placed on the external surface of the lid. The schematic design of the innovative cool box is presented in Figure 1 and Figure 2.
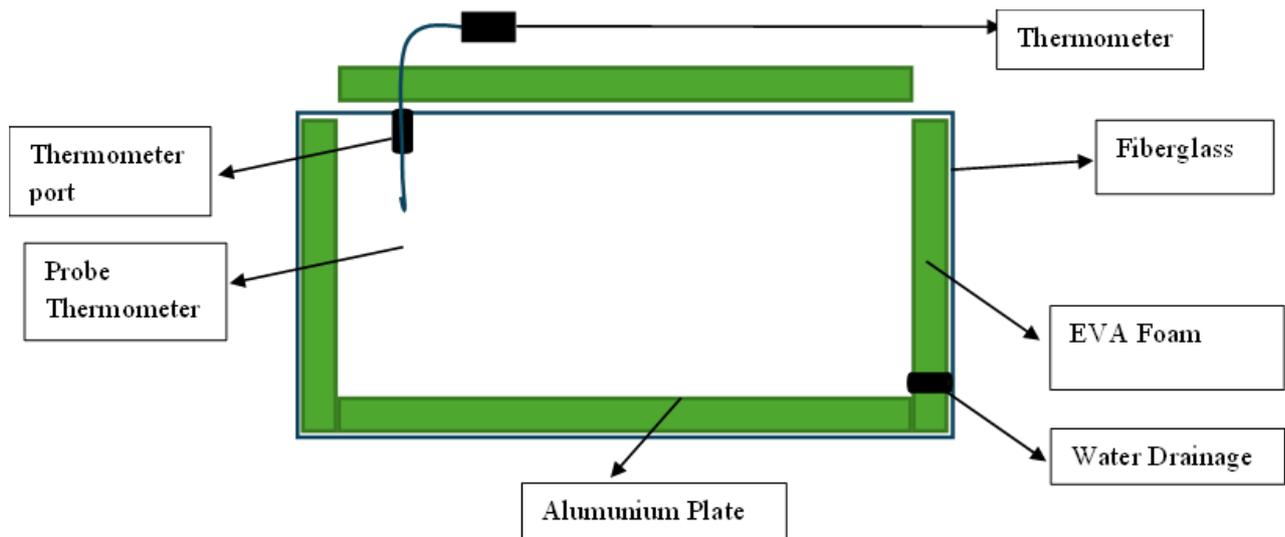
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Figure 1. Side View Of The Innovative Cool Box Design

Figure 2. Cooling Performance Test On The Innovation Coolbox On The Left And The Standard Coolbox On The Right Side

C. Testing Procedure and Data Analysis

Following the completion of the fabrication process, the innovative cool box was subjected to performance testing and comparison with a standard cool box. Data collection was initiated by determining the initial ice mass loaded into each cool box using a digital scale. Subsequently, temperature data were recorded from the thermometers installed in each cool box over a 48-hour observation period. Temperature monitoring was conducted at 5-minute intervals during the first 90 minutes to identify the optimal cooling performance, followed by 1-hour intervals up to 24 hours, and 2-hour intervals during the subsequent 24 hours. At the end of the 48 hours, the remaining ice mass in both the innovative and standard cool boxes was measured using a digital scale.

The efficiency of ice utilization was calculated based on the initial and final ice masses (kg) using the following equation:

$$\text{Ice utilization efficiency} = \frac{\text{Final ice weight (kg)}}{\text{Initial ice weight (kg)}} \times 100\%$$

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Data processing and statistical analyses were performed using Microsoft Excel. The experimental data were analyzed using an experimental design consisting of two treatments and three replications, namely the innovative cool box and the standard cool box. The results of the statistical analysis are presented in the form of tables and graphical illustrations describing the performance of both cool box types.

III. RESULTS AND DISCUSSION

Optimal temperature measurement was carried out by determining the lowest temperature that could be achieved by both cool boxes and the time required to reach it. The optimal temperature was measured over 90 minutes with recording intervals of 5 minutes. The test was conducted to assess the cooling capacity of both cool boxes and their cooling rates. The temperature measurement results are presented in Figure 3.
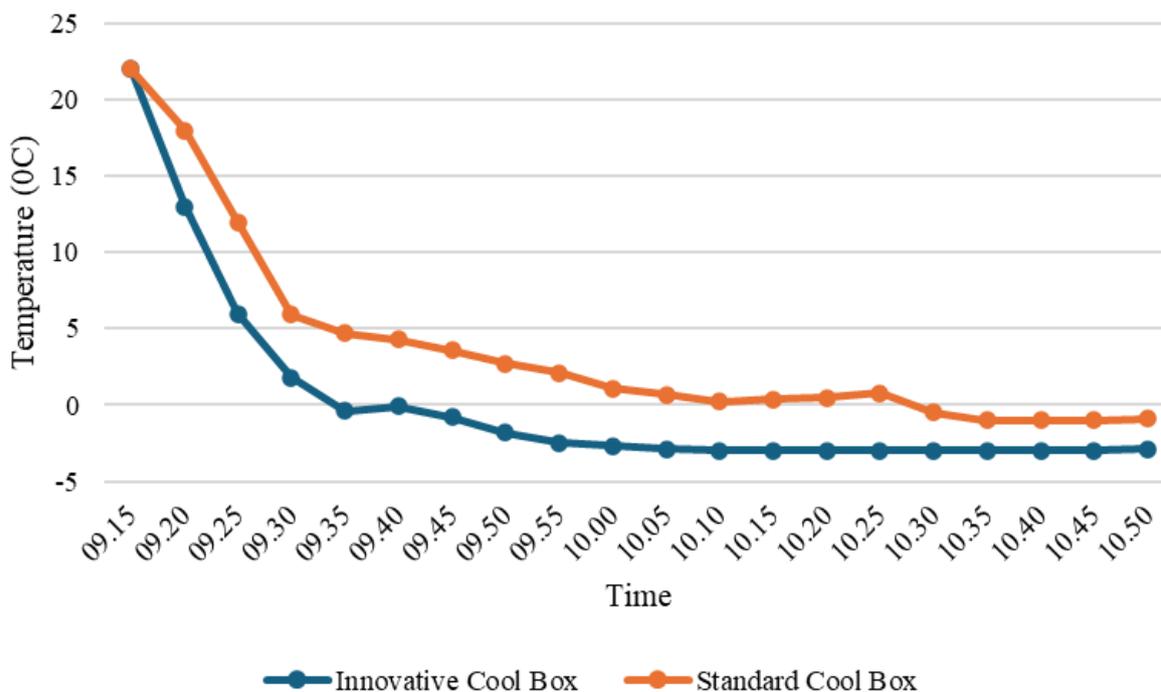

Figure 3. Optimal Temperature Profile of Cool Boxes

The test results for the innovative cool box and the standard cool box showed differences in optimal temperature and cooling rate between the two. The lowest temperature achieved by the innovative cool box was −3 °C, while the lowest temperature reached by the standard cool box was −1 °C. This indicates that the innovative cool box has superior cooling performance compared with the standard cool box, with a difference of 2 °C. The cooling rates of both cool boxes can be determined by observing the periodic temperature decrease during testing. Based on the temperature profile shown in Figure 3, the innovative cool box exhibits a faster rate of temperature decline than the standard cool box. The temperature in the innovative cool box required approximately 50 minutes to decrease from the initial temperature of 22 °C to −3 °C. The lowest temperature of the innovative cool box occurred between 10:10 and 10:45, or for approximately 35 minutes, resulting in a cooling rate of 0.5 °C/min. In contrast, the standard cool box required a longer time, approximately 80 minutes, to decrease the temperature from 22 °C to its lowest temperature of −1 °C, which occurred between 10:35 and 10:45, or for about 10 minutes; thus, the cooling rate for the standard cool box was 0.29 °C/min. Based on these results, the innovative cool box had a faster cooling rate of 0.21 °C/min, or 42% higher than the standard cool box in reaching its optimal temperature. [11] Conducted a similar test by incorporating aluminum material into a cooler box used for canned beverages. The aluminum-based cooler box exhibited better performance than the cooler box without aluminum, with a temperature difference of 3.6 °C. The innovative cool box made from a combination of an aluminum plate and EVA showed better cooling performance than the standard cool box made from fiberglass. Aluminum material has better heat transfer capability than fiberglass, which is used in the standard cool box. The thermal conductivity of aluminum is 237 W m⁻¹ K⁻¹ [12], whereas that of fiberglass is 0.05 W m⁻¹ K⁻¹ [13].

Temperature measurements at 10:50 showed that both cool boxes experienced an increase in temperature to −2.9 °C in the innovative cool box and −0.9 °C in the standard cool box. This demonstrates that the innovative cool box has a better ability to maintain the lowest temperature compared with the standard cool box. The innovative cool box was able to maintain the lowest temperature (−3 °C) for 40 minutes, while the standard cool box maintained its lowest temperature (−1 °C) for

15 minutes. Based on these observations, the innovative cool box with a combination of aluminum, EVA (Ethylene Vinyl Acetate) foam, and fiber materials has advantages in both cooling capacity and cooling rate compared with the layered-fiber standard cool box.

A. Performance of Cool Box Testing over 24 Hours
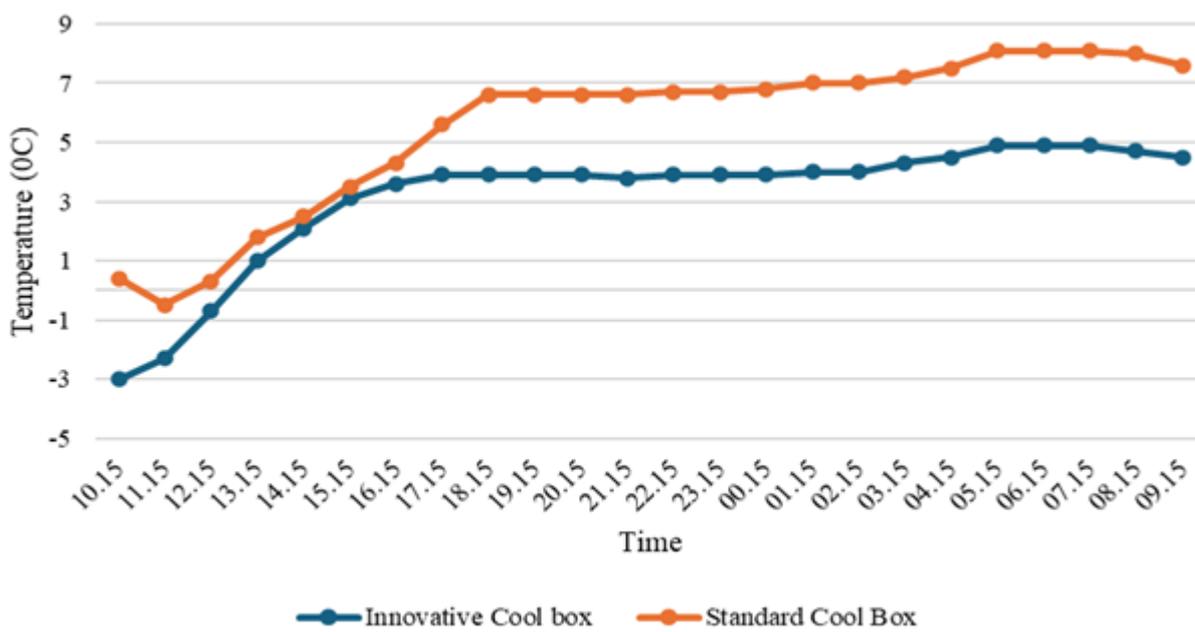
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Figure 4. Performance of Cool Boxes Over 24 Hours

The results of the 24-hour performance test of the cool boxes showed that, in general, the innovative cool box had advantages over the standard cool box in terms of the rate of temperature increase and cooling durability. In Figure 4, the optimal temperature graph shows that the lowest temperature of the innovative cool box was recorded at −3 °C at 10:10, whereas the lowest temperature of the standard cool box was −1 °C at 10:35. The 24-hour performance graph of the cool boxes in Figure 4 indicates that, within the time range of 13:15–15:15, the rate of temperature increase of both cool boxes was relatively similar; however, after this period, a considerable temperature difference between the innovative and standard cool boxes became apparent.

The increase and decrease in temperature inside the cool boxes are influenced by two main factors: the cooling insulation capacity inside the cool box and the reduction of heat transfer from the external environment. Ambient temperature outside the cool box also affects the internal cooling temperature. This can be seen during the testing period from 4:15 to 7:15, when the temperature inside the innovative cool box increased by 0.4 °C from 4.5 °C to 4.9 °C, while the temperature inside the standard cool box increased by 0.6 °C from 7.5 °C to 8.1 °C. The aluminum, EVA (Ethylene Vinyl Acetate), and fiber materials used in the innovative cool box play an important role in maintaining its cooling performance. The aluminum lining inside the innovative

cool box is critical for retaining the cold air within the box, whereas the EVA and fiber function to reduce heat transfer from the outside. In contrast, the standard cool box is made only of several layers of fiber, resulting in less effective insulation performance.

C. Optimal Performance of Cool Box Testing over 48 Hours

Optimal temperature measurement was conducted over a 48-hour testing period with recording intervals of 2 hours. Testing was performed to determine the optimal cooling performance inside the cool box over 48 hours. The optimal performance measurement of the cool box over the 48 hours is presented in Figure 5.

Results of the optimal performance test of the cool boxes indicate that the innovative cool box exhibits better performance than the standard cool box, as shown in Figure 5. The performance graph demonstrates that the innovative cool box is able to maintain a lower temperature for a longer duration compared with the standard cool box. According to the Indonesian National Standard (SNI) No. 2729:2013 on Fresh Fish, handling of fresh fish must maintain temperatures ranging from 0 °C to 4.4 °C to inhibit histamine formation [14]. [15] Similarly reported that fresh fish can be preserved for 3–4 days at temperatures between 0.5 °C and 4.4 °C. In addition, [16] found that the sensory limit of skipjack tuna stored at cold temperatures between 0 °C and 3 °C

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can be maintained for up to 10 days. Results presented in Figure 5 show that the innovative cool box can maintain temperatures below 4.4 °C for 18 hours, whereas the standard cool box can only maintain temperatures below 4.4 °C for 6 hours. Higher temperatures during fish handling accelerate spoilage after capture [17]. Conversely, lower storage temperatures help maintain fish freshness by reducing microbial contamination and sensory deterioration, thus keeping the product safe for consumption. Based on these results, the innovative cool box is capable of maintaining the desired temperature three times longer than the standard cool box.

D. Data Analysis Using Independent Sample t-Test

An independent sample t-test analysis was conducted to examine the differences in cooling performance in terms of temperature reduction and cooling durability between the innovative cool box and the standard cool box.
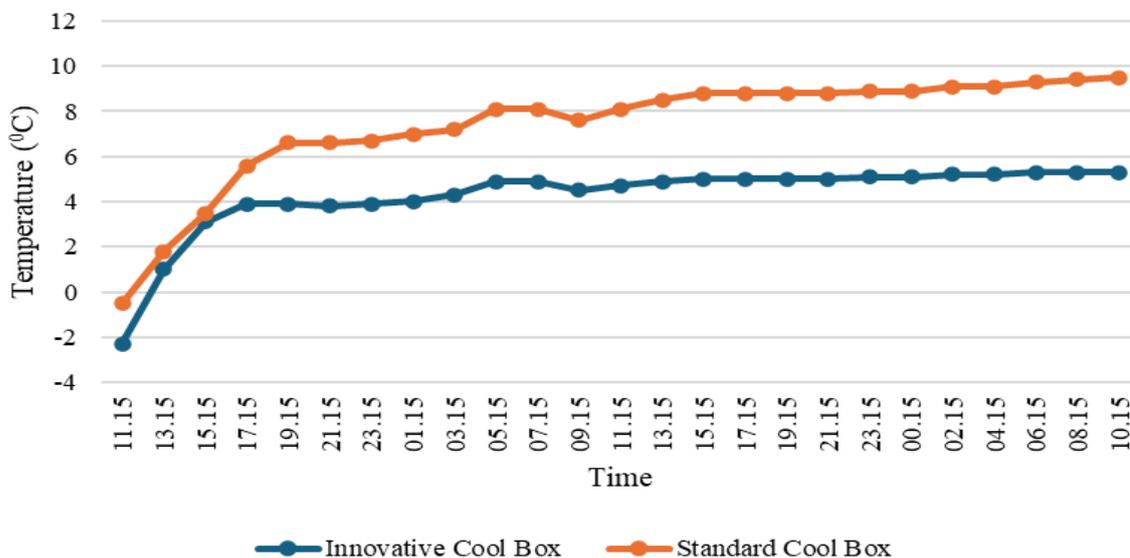

Figure 5. Performance of Cool Boxes Over 48 Hours

TABLE 2.
T-TEST: TWO-SAMPLE ASSUMING EQUAL VARIANCES

	Cool box invasion	*Cool Box Standard*
Mean	3,15	5,545833333
Variance	4,810434783	7,34259058
Observations	24	24
Pooled Variance	6,076512681	
Hypothesized Mean Difference	0	
Df	46	
t Stat	-3,366820956	
P(T<=t) one-tail	0,000772028	
t Critical one-tailed	1,678660414	
P(T<=t) two-tail	0,001544056	
t Critical two-tailed	2,012895599	

Based on the results of the independent t-test, a p-value of 0.000772028 < 0.05 was obtained, indicating a significant difference in temperature reduction performance and cooling durability between the innovative cool box and the standard cool box. In terms of temperature performance and cooling durability, the innovative cool box was significantly superior to the standard cool box.

E. Efficiency of Ice Utilization

Ice efficiency was calculated by measuring the initial and final weight of the ice placed into the cool box. The efficiency measurement was conducted over a 48-hour storage period, with the calculation as follows:

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TABLE 2.
CALCULATION OF ICE UTILIZATION EFFICIENCY IN COOL BOXES

Ice Weight (kg)	Innovative Cool Box	Standard Cool box
Initial ice weight	23.7	23.7
Final ice weight	6.2	7.3
Ice efficiency (%)	26.16%	30.80%

The ice utilization efficiency of the innovative cool box was 26.16%, whereas the standard cool box exhibited a higher efficiency of 30.80%, representing a difference of 4.64%. Based on experimental observations, the innovative cool box demonstrated lower ice efficiency compared to the standard cool box, which can be attributed to the aluminum material used in its construction, as aluminum absorbs heat more rapidly than the fiberglass material of the standard cool box. However, the higher heat absorption rate of aluminum enables the internal temperature of the innovative cool box to decrease more rapidly and to maintain a more stable thermal condition compared to fiberglass. Consequently, despite exhibiting lower ice efficiency, the innovative cool box shows superior performance in terms of temperature reduction and thermal stability relative to the standard cool box.

The efficiency of ice utilization in cool boxes is closely related to the rate of internal temperature increase, which is strongly influenced by variations in ambient temperature surrounding the cool box. Based on hourly performance observations over a 24-h period (Fig. 3), the highest temperature increase occurred between 12:15 and 13:15, during which the temperature of the innovative cool box increased by 1.7 °C, while that of the standard cool box increased by 1.5 °C. Similarly, performance testing conducted over a 48-h period with measurements taken at two-hour intervals showed that the maximum temperature increase occurred between 11:15 and 13:15, with temperature increases of 3.3 °C and 2.3 °C for the innovative and standard cool boxes, respectively. These results indicate that temperature increases predominantly occur during midday when solar radiation is at its maximum, leading to elevated ambient temperatures and consequently increasing the internal temperature of the cool boxes. The innovative cool box, which utilizes aluminum as the inner lining material, exhibits a higher heat transfer rate [18] [19], resulting in higher internal temperatures compared to the standard cool box made of fiberglass, with temperature differences of 0.2 °C during the 24-h test and increasing to 1.0 °C during the 48-h test. In addition, the outer layer, composed of ethylene-vinyl acetate (EVA), has a higher thermal conductivity (0.23 W m^{-1} K^{-1}) [20] than fiberglass, which further accelerates heat transfer in the innovative cool box relative to the standard cool box.

However, the rate of temperature increase observed in both the 24-h and 48-h tests indicates that the innovative cool box exhibited a lower temperature rise rate than the standard cool box. During the hourly measurements over the 24-h test, the temperature increase rate of the innovative cool box was 0.32 °C h^{-1}, while that of the standard cool box was 0.36 °C h^{-1}. Similarly, during the 48-h test with measurements taken every two hours, the innovative cool box showed a lower temperature increase rate of 0.15 °C h^{-1} compared to 0.20 °C h^{-1} for the standard cool box. These results demonstrate that the aluminum-based innovative cool box performs better in maintaining lower temperatures than the standard cool box, as it is capable of achieving a lower minimum temperature. Although the innovative cool box experienced a greater temperature increase than the standard cool box during periods of rising ambient temperature, it also exhibited a faster temperature reduction when ambient temperatures decreased, owing to more effective heat distribution associated with the aluminum material. Consequently, the final temperature of the innovative cool box remained lower than that of the standard cool box throughout the entire testing period, indicating that, overall, the innovative cool box outperformed the standard cool box in terms of thermal performance.

IV. CONCLUSION

Based on the research findings, it can be concluded that the innovative cool box exhibits significantly superior performance in terms of temperature reduction and temperature retention compared with the standard cool box. However, the ice-use efficiency of the standard cool box was higher by 4.64% than that of the innovative cool box.

REFERENCES

[1] Statistics Indonesia (BPS). *Export of Fresh and Chilled Capture Fish by Main Destination Countries, 2012–2020.* Statistics Indonesia,2019,www.bps.go.id/statictable/2019/02/25/2024/eksp or-ikan-segar-dingin-hasil-tangkap-menurut-negara-tujuan-utama-2012-2020.html. Accessed 19 Feb. 2023.

[2] Hartanto, T. R., Suharno, and Burhanuddin. "Export Competitiveness of Indonesian Tuna–Skipjack–Eastern Little Tuna in the United States Market." *Journal of Indonesian Fishery Product Processing*, vol. 24, no. 2, 2021, doi:10.17844/jphpi.v24i2.36075.

[3] Sovanda, B. Y. "Planning Study of a Jacketed Storage System Utilizing Liquid CO$_2$ as a Refrigerant." *Journal of POMITS Engineering*, vol. 2, no. 3, 2013, Department of Marine Systems Engineering, Faculty of Marine Technology, ITS

[4] Lubis, E., I. Solihin, and N. Afiyah. "Distribution and Quality of Spanish Mackerel from Blanakan Fishing Port to Fish Markets." *Journal of Indonesian Fishery Product Processing*, vol. 22, no. 3, 2019, pp. 433–440.

[5] Lokollo, E., and M. N. Mailoa. "Handling Techniques and Microbial Contamination of Fresh Scad Fish in Traditional Markets of Ambon City." *Journal of Indonesian Fishery Product Processing*, vol. 23, no. 1, 2021, pp. 103–111.

[6] Durrani, R. "Effects of Storage Temperature on the Microbiological Quality of Fish Meat from Two Different

International Journal of Marine Engineering Innovation and Research, Vol. 11(1), Mar. 2026. 208-215
(pISSN: 2541-5972, eISSN: 2548-1479)

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Managerial Systems." *Pakistan Journal of Zoology*, vol. 53, 2020, doi:10.17582/journal.pjz/20190503070517.

[7] Gelman, A. L., et al. "Effect of Storage Temperature and Preservative Treatment on the Shelf Life of Pond-Raised Freshwater Fish, Silver Perch (*Bidyanus bidyanus*)." *Journal of Food Protection*, vol. 64, 2001, pp. 1584–1591.

[8] Setyalina, R., and S. K. Sari. "Design and Analysis of a Cool Box as a Fish Storage Medium for Fishermen in Lumpur Subdistrict, Gresik Regency." *Proceedings of the 6th National Seminar on Applied Science and Technology*, Institut Teknologi Adhi Tama Surabaya, 2018, pp. 193–198.

[9] Priyonggo, P., et al. "Experimental Study on the Effect of Vacuum Insulation on the Fish Hold Insulation System of a 7 GT Fishing Vessel." *Inovtek Polbeng Journal*, vol. 11, no. 2, 2021, pp. 180–186.

[10] Wirahadi, M. "Interior Elements Made from Processed Styrofoam Waste and Orange Peel Waste." *Journal Intra*, vol. 5, no. 2, 2017, pp. 144–153.

[11] Renhard, N. G., et al. "Performance Testing of a 4.7-Liter Portable Beverage Cooler Using Thermoelectric Modules with and without Aluminum." *Online Journal of Engineering Faculty Students, University of Riau*, vol. 3, no. 2, 2016, pp. 1–4.

[12] Zhang, A., and Y. Li. "Thermal Conductivity of Aluminum Alloys: A Review." *Materials*, vol. 16, no. 8, 2023, article 2972, doi:10.3390/ma16082972.

[13] Anh, L. D. H., and Pásztory. Z., "An Overview of Factors Influencing the Thermal Conductivity of Building Insulation Materials." *Journal of Building Engineering*, vol. 44, 2021, doi:10.1016/j.jobe.2021.102604.

[14] Indonesian National Standard. *Fresh Fish*. SNI 2729-2013, National Standardization Agency of Indonesia, 2013.

[15] Asiah, N., et al. *Basic Principles of Food Storage at Low Temperatures*. 1st ed., Nas Medika Pustaka, 2020.

[16] Norita, N., M. Nurilmala, and A. Abdullah. "Quality of Gray Mackerel Tuna (*Thunnus tonggol*) under Different Storage Conditions." *Journal of Indonesian Fishery Product Processing*, vol. 22, no. 3, 2019, pp. 490–497, doi:10.17844/jphpi.v22i3.28947.

[17] Lestari, S., A. Baehaki, and I. M. Rahmatullah. "Effect of Post-Mortem Conditions and Storage Temperature on the Fillet Quality of Striped Catfish (*Pangasius djambal*)." *FishtecH Journal*, vol. 9, no. 1, 2020, pp. 34–41.

[18] Putra, B. A., S. Agustin, and Y. A. Nastiti. "Comparative Cost Analysis of Patrol Boat Production Using Aluminum and Fiberglass Materials." *Sigmat: Journal of Mechanical Engineering*, vol. 3, no. 1, 2023, pp. 26–33.

[19] Rahmawati, et al. "Effect of Aluminum, PVC, and Fiberglass Material Characteristics on Energy Efficiency in Small-Scale Wind Turbines." *Sriwijaya Journal of Electrical Engineering*, vol. 6, no. 2.

[20] Allan, J., H. Pinder, and Z. Dehouche. "Enhancing the Thermal Conductivity of Ethylene-Vinyl Acetate (EVA) in a Photovoltaic Thermal Collector." *AIP Advances*, vol. 6, no. 3, 2016, article 035011, doi:10.1063/1.4944557.