

## INTISARI

Platform lepas pantai milik PT Pertamina Hulu Energi *West Madura Offshore* telah mengalami masalah getaran yang signifikan pada struktur pendukung *air cooled heat exchanger* (ACHE). Getaran ini dapat menyebabkan kerusakan pada peralatan, mengurangi umur pakai struktur, dan meningkatkan biaya perawatan. Untuk mengatasi masalah ini, dilakukan penelitian tentang perancangan dan pengujian dinamis modifikasi desain struktur pendukung *air cooled heat exchanger*. Dua alternatif desain dikembangkan dari desain dasar dengan penambahan *bracing* di lokasi berbeda: alternatif 1 menambahkan *bracing* di tengah dudukan *fan*, sementara alternatif 2 menambahkan *bracing* di tengah dan samping dudukan *fan*. Hasil *meshing* menunjukkan bahwa ketiga desain memiliki nilai *orthogonal quality* dan *skewness* yang aman. Pengujian statis mengungkapkan bahwa desain alternatif 2 memiliki *equivalent von-Mises stress* terendah sebesar 29,326 MPa, total deformasi terendah sebesar 0,71746 mm, dan *safety factor* tertinggi sebesar 8,5248. Analisis modal menunjukkan peningkatan signifikan pada desain alternatif 2, dengan frekuensi natural tertinggi pada *mode shape* ke-17 sebesar 32,065 Hz, meningkatkan kekakuan dan stabilitas struktural serta mengurangi risiko resonansi. Analisis *harmonic response* menunjukkan bahwa amplitudo kecepatan getaran pada desain alternatif 2 menunjukkan hasil yang jauh lebih baik dari desain eksisting maupun alternatif 1 dengan amplitudo kecepatan getaran hanya 6,0147 mm/s pada unit E-635A dan 6,7766 mm/s pada unit E-635B, menunjukkan peningkatan stabilitas struktur dan pengurangan risiko kerusakan serta kebutuhan perawatan. Puncak frekuensi resonansi bergeser dari 25 Hz pada desain eksisting ke 31 Hz pada alternatif 1 dan 32 Hz pada alternatif 2, menunjukkan peningkatan kekakuan struktur dan menghindari area berbahaya akibat vibrasi tinggi.

**Kata kunci:** *air cooled heat exchanger*, perancangan struktur, pengujian statis, pengujian dinamis, *modal analysis*, *harmonic response*

## ABSTRACT

*The offshore platform of PT Pertamina Hulu Energi West Madura Offshore has experienced significant vibration issues in the support structure of the air-cooled heat exchanger (ACHE). These vibrations can cause equipment damage, reduce the structure's lifespan, and increase maintenance costs. To address these issues, a research was conducted on the design modification and dynamic testing of the ACHE support structure. Two alternative designs were developed from the baseline design by adding bracing at different locations: Alternative 1 added bracing in the middle of the fan mounts, while Alternative 2 added bracing both in the middle and on the sides of the fan mounts. Meshing results showed that all three designs had safe orthogonal quality and skewness values. Static testing revealed that Alternative 2 had the lowest equivalent von-Mises stress at 29.326 MPa, the lowest total deformation at 0.71746 mm, and the highest safety factor at 8.5248. Modal analysis showed significant improvement in Alternative 2, with the highest natural frequency at the 17th mode shape at 32.065 Hz, enhancing structural stiffness and stability while reducing resonance risk. Harmonic response analysis indicated that the vibration velocity amplitude in Alternative 2 was significantly better than both the existing design and Alternative 1, with amplitudes of 6.0147 mm/s on unit E-635A and 6.7766 mm/s on unit E-635B, indicating improved structural stability and reduced damage risk and maintenance needs. The peak resonance frequency shifted from 25 Hz in the existing design to 31 Hz in Alternative 1 and 32 Hz in Alternative 2, demonstrating increased structural stiffness and avoiding dangerous high-vibration areas.*

**Keywords:** *air-cooled heat exchanger, structural design, static testing, dynamic testing, modal analysis, harmonic response*