

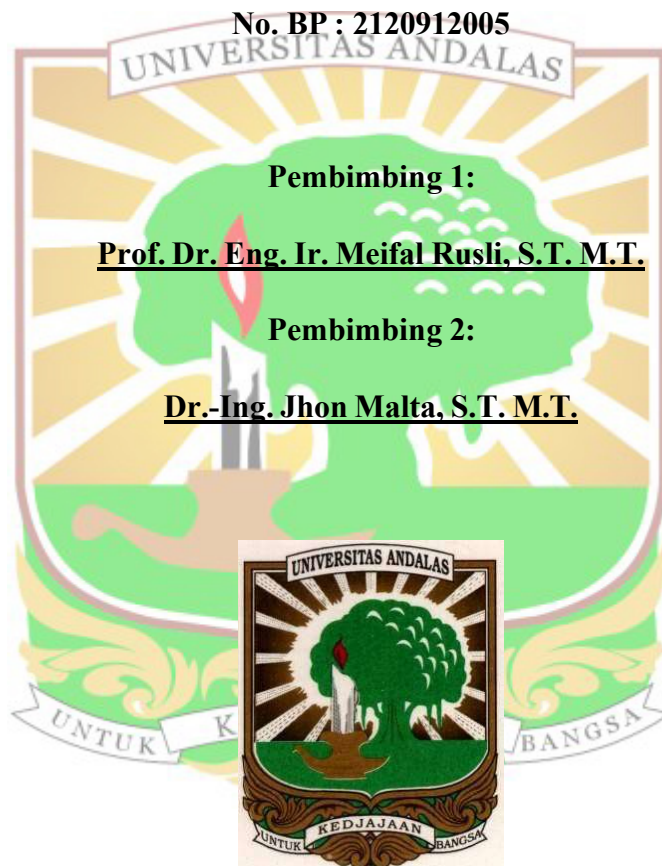
TESIS

**EVALUASI PENGGUNAAN ADAPTER BUSBAR BMC SEBAGAI
ISOLATOR TERMAL TERHADAP KINERJA SENSOR
AKSELEROMETER STANDAR DALAM MENDETEKSI CACAT PADA
BEARING**

Oleh:

NOVIANDY, S.T

No. BP : 2120912005



Pembimbing 1:

Prof. Dr. Eng. Ir. Meifal Rusli, S.T. M.T.

Pembimbing 2:

Dr.-Ing. Jhon Malta, S.T. M.T.

DEPARTEMEN TEKNIK MESIN

FAKULTAS TEKNIK - UNIVERSITAS ANDALAS

PADANG

2025

Abstrak

Penelitian ini mengkaji penggunaan adapter busbar berbahan *Bulk Molding Compound* (BMC) sebagai isolator termal untuk sensor akselerometer standar pada aplikasi pemantauan kondisi mesin bersuhu tinggi. Tiga variasi ketebalan (SM30–30 mm, SM40–40 mm, dan SM51–51 mm) diuji melalui simulasi termal, uji dinamis (*impact* dan *shaker*), serta pengujian langsung pada bearing cacat, kemudian dibandingkan dengan *stud mounting* konvensional.

Hasil simulasi termal menunjukkan bahwa peningkatan ketebalan adapter meningkatkan resistansi panas secara signifikan. Adapter SM51 menghasilkan isolasi terbaik dengan temperatur sensor 30,29 °C dan $\Delta T = 169,7$ °C, sehingga panas yang diterima sensor hanya 15,1%.

Hasil uji dinamis memperlihatkan bahwa isolator BMC tidak mengubah frekuensi pribadi utama sistem (707–730 Hz), namun menimbulkan respon tambahan pada frekuensi rendah (<5 Hz) dan memengaruhi amplitudo getaran sesuai ketebalan adapter. Uji *shaker* menunjukkan performa sistem tetap linier dan stabil ($R^2 > 0,999$; deviasi $< \pm 2\%$) hingga 500 Hz, meskipun terjadi penurunan akurasi pada frekuensi tinggi (≥ 1000 Hz).

Pada pengujian bearing, seluruh adapter tetap mampu mendeteksi cacat *outer race*. Domain percepatan dan *enveloping* memberikan sensitivitas terbaik, bahkan beberapa konfigurasi adapter meningkatkan amplitudo BPFO dan harmoniknya. Fenomena *rotating looseness* teridentifikasi dan terbukti dapat menutupi sinyal cacat melalui dominasi energi $1 \times TS$ dan harmoniknya, menyebabkan crest factor menurun meskipun terdapat cacat/defect.

Secara keseluruhan, adapter BMC SM30 memberikan kinerja paling optimal karena mampu menjaga sensitivitas deteksi getaran tanpa mengorbankan isolasi termal. Adapter ini direkomendasikan untuk aplikasi *online condition monitoring* pada mesin industri bersuhu tinggi, ketika *stud mounting* tidak memungkinkan dilakukan.

Kata kunci: Adapter isolator termal, *Bulk Molding Compound*, akselerometer, deteksi cacat bearing, vibrasi, *envelope analysis*

Abstract

This study investigates the use of busbar adapters made from Bulk Molding Compound (BMC) as thermal isolators for standard accelerometer sensors in high-temperature machine condition monitoring applications. Three thickness variations (SM30–30 mm, SM40–40 mm, and SM51–51 mm) were evaluated through thermal simulations, dynamic testing (impact and shaker), and direct testing on defective bearings, and subsequently compared with conventional stud mounting.

The thermal simulation results indicate that increasing the adapter thickness significantly improves thermal resistance. The SM51 adapter provides the highest level of isolation, producing a sensor temperature of 30.29 °C with a temperature drop (ΔT) of 169.7 °C, allowing only 15.1% of the heat to reach the sensor.

Dynamic testing shows that the BMC isolators do not shift the primary natural frequency of the system (707–730 Hz), but introduce additional low-frequency responses (<5 Hz) and influence vibration amplitude depending on the adapter thickness. Shaker testing demonstrates that the system maintains linear and stable performance ($R^2 > 0.999$; deviation < $\pm 2\%$) up to 500 Hz, although measurement accuracy degrades at higher frequencies (≥ 1000 Hz).

In the bearing defect tests, all adapters were capable of detecting outer-race damage. The acceleration and enveloping domains provided the highest sensitivity, and in some configurations, the adapters even amplified the BPFO components and their harmonics. Rotating looseness was identified and shown to obscure defect signatures due to the dominant energy at $1 \times TS$ and its harmonics, causing a reduction in crest factor despite the presence of a fault.

Overall, the SM30 BMC adapter delivered the most optimal performance, maintaining vibration detection sensitivity without sacrificing thermal isolation. This adapter is recommended for online condition monitoring applications on high-temperature industrial machines, particularly when stud mounting cannot be applied.

Keywords: thermal isolator adapter, Bulk Molding Compound, accelerometer, bearing defect detection, vibration, envelope analysis