

Structure-borne Transformer Noise Reduction by Air Isolation

Transformers transmit noise, thru the air, to the neighboring spaces inconveniencing the occupants. The noise transmitted in this fashion is called 'airborne noise'. In addition to airborne noise transformers transmit vibration through the structure of the building, where the transformer is sitting, to the neighboring spaces causing structure-borne noise.

The airborne part of the transformer noise is normally abated by enclosing the transformer in a soundproof enclosure (room). The structure-borne part of the noise should be treated by *properly isolating* the transformer from the structure, abating the transmission of transformer vibration to the structure.

In a recent application, DEICON was asked to further improve the structure-borne noise reduction of two large transformers (9000 pounds, each) installed in a multi-story residential building. The transformers were housed in sound proofed rooms and isolated from the floor via mounts (compressed fiberglass mounts for one transformer and cork/neoprene mats for the other). In a preliminary study including some laboratory tests it was concluded that the compressed fiberglass mounts had too much damping deteriorating their high frequency vibration isolation and the cork/neoprene mounts were too stiff to effectively isolate the transformer. It was decided to change the isolation schemes from compressed fiberglass and cork/neoprene to air.

Switching the mounting systems to air, lowered the transmission of vibration from the transformer to the structure drastically abating the transmission of the structure-borne noise. The picture shows two of the newly installed air mounts under the transformer. In total 6 air mounts are holding the machine.

The plot shows the power spectrums of acceleration, over the frequency range of 0-2400 Hz, measured on the support/base structure of the transformer next to one of the mounting feet. The blue trace shows the measurement with the cork/neoprene mount (mat) in place and the red trace shows the same measurement with the air mounts in place. Clear from this figure, the isolation effectiveness of the air mounts by far exceeds that of the existing cork/neoprene mats.

The sound measurements before and after changing the mounts were done in the residential area; not shown for the sake of brevity. An improvement in line with that of vibration abatement was observed.

Transformer noise (hum) is caused by the extension and contraction of the core laminations when magnetized (a phenomenon known as magnetostriction). This extension and contraction (vibration) takes place twice during a normal voltage or current cycle. That is, the transformer vibrates mainly at twice the frequency of the supply, i.e. 120 Hz in North America (and 100 Hz elsewhere) and to a lesser extent at 60/50 Hz. Considering that this 120/100 Hz vibration is not quite sinusoidal, the higher order harmonics of the fundamental frequency (240, 360, 480, ... Hz) are also present in the spectrum of the vibration and the consequent noise. The higher order harmonics also exist, to a lesser extent, for 60/50 Hz component.

The reasons for choosing air as the isolation medium were: 1) softness enabling air to provide the highest degree of low-frequency isolation of any type vibration isolator, 2) large load-bearing without, excessive static deflection and 3) negligible overall damping enhancing high-frequency isolation.

