Structure-borne Transformer Noise Reduction by Air Isolation

Transformers transmit noise partly through the air (airborne noise). In addition to the airborne noise transformers transmit vibration through their support structure 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 (weighing 9000 pounds, each) installed in a multi-story residential building. The transformers were housed in soundproofed rooms and isolated from the floor via vibration isolators (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 media from compressed fiberglass and cork/neoprene to air.

Switching the mounting systems to air isolation, lowered the transmission of vibration from the transformer to the structure drastically abating the structure-borne noise. Figure 1 shows two of the newly installed air mounts (air springs) under the transformer. In total 6 air mounts were used to the isolation system.

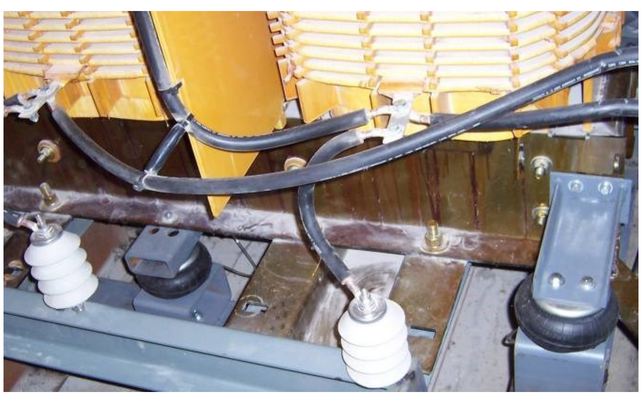

Figure 1 Two of the mounting feet of the transformer

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.

Figure 2 shows the power spectra 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 old cork/neoprene mats.

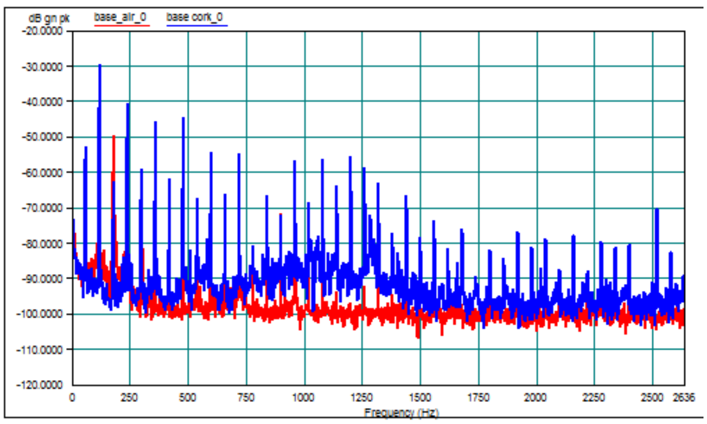

Figure 2 Power spectra before (blue trace) and after (red trace) switching the mounting scheme to air

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.

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.