Ultrasonic Gas Leak Detection Using BROADSONIC Optical Ultrasonic Sensing

Identifying pressurized gas leaks via broadband ultrasonic emission signatures from 20 kHz to 600 kHz

The Challenge

Pressurized gas leaks in industrial and commercial equipment are a significant source of fugitive methane emissions and a safety hazard. Small leaks at pipe fittings, valve packings, and compressor seals often go undetected because they produce no visible sign and their audible hiss is masked by ambient noise. Conventional detection methods such as handheld combustible gas detectors and soap bubble testing require close proximity, are slow to deploy across large facilities, and provide no quantitative data about leak severity.

Pressurized gas escaping through a small orifice generates broadband ultrasonic noise as turbulent flow interacts with the leak geometry. This signature extends well above the audible range, but conventional microphones are limited to below 20 kHz and most commercial ultrasonic leak detectors operate in a narrow band around 40 kHz. BROADSONIC is an optical ultrasonic sensor that overcomes these limitations: non-contact, inherently immune to electromagnetic interference, with broadband sensitivity from Hz to 5 MHz and configurable sub-Hz frequency resolution.

Result: Broadband Ultrasonic Leak Signature

BROADSONIC was used to measure acoustic emissions from a gas leak at a compressor fitting. The frequency spectrum was captured from 0 to 600 kHz, with a background noise measurement taken at the same location for comparison. The results demonstrate three key findings:

1. Clear ultrasonic signature above the audible range. The leak signal (red) rises well above the background noise (gray/green) across the ultrasonic band from 100 kHz to beyond 500 kHz. The strongest contrast occurs in the 100 to 300 kHz region, where conventional microphones have no sensitivity.

2. Broadband spectral content enables leak characterization. Unlike narrowband detectors that sample a single frequency, BROADSONIC captures the full spectral shape of the leak emission. The spectral envelope encodes information about leak geometry, orifice size, and gas pressure, providing a richer diagnostic fingerprint.

3. High signal-to-noise ratio in the ultrasonic band. While the leak signal and background noise converge at audible frequencies (below the dashed 20 kHz line), the ultrasonic band provides 20+ dB of contrast, making detection robust in noisy industrial environments.

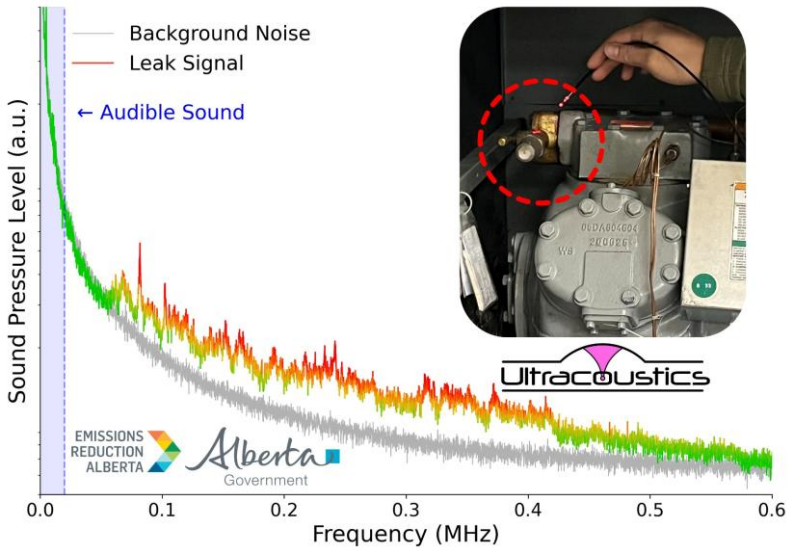

Figure 1: *Broadband acoustic spectrum, 0 to 600 kHz. The leak signal (red) from a compressor fitting is clearly distinguished from background noise (gray/green) across the ultrasonic band. Shaded region marks the audible range. Inset: BROADSONIC sensor positioned near the leak source.*

Implication: Continuous Leak Monitoring

Fugitive emissions from gas leaks represent both a safety risk and a significant contributor to greenhouse gas inventories. Current leak detection and repair (LDAR) programs rely on periodic manual surveys, meaning leaks can persist for weeks or months between inspections. BROADSONIC enables a shift to continuous, automated monitoring. A baseline acoustic signature captured under normal conditions serves as the reference; any change in the ultrasonic spectral profile triggers an alert, giving operators early warning before a small leak becomes a large one.

The broadband spectral data also supports leak quantification. Because spectral shape and amplitude correlate with orifice size and pressure differential, BROADSONIC measurements can estimate leak rates, enabling operators to prioritize repairs based on emissions impact.

Key Advantages for Gas Leak Detection

Detect fugitive gas emissions earlier, more reliably, and with richer diagnostic data than conventional methods.

Detection Challenge	How BROADSONIC Solves It
Audible hiss masked by ambient noise	Broadband ultrasonic sensitivity from 20 kHz to 5 MHz detects leaks where industrial background noise is minimal
Narrowband detectors miss spectral detail	Full spectral capture from Hz to 5 MHz provides a complete acoustic fingerprint for characterization and quantification
Periodic surveys miss intermittent leaks	Continuous optical sensing enables 24/7 automated monitoring with real-time alerting on spectral changes
Sensor degradation in harsh environments	Optical transduction is immune to EMI, corrosion-resistant, and requires no electrical connections at the sensing point
No quantitative leak rate data	Broadband spectral shape and amplitude correlate with orifice size and pressure, supporting leak rate estimation

Contact: To discuss how BROADSONIC can support your gas leak detection and emissions monitoring requirements, please contact Ultracoustics Technologies Ltd. at kyle@ultracoustics.com