Noise Attenuation of Natural Gas Compressors Using Acoustic Array Technology

By
Corey Kinart, MBA, PEng
HGC Engineering

Introduction to Speaker

• 5 years: military aerospace
  – F404-GE-400 gas turbine engine (F/A-18)
• 12 years: acoustical consultant
  – extensive work with industrial gas turbine applications
A Brief “Noise 101”

• Sound Pressure Level
  – Measured logarithmically in decibels [dB]
    
    $1 + 1 \neq 2!!$

• Pitch and Frequency
  – Measured in units of Hertz [Hz]
    • 1 Hz = 1 oscillation per second
  – Low frequency sound → tuba, thunder
  – High frequency sound → piccolo or hissing air leak
  – Human hearing range: 20 Hz to 20 kHz
A Brief “Noise 101”

• A-weighting Network
  – We have different sensitivities to sounds of different frequencies
  – A-weighting mimics response of human ear

A-Weighting Network

![Graph showing A-weighting network with response in dB re: sensitivity at 1 kHz and frequency in Hz. The graph highlights the response at 1,160 Hz.]
What is Noise?

- Simply put: Unwanted Sound
- Can interfere with:
  - Sleep
  - Enjoyment of property
- Can lead to complaints

The Importance of Environmental Noise

- Regulations/ordinances, etc.
- Environmental Approvals, Assessments
- Financing obligations
- Corporate Social Responsibility
Natural Gas Compressor Stations

Gas Compressor
The Issue

• Sound emissions from natural gas compressors have strong tonal component
  – Emitted to the outdoors via gas piping, compressor building envelope (ventilation openings, walls, doors)
  – “Blade Pass Frequency” (and higher harmonics)

Gas Compressor Tones

[Diagram showing sound pressure levels at various frequencies, highlighting Blade Pass Frequency at 1,160 Hz and harmonics at 2nd, 3rd, and 4th orders.]
The Issue (cont’d)

• So… who cares?
  – Tonal sound has greater potential for audibility and annoyance
  – Some noise guidelines/ordinances penalize tonal sound

Historical Approach to Noise Control

• “Brute Force”
  – Silencers, acoustic enclosures, barriers, acoustical lagging (wrapping)
• All downstream of the “real” source
• Costly; create accessibility issues
Noise from Above-Grade Piping

• Gas compressor noise transmitted through gas medium, radiated to environment through piping walls
• Typically mitigated with acoustical lagging

Acoustical Lagging
Even More Brute Force

Acoustic Array

• Designed to limit generator of noise from gas compressors at the source
• Two types:
  – Flat plate
  – Pipe
Acoustic Array (cont’d)

• Rely on physics of side branch Helmholtz resonator
Helmholtz Resonator (cont’d)

- Can be tuned to respond (i.e. resonate) at particular acoustic frequency
  - Vary dimensions of cavity and length/diameter of neck

Acoustic Array (cont’d)

- Employ many Helmholtz resonators
  - Target blade pass frequency and higher harmonics
  - Can be “stacked” to attenuate noise over larger frequency range
Acoustic Array

- Demonstrated attenuations of 10 dB+

Without Array

With Array

Image Credit: Liu, Z and Hill, D. Centrifugal Compressor Noise Reduction by Using Helmholtz Resonator Arrays, Dresser-Rand, Olean, NY USA, 2007
Acoustical Benefits

• Compliance with regulatory requirements
  – May alleviate tonal penalty
• Reduces audibility (complaints)
• Reduces cost to control noise from other sources
• Creates “acoustical headroom”

Additional Benefits

• Reduced unsteady aerodynamic load on impeller blades and diffuser vanes
• Reduced pipe vibration, which improves structural integrity and instrumentation life
Questions?

Noise Attenuation of Natural Gas Compressors Using Acoustic Array Technology

By
Corey Kinart, MBA, PEng
HGC Engineering

Thank you!