www.iagtcommittee.com October 23rd - 25th, 2017, Banff, Alberta

Noise Attenuation of Natural Gas Compressors Using Acoustic Array Technology

By
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Presented at the 2017 Symposium on Industrial Application of Gas Turbines (IAGT)
Banff, Alberta, Canada - October 2017

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 ≠ 2!!

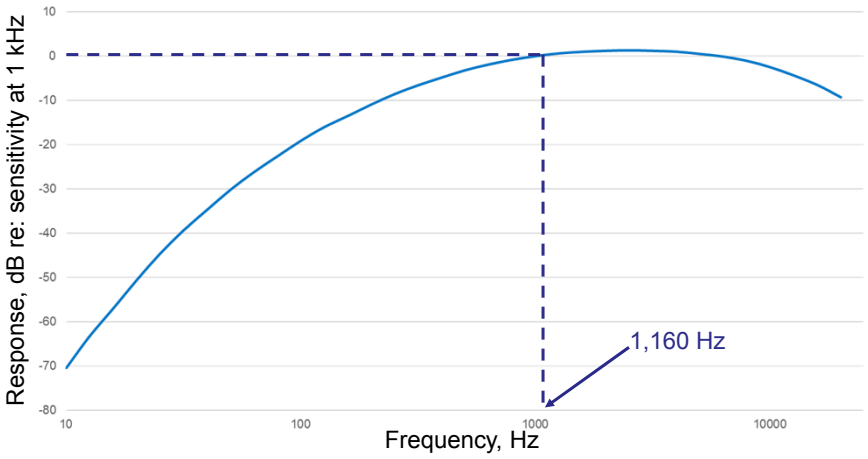
A Brief “Noise 101”

- 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



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

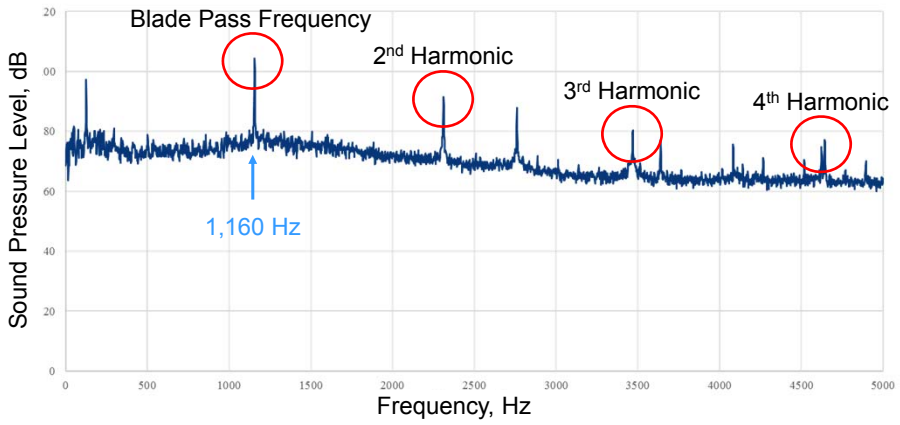
Natural Gas Compressor Stations

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



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

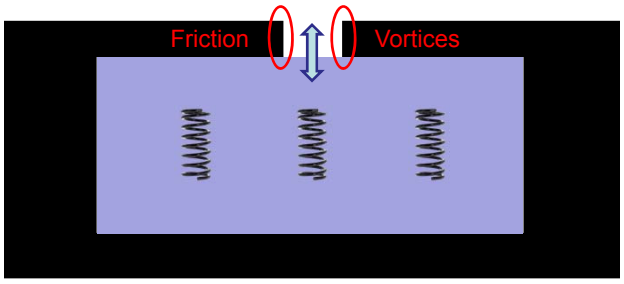
- Designed to limit generator of noise from gas compressors at the source
- Two types:
  - Flat plate
  - Pipe

Acoustic Array (cont'd)

- Rely on physics of side branch Helmholtz resonator

Helmholtz Resonator

Bulk Gas Flow



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

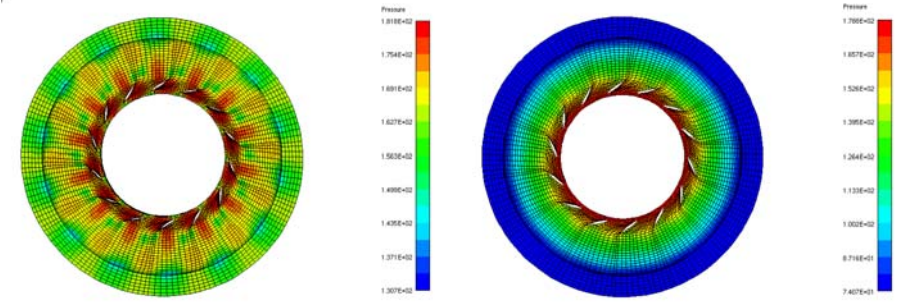
Acoustic Array

(Bottom Half)

Dresser-Rand US patents: US 6,550,574 and US 6,601,672

Acoustic Array (cont'd)

- 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?

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