Figure 1. Compressor noise testing with no acoustic blanketing (left) and with acoustic blanketing (right)

MEASURING MACHINERY NOISE

EVALUATION OF ACOUSTIC BLANKETING TO MITIGATE COMPRESSOR NOISE

BY MARK PECHULIS

Exposure to potentially damaging machinery noise is an everyday risk for millions of factory workers. The U.S. Occupational Safety and Health Administration (OSHA) estimates that companies pay out more than $242 million each year in worker's compensation claims due to hearing loss.

Centrifugal compressors in refineries, petrochemical plants, liquefied gas services, and other industrial applications can be a major source of noise in plant operations. As a result, they are subject to noise standards established and regulated by OSHA to protect workers from exposure to elevated noise levels that can lead to hearing loss over time.

To meet OSHA noise standards, operators are required to manage plant noise levels for worker safety and comfort, and for environmental compliance in the communities where they operate. Plant operators rely on the manufacturer's estimated noise ratings to determine a unit's contribution to overall plant noise, and they require manufacturers to meet certain noise level guarantees.

Identifying and mitigating compressor noise is a complex process that can be addressed either through design engineering or by reducing noise from an already installed unit. For that purpose, manufacturers have developed noise-prediction tools to help determine the most cost-effective noise reduction methods.

Elliott began collecting noise data from its rotating equipment in the 1970s and initiated a noise-prediction program at that time. The program incorporates semi-empirical equations as a function of the operating conditions of the equipment, refined over time with the continuous goal of more accurate predictions. Recently, the company teamed with an acoustical consultant from Frank & Faibusch Strategies of Whitefish, Montana, on a two-phase project to validate noise prediction algorithms and testing methods and evaluate upgraded acoustic blanketing on compressors. Phase 1 included shop testing of a compressor and evaluation of acoustic blanketing (Figure 1). Phase 2, which includes field testing and acoustic blanket improvements and optimizations, will be completed in 2020.

During Phase 1, noise data from a large, back-to-back, two-section Elliott 70M compressor was collected during shop performance loop testing. Due to a high degree of background noise from untreated compressor and throttling valve piping, and reverberant reflections from the shop floor, the background noise level exceeded the compressor's noise contribution by well over 10 dBA, the limit for sound intensity method.

As accurate sound pressure level or sound power measurements were not possible under those conditions, the test team constructed a large, relatively lightweight acoustical test enclosure sealed against the side of the compressor to isolate the background noise from the shop floor. The enclosure featured custom-fit acoustic blanketing on the internal frame.

The Phase 1 test team used three test methods to collect and compare noise data (Figure 2). In the first test, they used a sound-intensity probe with two microphones to scan equipment surfaces and record emitted noise.

For the second test, they used an acoustical pipe box with a single microphone inside to isolate machinery surface noise from outside contaminating noise. For the third test, the team used a soundtube to confirm the accuracy of the other test measurements. The soundtube consists of a microphone inside a Plexiglas tube sealed against a surface and with sound-absorbing material.

Phase 1 testing was performed with and without removable acoustic blankets on the compressor, and the insertion loss was determined for the acoustic blankets at different locations on the compressor casing (Figure 3).

Acoustic blankets on the main compressor casing, which were not actually required for the application, showed a nearly 20-dBA reduction for predominant impeller blade passing frequency components. Tests on the bearing housings and casing pedestals showed that blankets were not needed in this case, but in other situations, would further aid in meeting noise specifications.

Figure 2. Noise measurement team collecting the sound intensity data inside sealed enclosure on the compressor casing

Execution of Phase 1 testing was a first step toward more accurate prediction of equipment noise and improved confidence in noise guarantees. However, noise levels from turbomachinery have the potential to exceed site requirements, even with attenuating treatments, such as acoustic blanketing. To address this issue, Phase 2 of the noise prediction test will use data collected at design conditions to improve and optimize noise attenuation options.

Phase 2 testing has two main goals. The first is to review, evaluate, and optimize acoustic blanket treatment alternatives, and to develop an acoustic blanket application database to meet different design requirements.

This information will provide more options when trying to meet noise requirements. Phase 2 testing will evaluate whether enhancements to certain areas of the blanketed coverage will reduce overall noise more than the current blanketing configuration. This will include a review of existing data and measurements from Phase 1 testing.

The second goal of Phase 2 testing includes collection of field noise data from the same 70M compressor tested during Phase 1, with installation and commissioning in 2020. The customer plans to treat surrounding piping and equipment acoustically to reduce noise emissions.

The test team will take noise measurements with and without acoustical blankets, as well as test the enhanced blanket configuration. Background noise should be low enough to use the noise-measuring instruments without the need for an acoustic noise enclosure.

Completion of Phase 2 testing will update and validate the noise prediction algorithms with the latest equipment acoustic data, and improve noise attenuation options to better meet stringent customer requirements for reduced equipment noise and accurate noise level guarantees. ■

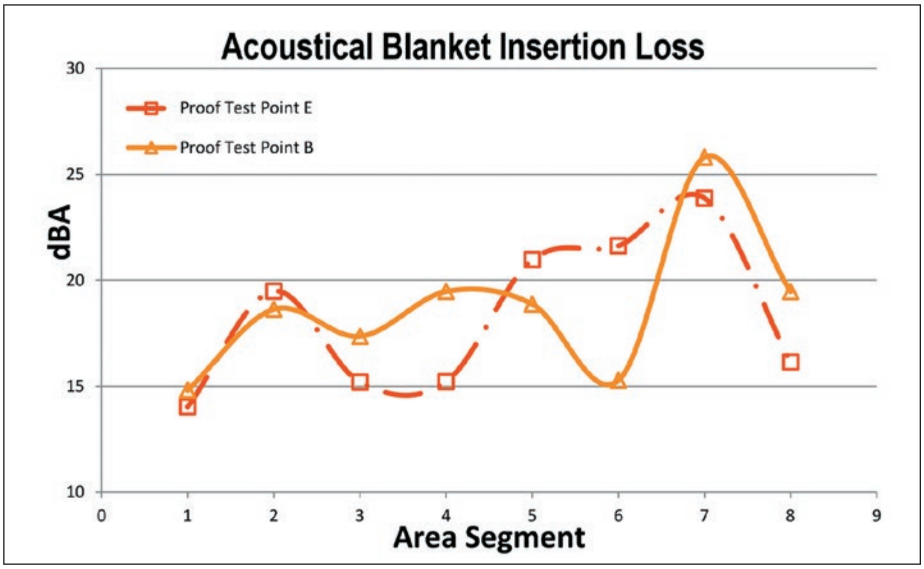

Figure 3. Acoustic blanket insertion losses at locations on the compressor casing

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