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Determining Sound Power Levels of Enclosed Gear Drives Using the Sound Intensity Method

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TECHNICAL PAPER

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

This paper will examine use of the sound intensity measurements to calculate sound power levels of enclosed gear drives under full load. Important characteristics of the test environment will be discussed. Acoustic intensity concepts and theory will be presented. Equipment requirements and acoustic requirements of the sound field for collecting accurate data will be discussed. Actual sound intensity data with a discussion of measurement quality indicators are included. Finally, a case study will be presented that illustrates how this data was used to validate a design improvement.

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Introduction

Sound power measurements are important for making direct comparisons between different enclosed gear boxes because sound power is independent of the measurement environment. Sound power levels can be used to determine resulting sound pressure levels at a distance from the source or can be used to select appropriate acoustical treatments.

The ability to supply customers with accurate sound power levels is becoming more important. First, some international trade regulations require conformance to noise standards. Secondly, a quieter enclosed gear drive has the perception of being higher quality. Consumers demand quieter products and quieter industrial gear drives make for better working environments. The final reason for the increased popularity of sound power measurements is the reduced cost of obtaining the data by using the sound intensity method.

What is sound intensity?

The sound intensity in a specified direction at a point is the average rate of sound energy transmitted in the specified direction through a unit area normal to this direction at the point considered (1). More simply, sound intensity is a vector that describes the net amount and direction of acoustic power at a given point in

space.

$$I = W/A$$

Where I is intensity, W is power, and A is area

Since sound intensity is a vector quantity, it can be used to calculate the net power emanating from a surface. Sound power is computed by measuring the normal spacial-averaged intensity over an area that encloses the gear drive and multiplying it by the measurement surface area enclosing the source.

How is sound intensity measured?

Sound intensity can be calculated from measurements of pressure and particle velocity due to the following relationship:

$$I = W/A = F \cdot V/A = P \cdot V$$

Where F is force, P is pressure, and V is velocity.

The pressure term is easy to measure using a single microphone, so the challenge in measuring sound intensity is to accurately measure the particle velocity. From Newton's Second Law:

$$-\frac{\delta P}{\delta x}(x,t) = \rho_0 \frac{\delta V}{\delta t}(x,t)$$

Where ρ_0 is the density of air, $\delta P/\delta x$ is the pressure gradient, and $\delta V/\delta t$ is the time rate of change of