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An approach to correlate friction-induced noise with coefficient of friction

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ABSTRACT

In this research study, an attempt has been made to set up a relationship between the frictional noise and friction process parameters to fix the key factors to control the friction-induced noise. The contour interpolation technique and Regression were utilized to correlate frictional noise with the coefficient of friction during the sliding of Steel/Aluminum 4047 alloy and Steel/Alpha Brass alloy tribo-pairs. The effect of surface roughness and frequency was also studied. The results indicate that the range of frictional noise obtained for different testing conditions was 79.56–94.35 dB for Aluminum 4047 alloy and 75.91–90.51 dB for alpha Brass alloy. The results obtained in the present study reveal that sound pressure levels can be mitigated to a good extent provided optimal selection of tribo-parameters.

1. Introduction

Friction-induced noise usually gets generated while rubbing two surfaces. Friction, caused by sliding solids, causes waves and oscillations within solids, which emit sound into the surrounding medium. In modern cities, noise annoyance is now acknowledged as a public health concern. In cities, automobile noise is the primary cause of noise pollution [1]. Noise pollution standards vary depending on the country, the type of environment (urban, industrial, residential), and the specific context (e.g., daytime vs. nighttime noise levels). It is recommended by the EU Directive 2002/49/EC on environmental noise that member states implement noise mitigation strategies to keep sound levels in residential areas below 65 dB(A) during the day and below 55 dB(A) at night. Furthermore, OSHA (Occupational Safety and Health Administration Standards) establishes 90 dB(A) as the maximum amount of noise that can be tolerated during an 8-hour workday in the workplace. If noise levels exceed this limit, then hearing protection should be used [2] . The problem, taken more broadly, is controlling our machinery and equipment's friction noise. A straightforward example of frictional noise is the squeal of car brakes. The squeal of tires during emergency braking proves it is aggressive and even frightening. The primary goal in enhancing our quality and safety is avoiding frictional noise like this. This mitigation requires studying the fundamentals of friction, wear, and the relationships between vibration and noise to design systems with reduced noise. Microscopic motion is necessary for the dissipation of energy in friction damping between surfaces, such as joints. Friction changes surface kinetic energy into heat energy at the atomic level. The process behind the coupling of friction and acoustics at the atomic level is the conversion of disordered atomic vibrations in a material to thermal energy [1]. Some research studies have indicated that a high friction coefficient results in more frequent squeal generation and high sound levels. Frictional noise increases with an increase in friction [3,4]. Over the past few decades, substantial efforts have been made to know the genesis of friction-induced noise, and various research approaches have been established to investigate its properties. Considering the frictional noise as a result of undesirable vibration of friction interface, many studies have focused on the interface's effect on friction-induced noise. The friction causes a remarkable variation in a friction interface. The system vibrations get triggered by the extreme fluctuations of frictional force, emitting frictional noise to the surroundings [5]. The outcomes attained by various researchers validated that wear features (adhesion, plowing, and behavior of wear debris), coefficient of friction, and the actual area of contact extensively impact the generation of frictional noise [5–13]. The surface topography, wear particles, and chemical and physical characteristics of the friction interface play an essential role in generating frictional noise [14].

The frequency at which the noise is produced has been used to categorize the frictional noise. Noise frequencies between 100 and 500 Hz are referred to as groaning and moaning, whereas noise frequencies between 500 and 1000 Hz and between 1 and 20 KHz are referred to as

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