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Industrial Noise: Noise Power Spectrum of Shearing Machine

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Abstract: Industrialization, resulted in increased activity, particularly traffic and heavy machinery which in turn resulted in increased noise pollution. It is known that exposure to loud noise for prolonged periods of times is dangerous and can affect quality of life with reference to health and psychology. In severe cases it may result in damage or permanent loss of hearing. Exposure to 85 dB noise for more than eight hours and 100 dB noise for more than two hours is considered to be dangerous for humans. We studied noise due to machinery in use with heavy industry and present finding and details on noise due to AIDA 600 Ton shearing Machine used in forming of heavy metal sheets in the process of manufacture of discs for disc breaks of two wheelers.

Keywords: Shearing machine, Blanking Operation, Noise Power Spectrum, Fourier transform.

I. INTRODUCTION

Noise pollution is a major problem in developed and developing countries [1] and exposure to loud noise adversely affects the quality of life and it has serious effects particularly in relation to health and psychology [2-3]. Noise at higher frequencies is more annoying and has adverse effect on health and psychology of the residents in nearby areas. Major part of the noise in the urban areas comes from activities of various kinds such as Industry, traffic, construction work and operation of machinery and thus this noise is becoming serious concern. In view of this, the study of noise assumed importance in recent times and regulations and norms are laid down for noise and its control.

Frequency distribution of noise helps characterizing noise and provides deeper insight in to the likely hazards it may cause. Such study in turn helps understanding the origin of noise from different parts of the activity and machines and is useful in finding plausible methods of controlling the same [4 – 7]. In view of this we studied frequency distribution of noise arising from AIDA 600 Ton shearing Machine used in forming of thick metal sheets by blanking and piercing operation. The results obtained are interesting and clearly characterize various sounds. Sound level, its frequency spectrum and its variation over time characterize noise to estimate its hazards[8]. Noise can also be characterized by its frequency content and noise power spectrum analysis with many applications; this approach makes use of Fourier Transform technique [9].

Recordings of Noise in general give an impression of noise and allow a qualitative feel of the nature of noise regarding the distribution of intensity of sound at different constituent frequencies. However the frequency analysis of the audio recording of noise using Fourier transform technique reveals interesting finer details hidden into the whole sound. The Frequency spectrum [10] of noise obtained using Fourier transform [11] of the noise recording will clearly show distinct frequencies at which noise is present that too in what proportion. Similarly it will clearly categorize various frequencies over which appreciable noise is present, also it will show frequencies over which noise remains low. The amplitudes of sound obtained using FFT are complex quantities having both real and imaginary component and the value of amplitude is found by taking the absolute value of this complex amplitude from which power can be found. The frequency analysis of noise audio recordings provides a reliable means to understand the frequency distribution of noise and the characteristic frequencies of sound produced by various parts of machines.

II. METHODOLOGY

For the purpose of finding out power spectrum of the noise produced by AIDA 600 Ton shearing Machine used in industry for forming metal sheet where lot of noise is generated. The noise studied originates from operation of the machine while performing the blanking operation. Blanking and piercing are shearing processes in which a punch and die are used to modify webs. The tooling and processes are the same between the two, only the terminology is different: in blanking the punched out piece is used and called a blank; in piercing the punched out piece is scrap [1]. The process for parts manufactured simultaneously with both techniques is often termed 'pierce and blank'. An alternative name of piercing is punching. The job under blanking operation was the disc from the disk brakes of two wheelers, it is a circular steel plate with a thickness of 4.5 mm. During the stroke a 5 inch hole is cut at the center and 45 small holes are punched in a circular pattern around the central hole. This shearing operation produces a loud noise and the actual noise power levels measured using a calibrated meter exceed the permissible limit of 85 dB.

The sound samples were recorded during different operations. Recording was implemented using standard sound system with dynamic microphone and the recorded noise was saved in standard wave format files with ".WAV" file extension for further use. The frequency distribution of noise in these samples was found using FFT. The wave files were analyzed using Fourier transform technique in Mathcad and the noise amplitude at different frequencies was saved in file for further processing and estimation of noise power. This technique is used for Transformation of time domain data into frequency domain. The wave files contain information on sampling frequency, the data size etc that is used in the Mathcad programs for finding out the power spectrum the sampling rate used throughout the study was 44.1 KHz and the data size was 16 bit.

After reading the audio file in Mathcad program the length of the audio file is determined, the time for each sample is estimated from the sampling rate and an array corresponding to the data points is generated and populated. Fourier transform requires that the number of data point used comply with Nyquist Criterion, thus from the data read, a suitable interval is chosen. For FFT the number of data points should be equal to 2N where N is an integer. In most of the studies we used 8192 data points which corresponds to N = 13 and the sample studied has a duration of little less than 0.2 seconds of recorded sound. On implementation of the FFT this gives power spectrum in terms of audio powers at different frequencies. The number of frequencies at which the power spectrum is available is half of the number of data points used i.e. 8192 / 2 = 4096, thus FFT extracts power at 4096 frequencies. The resulting power in the power spectrum is a complex quantity due to reasons presented earlier. The magnitude of power can be estimated using the modulus of this complex amplitude from FFT.

Noise power spectrum obtained from three samples from AIDA 600 Ton shearing Machine used in heavy industry are shown in Fig. 1. The power spectra for the first two samples are not much different and are typical representative of the noise when the machine is idle and not performing any task where as the third one contains noise due to dropping of the job plate. Major part of the power spectrum while idling is confined to lower frequencies well below 1 KHz. Dropping of the job plate has its own natural frequency and is located at 2670Hz, the plots shown are normalized for ease of comparison of relative noise power at different frequencies.

When the machine is actually performing a stroke, making all the holes in a single punch with the help of the system of dyes and punches, a loud noise is generated that is distributed over a wide range of frequencies as is shown in Fig. 2. The first peak is at 113 Hz and the following three peaks are located at 3 KHz, 6.7 KHz and 7.3 KHz respectively. The first peak is a low frequency component that is attributed to vibrating part of the machine during the blanking operation, the low frequency corresponds to the natural frequency of larger machine parts. The rest of the three humps are mostly contributed by the job being processed i.e. the thick steel plate being cut to make the disc for the disc break and the different humps present in the power frequency spectrum are representatives of different modes of vibration of the plate as it has lot of structure to it.

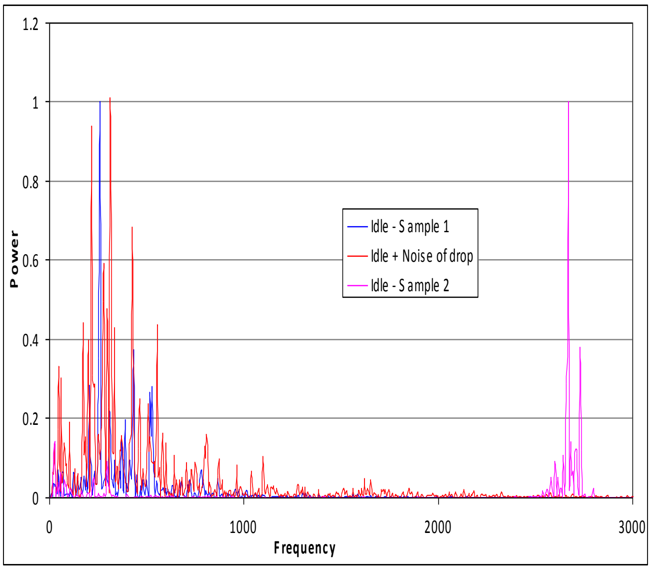

Figure. 1 Noise Power spectrum for AIDA 600 Ton shearing Machine in idle state.

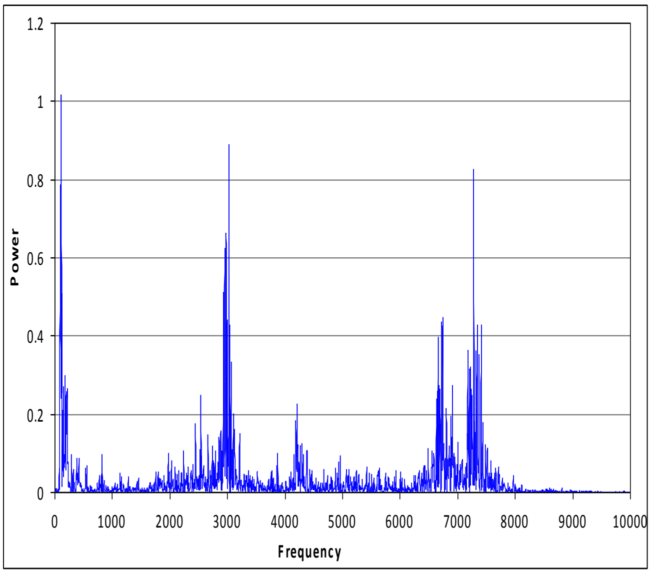

Figure. 2 Noise Power spectrum for the shearing Machine during the blanking operation.

No appreciable noise is present at frequencies higher than about 8KHz whereas the noise almost diminishes beyond 1 KHz when the machine is idle indicating that most of this noise is generated during the stroke while performing blanking operation.

In addition to the noise generated during blanking operation, or when the machine is idle, there is lot of noise generated by rest of the activity such as shifting of the plates, collecting of the plate etc. The pattern of the noise power spectrum is characteristic to the operation with minor differences as it is a random process so far as the vibrations and noise production is concerned. Sizable noise is contributed by such activity and the noise is distributed over wide range of frequencies and no specific trend or pattern can be discerned from the noise power spectrum as the frequency distribution of noise keeps on changing from time to time and sample to sample as there is no rhythm or synchronization in the activity. Fig. 3 shows noise power spectra recorded when the jobs were being shifted, collected in trolleys during the blanking operation.

Fig. 3 shows comparison of four power spectra recorded during the blanking operation where simultaneous handling of the work pieces was going on as the operation is continuous and the stokes occur one after the other throwing one plate at every stroke. The noise produced is different for the four cases presented and the reason is attributed to the fact that during handling of the worked pieces the conditions are never alike and the bulked being handled keeps on changing.

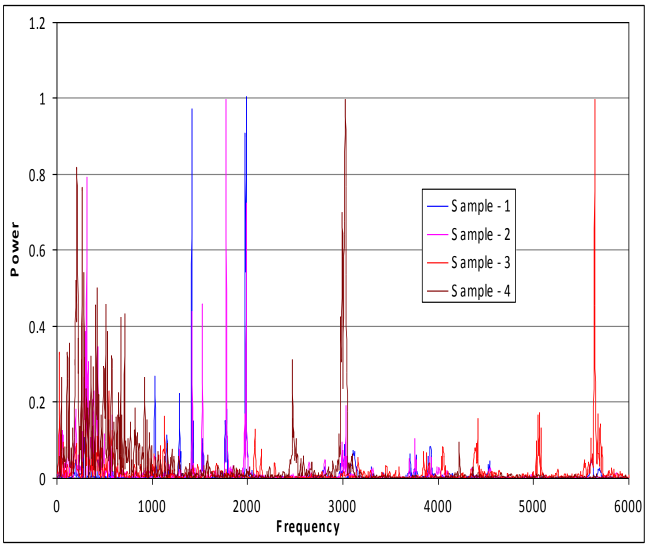

Figure. 3 Noise Power spectrum for the shearing Machine during the blanking operation.

III. RESULT AND DISCUSSION

Heavy Machines like AIDA 600 Ton shearing Machine used in forming of thick metal sheets of constitute sizable component of noise in industries handling heavy metal sheet forming applications. The noise from such activities exceeds 110 dB during routine operations, and such noise levels fall in high risk regime and exposure to such noise levels continuously for several minute may cause damage to hearing. Fig. 1 shows that for AIDA 600 Ton shearing Machine, in idle mode, which prevails for most of the time, the noise contributed is of low frequency which is major concern, also at the time of strokes the noise levels are too high and the noise is distributed over a wide range of frequencies and such broad band noise has more severe effects.

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