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Design Optimization for Vibration Level of Root Blower With No Load Condition

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ABSTRACT

The physical movement or motion of a rotating machine is normally referred to as vibration. Since the vibration frequency and amplitude cannot be measured by sight or touch, means must be employed to convert the vibration into a usable product that can be measured and analyzed. Electronics, mechanics, and chemical physics are closely related. Therefore, it would logically follow that the conversion of the mechanical vibration into an electronic signal is the best solution. The means of converting the mechanical vibration into an electronic signal is called a transducer. The transducer output is proportionate to how fast the machine is moving (frequency) and how much the machine is moving (amplitude). The frequency describes what is wrong with the machine and the amplitude describes relative severity of the problem. The motion can be harmonic, periodic, and/or random. All harmonic motion is periodic. However, all periodic motion is not harmonic. Random motion means the machine is moving in unpredictable manner. Vibration analysis is one of the best ways for companies with heavy industrial rotating machinery to save money. This paper describes methods so as to reduce vibration. Measurement of vibration is made by using FFT Analyzer.

KEYWORDS: *Transducer, Random Motion, Vibration Isolator, FFT Analyzer.*

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I. INTRODUCTION

In the 21st century we are much more ahead in the modern machine designs and technology which will fulfil the today's need of industries. Now the main requirement of the industries is to increase the efficiency and reliability of equipment. To fulfil this requirement we have to optimize design with the help of various techniques. As the study is concerned about optimization in design of root blower one of the method for optimizing design is reducing the vibration in root Blower. Vibration is a mechanical phenomenon whereby oscillations occur about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random such as the movement of a tire on a gravel road. Vibration is occasionally "desirable". For example, the motion of a tuning fork, the reed in a woodwind instrument or harmonica, or mobile phones or the cone of a loudspeaker is desirable vibration, necessary for the correct functioning of the various devices[1].

More often, vibration is undesirable, wasting energy and creating unwanted sound – noise. For example, the vibrational motions of engines, electric motors, or any mechanical device in operation are typically unwanted. Such vibrations can be caused by imbalances in the rotating parts, uneven friction, the meshing of gear teeth, etc. Careful designs usually minimize unwanted vibrations. When a machine moves, its motion induces vibration in its structure. At low speed its vibration can be ignored, but at moderate and high speed this vibration become larger and various parts of machines no longer move the way in which they were indented to move. Many machines in industries have performance limitations due to vibration problems. The generally accepted methods for vibration control of industrial equipment include; Force Reduction, Mass Addition, Tuning, Isolation, and Damping. This paper will briefly introduce each method, and describe practical methods for their application. Several scenarios and case studies will be presented, with emphasis on pragmatic solutions to industrial vibration problems [2] [3].

II. ROOT BLOWER

The root blower is also known as positive displacement pump. It is used in conditions ranging from strong vacuum to high pressure in all branch of industry. The Root's Blower consists 2 or 3 lobe of rotors and rotate in synchronous and opposite direction by two timing gear. The two rotors are assembled with casing and keep small gaps with no contact of rotation between the casings. The two rotors rotate in synchronous and opposite and continue to turn and trap a quantity of fluid between the rotating rotors, casing and side plates. Continue rotation carry the trapped volume around the rotor and casing out to the discharge port.

The Processes are as Follow: 1. Fluid enter 2. Enclose by rotor and casing 3. Discharge fluid Root blower has wide range of application in many of the industries. Roots blowers are used in waste water treatment plants for aeration. Roots blowers are used to supply required air for pneumatic conveying systems. It is also used in the agricultural application, dying purpose in industries, paper industries, etc. Simple design, easy handling and stable performance make a wide range of applications [4]. Along with wide range of application one of the major disadvantages is the maintenance of blower. As in many cases it has to work under high speed, due to which undesirable vibrations are produced. So by analyzing the vibrations and reducing it by suitable method led to improve the performance of the blower. Due to simple design, easy handling and stable performance makes a root blower to be used for wide range of applications. Most industries are facing the huge problem regarding the regular maintenance of blower. There are so many reasons due to which the failure of the component takes place in root blower.

But one of the major reasons is the vibrations produced by the blower. High vibrations were observed in the rotating parts of blower. The main aim of the selecting topic is to find vibration frequency of blower. In the analysis of blower the measurements are taken at various duties like casing, foundation, bearing and timing gears. By analyzing the amount of vibration in the root blower using FFT Analyzer's we can determine the main areas where the vibrations are created more than the give standard values.

Analyzing the vibrations of the root blower we can provide suitable preventive measures so that the performance of the blower can be increased. As the vibrations are reduced we can obviously increase the life of the different components and reduce the maintenance.

III. PRACTICAL METHODS FOR VIBRATION CONTROL OF INDUSTRIAL EQUIPMENT

[1] **Force Reduction** of excitation inputs due to, for example, unbalances or misalignment will decrease the corresponding vibration response of the system.
[2] **Mass Addition** will reduce the effect (system response) of a constant excitation force.
[3] **Tuning** (changing) the natural frequency of a system or component will reduce or eliminate amplification due to resonance.
[4] **Isolation** rearranges the excitation forces to achieve some reduction or cancellation.
[5] **Damping** is the conversion of mechanical energy (vibrations) into heat.

IV. ISOLATION

Isolation reduces the transmitted vibration response of a system by rearranging energy so that inertia (mass) opposes force. Resilient supports (isolators), typically elastomeric, spring, and/or pneumatic, decouple a system from force inputs, and cause the isolated system to be out of phase with the force inputs. [5] Referring to Figure 1, below, the frequency ratio, f / f_n, must be greater than $\sqrt{2}$ (isolation zone) for isolation to be successful. As the frequency ratio increases, force transmitted (vibration response) decreases. Systems where the frequency ratio is below $\sqrt{2}$, (amplification zone) are not suitable for isolation.

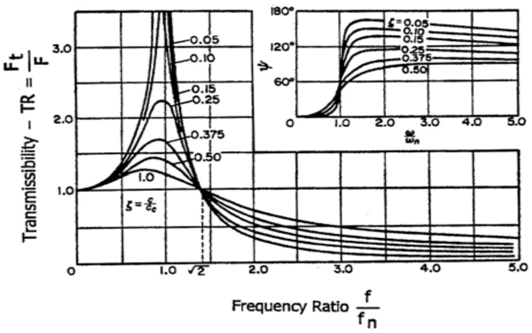

Figure1. Transmissibility Diagram

F_t = force transmitted [N]
F = force input [N]
f = frequency of force input, Hz
f_n = (isolated) system natural frequency, Hz
ζ = c/cc = damping ratio.

V. ASSESSMENT CRITERIA

In this guideline the vibration severity of blower is classified on the basis of following parameter:

- Machine group corresponding to machine design and bearing
- Type of machine mounting

Machine mountings are subdivided into two groups on the basis of their elasticity of foundation. Normally blower units are installed on the rigid base frames together with their drives (Engine, gearing) and ancillary systems. This base frame can be mounted directly upon the foundation (concrete slab, industrial building flooring, etc.) and bolted down permanently to it (rigid mounting).Another possibility is to mount only the drive unit (motor and blower) or even the entire set on defined spring elements so as to insulate the foundation (intermediate floor of building, ship's deck, base frame of acoustic hood, etc.) against vibration excitations. This is very often encountered with smaller to mid-range mass-production blower units but in experimental cases also with process-gas blower.

Should it be necessary in doubtful case to decide whether a sub frame is rigid or resilient, if this guideline is used (rather than DIN ISO 19816-3) the entire mass and vertical spring stiffness of the mounting of compressor set part in question must be taken into consideration. A resilient (low tuned) mounting of the blower set means that the corresponding first vertical natural frequency of total vibration system consisting of blower and sub frame is at least less than the smallest existing relevant exciter frequency (with the blower this is the simple rotational frequency of secondary rotor, in the overall system in most cases the rotational frequency of drive motor even if this is installed on a base frame).With resiliently mounted machines the vibrational level tends to be higher than is the case with a rigid mounting.

VI. EVALUATION

This guideline describes in a generalized from the two criteria for evaluating the housing and rotor vibrations of root blowers. One criterion relates to the magnitude of the broadband measured vibration, the other relates to change in the magnitude of vibration irrespective of whether it is an increases or decreases [6].

VII. TEST METHODOLOGY

The root blower used for design optimization is as shown in figure 2. The blower is manufactured by Kulkarni Power tools Ltd. of model SR069. The test readings are taken with FFT analyzer. The accelerometer connection are made ready for taking the readings in three positions viz. vertical, horizontal and axial respectively at drive and non-drive end of blower.

Figure 2: Test set-up.

The test set-up is made for following three arrangements:
a) Flexible arrangement: In flexible arrangement the blower is mounted on flexible spring support.
b) Buffer pad arrangement: The flexible arrangement is replaced by buffer pad arrangement.
c) Flat pad arrangement: The buffer pad arrangement is replaced by flat pad arrangement.

VIII. RESULT AND DISCUSSIONS

Flexible Arrangement: The readings are obtained by using FFT analyzer for flexible arrangement.

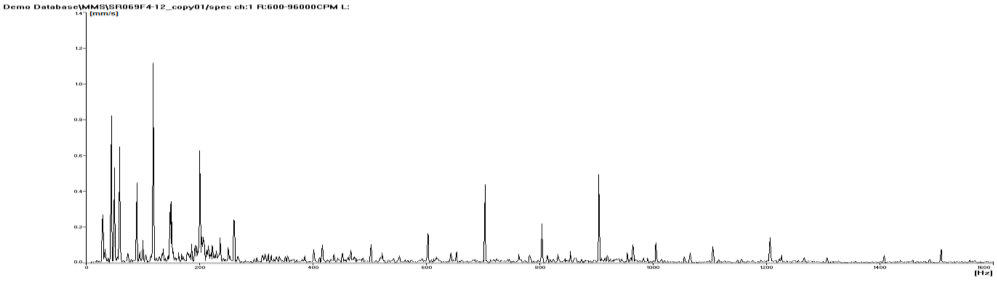

Figure 3: Frequency response graph for rigid frame arrangement.

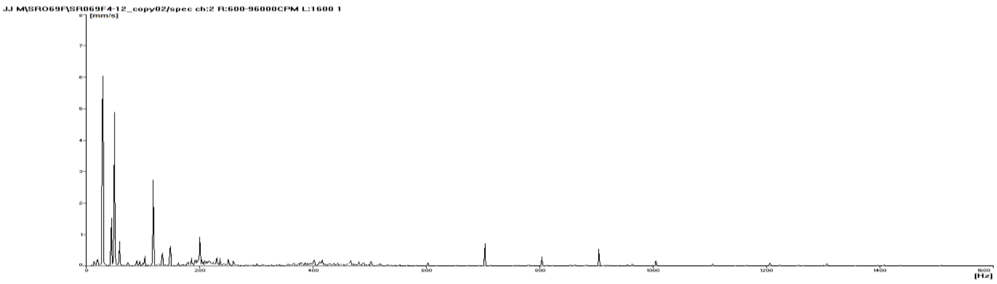

Figure 4: Frequency response graph for flexible type arrangement

Table 1. RMS values for rigid frame arrengement

Blower Model: SR069				
Arrangement Type: RIGID Before Modification				
Remark: With FFT Analyser				
Blower rpm: 3000 RPM			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	18.4	16.5	10.16
	Non Drive	18.8	16.7	14.8
BB Side	Drive	8.24	11.6	8.17
	Non Drive	9.02	7.27	13.2

Table 2. RMS values for flexible type arrengement

Blower Model: SR069				
Arrangement Type: Flexible Type Arrangement				
Remark: With FFT Analyser				
Blower rpm: 3000RPM			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	8.2	5.07	5.3
	Non Drive	6.4	6.12	8.5
BB Side	Drive	5.5	6.7	5.7
	Non Drive	8.7	9.61	7.9

Comparing the observation of fixed frame arrangement and flexible arrangement it can be observed that the vibrations are reduced in the flexible arrangement.

Buffer Pad Arrangement: The readings are obtained by using FFT analyzer for Buffer Pad arrangement.

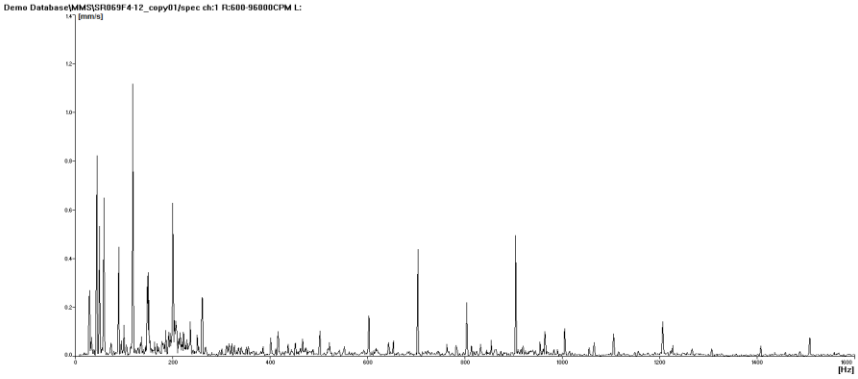

Figure 5: Frequency response graph for rigid frame arrangement

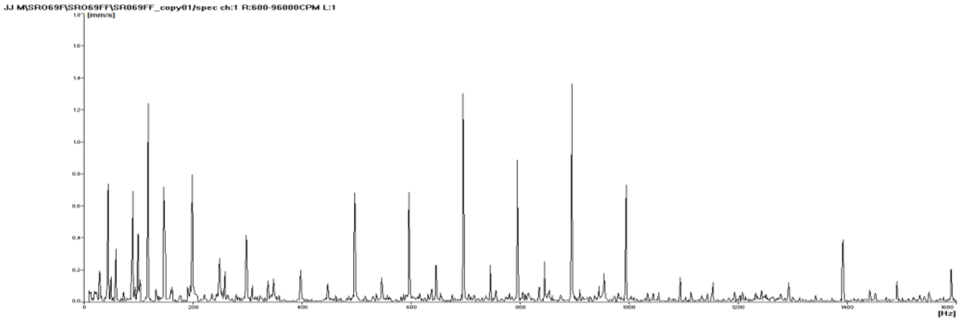

Figure 6: Frequency response graph for buffer pad arrangement

Table 3. RMS values for rigid frame arrengement

Blower Model: SR069				
Arrangement Type: RIGID Before Modification				
Remark: With FFT Analyser				
Blower rpm: 3000 RPM			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	18.4	16.5	10.16
	Non Drive	18.8	16.7	14.8
BB Side	Drive	8.24	11.6	8.17
	Non Drive	9.02	7.27	13.2

Table 4. RMS values for buffer pad arrengement

Blower Model: SR069				
Arrangement Type: Buffer Pad Arrangement				
Remark: With FFT Analyser				
Blower rpm: 3000			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	7.7	5.8	3.5
	Non Drive	8.04	5.2	5.2
BB Side	Drive	5.15	6.3	2.13
	Non Drive	5.8	4.7	6.03

Comparing the observation of flexible arrangement and buffer pad arrangement it can be observed that the vibrations are reduced in the buffer pad arrangement.

Flat Pad Arrangement: The readings are obtained by using FFT analyzer for Flat Pad arrangement.

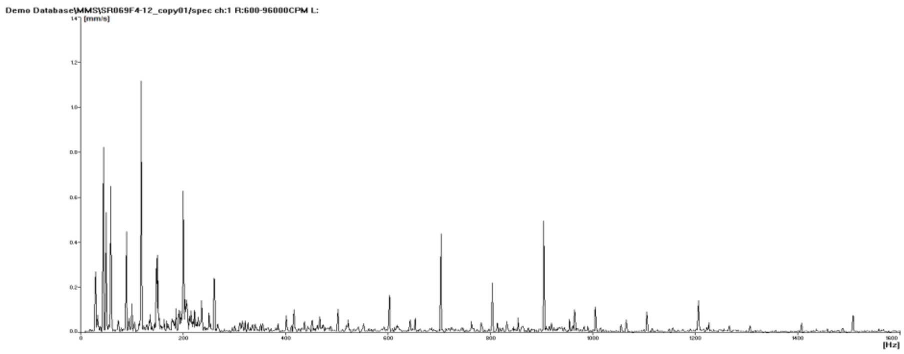

Figure 7: Frequency response graph for rigid frame arrangement.

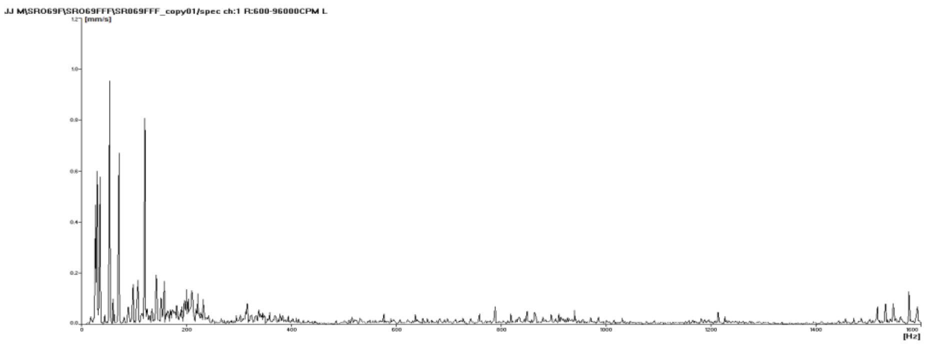

Figure 8: Frequency response graph for flat pad arrangement.

Table 5. RMS values for rigid frame arrengement.

Blower Model: SR069				
Arrangement Type: RIGID Before Modification				
Remark: With FFT Analyser				
Blower rpm: 3000 RPM			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	18.4	16.5	10.16
	Non Drive	18.8	16.7	14.8
BB Side	Drive	8.24	11.6	8.17
	Non Drive	9.02	7.27	13.2

Table 6. RMS values for flat pad arrengement

Blower Model: SR069				
Arrangement Type: Flat Pad 1+1				
Remark: With FFT Analyser				
Blower rpm: 3000RPM			Pressure: No Load	
		Vibration [RMS]		
Reading no.1		V	H	A
RB Side	Drive	1.70	3.50	1.90
	Non Drive	1.25	3.90	2.00
BB Side	Drive	1.5	3.30	1.85
	Non Drive	1.20	3.50	2.00

Comparing the observation of buffer arrangement and flat pad arrangement it can be observed that the vibrations are reduced in the flat pad arrangement. This is due to the fact that the flat pad absorbs the vibrations which are then transmitted to the foundation.

IX. CONCLUSION

To increase the performance of the any Industrial equipment it is necessary to analyze the problem. There are many methods to control and minimize the vibrations in the equipment. But some of the important are discussed in this paper. With the help of techniques discussed in this paper will help to reduce the vibration occurred in the equipment. The vibration levels obtained in case of flat pad Arrangement are much less than other Arrangements.

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