# The Study of Components Used for Automation of the Vibration Testing Machine (VTM) – A Review

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*Abstract:*

**The paper addresses the need for automation in production line. A detailed study of various components required for converting a manual bearing vibration testing machine to an automatic one is carried out. Function and Description of each component is studied. The components include conveyor belts, laser dopplervibrometer, pneumatic system, mechanical probe, timing and control sensors, speed control system, data analysis and storage unit. A method of selecting each component for automatic vibration testing machine is offered. Based on the structure of automated machine the initial set of alternate variants is defined and a formal model of automatic vibration testing machine is developed. Automation will significantly decrease the production time and increase the production rate of bearings.**

*Keywords:* Vibration testing machine, conveyor belts, pneumatic system, laser dopplervibrometer,Rod less cylinders,

## I. INTRODUCTION

In the 21st century upgradation has become must, so we need to upgrade all the previously manually operated machines into a fully automatic machines with new technologies. The problem with manual machines is low production rate, more time consumption at each process, human errors and high cost of production. All we need from a machine is high production in minimum period with less human interruption.

Automation is the technology by which a process is performed with minimum human interference. Automatic control is the use of various control systems for operating equipment such as machinery, processes in industries, boilers and heat treating ovens, switching on cellular networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal human intervention. Some processes have been completely automated.

What is Vibration? Vibration is a mechanical phenomenon where oscillations occur at an equilibrium point. The oscillations may be periodic, such as the motion of a pendulum or random, such as the movement bouncing ball and vibrating a tuning fork.

Vibration is not desirable as it wastes energy and creates noise. For example, the vibrational motions of IC engines, electric motors, or any mechanical device in operation are typically unwanted. These vibrations are caused by imbalances in the rotating parts, uneven friction, or the meshing of gear teeth. Efficient designs usually minimize unwanted vibrations.

Why automation is required in vibration testing? Vibration Testing Machine (VTM) is a machine which detects vibration and interprets the results. So as to upgrade a manually operated VTM, we need to design a fully automated one with the help of actuators, sensors and conveyor mechanism. The design procedure first requires the details and various parameters of different components of automation, these include speed control of conveyor belt, timing of actuators pneumatically through proximity sensors.

The MVO 150A is capable to measure the most of this bearing types except HUB Bearings. Additional to the standard axial loading unit, it can be equipped with a radial loading device. For e.g., cylindrical roller bearings can be tested. The MVO works with vertical high-precision hydrodynamic test spindle. The driving unit is mechanically separated from the machine frame for an optimum vibration isolation. Thrust test loads and the radial test loads are applied by using the pneumatic loading unit. The evaluation of the noise and the vibrations and the corresponding classification of the test pieces are also carried out via the measuring electronics.

## II. COMPONENTS USED IN AUTOMATION OF VTM

### *A. Conveyor Belt*

A belt is the carrying medium of a belt conveyor system. A belt conveyor system consists of two or more pulleys or idler pulley also called as drums, with an endless loop of conveyor belt that rotates over them. One or both of the pulleys are powered electrically or mechanically, moving the belt and the material on the belt forward. The powered pulley is also called as driver pulley and the unpowered pulley is called as driven or idler pulley.

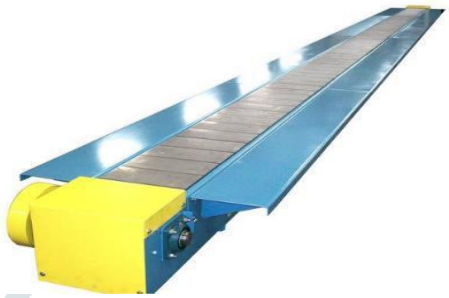

Fig.1Conveyor Belt

### *B.Proximity Sensor*

A proximity sensor is a sensor able to detect the presence of any objects without any physical contact. The sensor emits a beam of electromagnetic radiation, and looks for deviation in the field or return signal. The object being sensed is also referred to as the target of proximity sensor. Different materials demand different sensors. For example, a capacitive proximity sensor is suitable for a plastic material; an inductive proximity sensor is used for a metal target. Proximity sensors can have a better reliability and increased functional life because of physical contact between the sensor and the object. Proximity sensors are used in monitoring machine vibration to measure the fluctuation in distance between a shaft and its bearing.

Fig 2.Proximity Sensor

### *C.Rodless cylinder*

Rod less cylinders consist of relatively long piston. Cable cylinders has openings at one or both ends, but pass a flexible cable rather than a rod. They are mainly of two types - mechanical type and magnetic type. In the magnetic type, the cylinder is thin-walled and acts as a powerful magnet, and pulls along a magnetic traveler on the outside. In the mechanical type, part of the cylinder extends through a slot cut down the length of the cylinder.

Fig.3 Rodless Cylinder

*D.Hydrodynamic Bearing*

Hydrodynamic Bearings are based on the lubricating principle involved in the bearings. Apart from the construction that acts as the bearing, the lubrication plays a very important role in the construction to act as bearing. Hydrodynamic Lubrication is formed basically due to the action of the moving parts such as shafts. When sufficient quantity of lubricant is present between two surfaces in which the relative velocity of the moving surfaces tends to pump the lubricant between the two surfaces and forms a dynamic film of the lubricant.

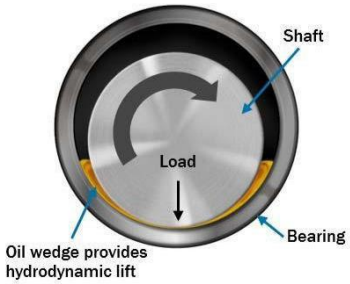


Fig.4 Hydrodynamic Bearing

*E.Laser Vibrometer*

The laser vibrometer use the principle of the heterodyne interferometer to acquire the characteristics of the mechanical vibrations or transient motion processes. With this type of heterodyne interferometer, a carrier signal is generated on the photo detector with the help of a Bragg cell. To make the vibration measurement, the beam of a helium neon laser is pointed at the vibrating object generates a frequency modulation of the laser light due to the Doppler Effect. This modulation is recovered in the signal processing unit with the help of suitable decoders.

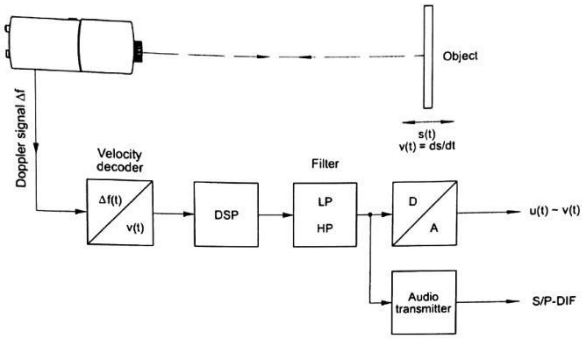


Fig.5 Laser Vibrometer (Principle of operation )

## III. LITERATURE REVIEW

*1. S. Sanchez-Caballero , M.A. Selles, S. Ferrandiz, M.A. Peydro [1]*

In this study, an analysis of the probable causes of the failure in-service of a section of a plastic modular belt was conducted. The study begins with a recreation of the service conditions in a traction gear. An analysis of the fractures revealed the existence of defects in the interior parts of the belts. With the objective of determining the origin of the imperfections and their influence on the failure.

*2. Gabriel Fedorko, Vladimír Ivan [2]*

This paper dealt with modeling of tension conditions in the lot of conveyor belt and used the finite element method. Mazurkiewicz used the finite element method for analysis of conveyor belt jointing by shackles. Application of technology of computer-aided design to large-scale long belt conveyor is presented in the author presented a simplified approach to modelling the rolling contact phenomena that occur at the surface of a wheel driven rubber belt.

*3. Shirong Zhang, Xiaohua Xia [3]*

This paper intends to improve the efficiency of belt conveyors using model based optimization. An analytical energy model lumps all the parameters into different coefficients. After an off-line and an on-line parameter estimation schemes are applied to identify the new energy model, respectively. Energy efficiency optimization of belt conveyors, making financial and environmental sense, is the ultimate purpose of this paper. The analytical model makes the energy optimization of belt conveyors feasible.

*4. AfrimDushi, Florian Kongoli, Ian Mcbow, Musa Rizaj [4]*

This paper shows an experiment designed using central composite rotatable design of second order, according to the mathematical model of desirability functions. The various tests carried out were Spirit Burner test, Surface resistance test, and Limit oxygen index. The intent of this study is to optimize the rubber ingredients which are the main factors that give flammability to conveyor belts. The ingredients taken into consideration as factors are chlorinated paraffin and clay.

*5. S.C. Fok, E.K. [5]*

In this paper the repeatability of a pneumatic rod less cylinder system under closed-loop control is examined for its potential use. The analysis shows that the linearized continuous time dynamics is dependent on the operating conditions. This causes positioning problems when a controller is designed based upon the transfer function obtained at a particular operating condition. There are uncertainties associated with the dynamics which can lead to errors in both transient and steady-state responses. Based on the results, the pneumatic rod less cylinder system investigated in this paper is suitable for use in many load positioning applications where the desired load position can vary over the full range of the actuator motion.

*6. Kaiji Sato, Yusuke SanoI [6]*

The present paper describes a practical controller design method for precision positioning of pneumatic cylinder actuator stages. Pneumatic actuators have no linear characteristics, which reduces the precision motion. The purpose of the study is to clarify a practical and intuitive controller design procedure for precision positioning of a pneumatic cylinder actuator. In order to overcome the problems associated with pneumatic cylinder actuators with friction characteristics, three elements are added to the conventional CM NCTF controller and the PI element was replaced by the PD element.

## IV. CONCLUSION

In this paper, the components for the automation of Vibration Testing Machine (VTM) are listed with their description. The system specifies need for automation in VTM so as to improve the accuracy, production time, productivity and which in turn reduces vibrations in machines and reduces human interference.

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