Polytec

Industrial Quality Control

Field of Application

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100 % Inspection of Steering Gears Using Polytec IVS Digital Laser Vibrometers

TRW Automotive in Gelsenkirchen wants to ensure that the pumps on hydraulic steering gears do not make any unwanted noises while driving. All motor pump assemblies (MPA) are subjected to numerous test steps as soon as they have been assembled and before being installed in the steering system. The vibration characteristics are measured by more than fifteen Industrial Vibrometers and are used as an indicator of the actual noise under normal operating conditions. Based on the vibration spectrum the process controller either approves the assembly for subsequent processing or rejects it as being faulty.

Introduction

TRW manufactures modern steering gears with electro-hydraulic control at their facility in Gelsenkirchen, Germany. These electrically powered hydraulic steering (EPHS) systems are shipped to automotive assembly lines pre-assembled, filled with hydraulic oil and completely tested. Separate motor pump assemblies (MPA) are also supplied to auto manufacturers who prefer to install, attach hoses and fill with hydraulic fluid. Hydraulic pressure is generated by a motorized pump and is electronically regulated consistent with the vehicle speed, the steering force and the steering angle rate. The MPA is first assembled and then thoroughly checked for noise and performance values while passing through several automatic test stations (Figure 1). Production is between 1500 and 2200 units per day per plant.

Figure 1: Automatic test station for motor pump assemblies (MPA). Mark: IVS vibrometer

Polytec GmbH
Optical Measurement Systems
Application Note
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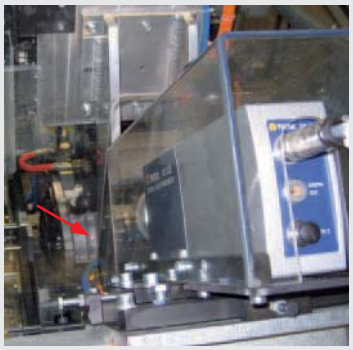

Figure 2: Vibration measurement on the MPA (motor pump assembly). Mark: red laser reflection

Figure 3: Protective housing with air wipe for the IVS vibrometer

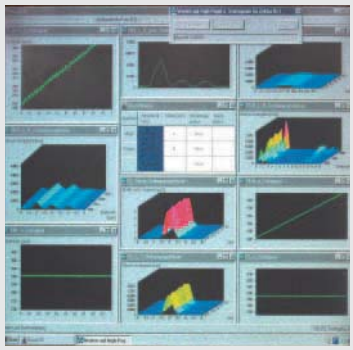

Figure 4: Test system produces a graphical representation of the vibration spectra and time signals on the process control computer display

Test Technology

The test cycle simulates typical operating conditions by filling the MPA with hydraulic oil and bringing it up to operating pressure with the pump (Figure 1). After mechanical, pressure and leak testing, the assembly passes to noise testing. During the noise testing all relevant operating modes are ingeniously simulated, from various pump speeds to standby operation with minimal pressure, to full capacity at pressures exceeding 100 bar. The test-mode vibrations are measured by IVS vibrometers which are fully integrated into the test stand and are protected by a transparent housing (Figure 2).

An air wipe is used to protect the laser optics from the dirt and grime of the industrial manufacturing environment (Figure 3). The output signal of the IVS is acquired and evaluated directly by the process control computer. The test system displays the results of the various tests on a screen (Figure 3) and passes approximately 150 measurement values per test sample into the process control system. From these values, an algorithm determines whether all quality criteria have been fulfilled and either accepts or rejects the assembly. The vibrometers are subject to the same quality control as all test equipment; every time there is a shift change, a calibration test run is made using a master sample. Diagnostics which can immediately detect a measurement or system error are also integrated into the analysis system.

Motor rotation can excite many different resonances. Particular attention is paid to the harmonics of the excitation frequency. Order analysis allocates these vibrational frequencies to certain components. Fourth order vibrations, for example, are due to inadequate true-running accuracy of the pump axis.

The correlations between vibration signature frequencies and component responses were determined in advance by TRW Research & Development. This reservoir of knowledge simplified the production line measurement task. The optimal positions for both sample points were determined in advance by using a PSV Scanning Vibrometer to analyze the operational deflection shape of the MPA's surface.

Summary

TRW motor pump assemblies are 100 % inspected before integration into the steering gears systems. The inspection process is fully automated with a noise spectrum test measurement performed by the IVS vibrometers. MPA's that pass this test assure that only quiet assemblies are put into manufactured vehicles and that drivers experience performance and reliability without distracting or annoying noise. The fact that noise levels in cars are continuously being reduced makes it increasingly important to reduce the noise level of individual components. Furthermore, the automated collection and storage of data provides traceability for component quality and an existing data base for correlation refinement through association with longer term events.

For more information please contact your local Polytec sales/application engineer or visit our web page **www.polytec.com/industrial**.

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