

Application of Laser Ultrasonic Visualization Detection in the Detection of Cylinder Sleeve

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Abstract— This paper introduces the detection of laser ultrasonic visualization. It describes the working principle of cylinder sleeve and the formation causes of defects. It bases on the use of LUVI technology to check the defects by experiments of cylinder sleeve, and the experimental results are analyzed. Finally it points out the application field of the laser ultrasonic visualization nondestructive testing and development prospects.

Keywords-laser ; ultrasonic ; nondestructive detection of defects in visualization ; cylinder sleeve

LUVI uses laser pulse that inspires ultrasonic non-destructive testing methods to achieve. Its biggest advantage is non-contact scanning mode, surface and interior visualization of surfaces, un-continuous and narrow the complex shape detection, high detection precision, accuracy. Visualization of laser ultrasonic detection is currently the world's first spread through the process of visualization. It visually Detects object interior damage and defects of the technology. The technique of testing technology has a revolutionary leap.

Cylinder liner is the core parts of the engine. The structure, material, processing precision of cylinder sleeve that surface lubrication characteristics directly affect the engine power, economy, reliability, Environmental protection. The cylinder liner is widely used in passenger cars, commercial vehicles, Engineering machinery, agricultural machinery, military, railway

locomotives, marine power, generator power field. But the crack damage and point corrosion is cylinder liner, running way of the outstanding problems. In this paper, detector for cylinder sleeve for visual detection by LUVI-SP2 JinBo carries on the experiment and the analysis of crack, using of the process of fatigue crack and corrosion defects. Experiments show that the laser ultrasonic detection technology in the detection of focal length electric adjustment cylinder sleeve by focusing a laser generator built in, using of cylinder liner for irradiation and scanning. It can realize the reproduction of ultrasonic in cylinder sleeve in real communication process and can directly check the defect or damage.

I. Introduction detection technology of laser ultrasonic visualization

Detection of laser ultrasonic visualization is to combine the laser ultrasonic detection technology and visualization technology. Ultrasonic signals are generated by pulsed laser fire, through visual processing on the received signal to realize the ultrasonic propagation process visualization, and then realize the visual detection. At the time of detection, laser irradiation of the surface of the object, the local instantaneous heat generating ultrasonic wave in the expansion of its internal communication, to return to the surface of the object as defect reflected wave is observed when it reaches the abnormal position. This can be achieved to observe influence the change of structure and physical properties of objects of the ultrasonic signal. It can also be dynamically viewing the actual propagation process of ultrasonic in the object, which intuitively detect the object internal injury.

LUVI detection system used in this subject is the national aviation high-tech industrial bases and the national "one thousand project" distinguished experts together to create specialized in nondestructive testing technology research, the company's main testing instrument of independent research and development, design, manufacture, import and export of related equipment, product sales and after-sales service, technical training, comprehensive inspection business of high-tech technology such as trustee to check. The test system used by small ultrasonic C scan device TT - UTCS01, using water immersion focusing probe receiving ultrasonic signal. This method has the following advantages:

A. For narrow department, are of complex shapes and convenient detection.

B. It is easy to high temperature, high pressure, high stress, high speed and so on difficult test parts of the test.

C. It can be observed at the scene of the detection in real time detection of ultrasonic transmission image, through the observation of animation, testing method (it can decrease the residual and error detection rate).

4) The outline of is detected and the relationship between the damage location can be recorded in the form of the image, so easy to locate damage parts.

It is because of the laser ultrasonic visualization detection technology has more advantages, also for us to solve the current cylinder liner inspection provides a feasible method.

II. Structure and defect of cylinder sleeve

Cylindrical parts of cylinder liner in internal combustion engine cylinder embedded in it, and the piston and piston ring cylinder components together, the cylinder fuel combustion pressures into mechanical energy to work through the crank connecting rod mechanism is one of the key parts in the worst working condition of the engine. The cylinder sleeve and the cylinder,

cylinder head, cylinder pad directly assembly mating, itself has the larger assembly stress. It works continuously by the vibration, bearing large impact, damage. Cylinder hole under constant friction and corrosion, easily to be damaged, and the damage may be caused by failure of cylinder liner cylinder. The failure of cylinder sleeve is the engine, and it does not work.



Figure1. Cylinder liner

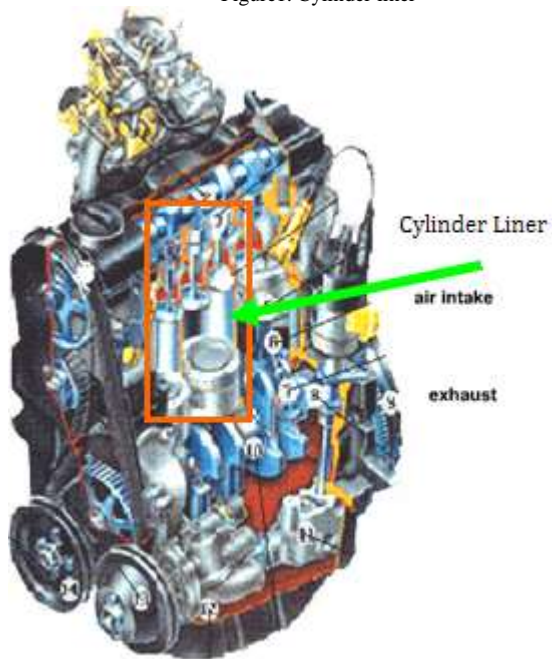


Figure2. The positions of the cylinder liner in machinery

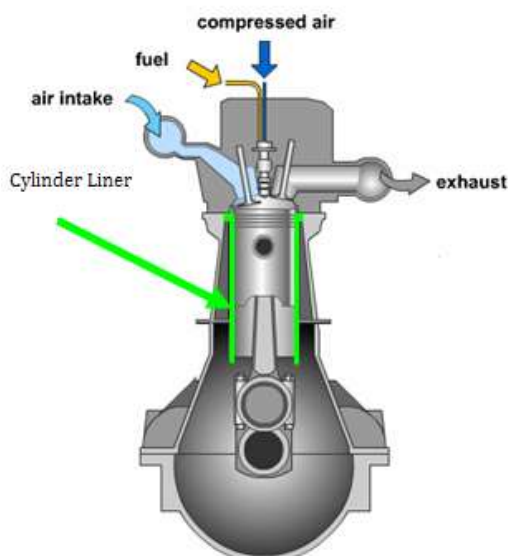


Figure3. Cylinder liner with other components of the assembly

Cylinder liner is the heart of the engine components, and the combustion chamber components in the main body. It is also the engine friction, under high temperature and high pressure parts. The inner wall of the cylinder liner and piston head, cylinder head bottom constitute combustion working volume, engine work, cylinder liner inner surface directly contact with high temperature and high pressure gas, the outbreak of the gas pressure can be up to 4×10^6 pa, the highest temperature can reach 000°C or so and strong corrosion effect, and the process of inlet air and the outer surface of the cooling water temperature only a few degrees. Cylinder pressure difference and temperature difference between inside and outside that make cylinder liner inner surface touch the fire (surface) due the expansion of the surface (water surface) hampers and compressive stress, the external surface of the cylinder liner (water surface) by touching the fire (surface) on the inner surface of stretching and tensile stress is produced. At the same time, the inner wall of the cylinder liner is the piston and piston ring friction, knock, and the lateral thrust action, the surface erosion and cavitation by cooling water, the upper is the role of the cylinder head installed pre-tightening force, all of these make the cylinder liner is considerable mechanical stress, thermal stress and chemical corrosion, etc. In view of the working conditions of the cylinder liner is very bad, so the cylinder liner in use process will inevitably produce a variety of failure, and make the engine compression in the event of fault failure light blue smoke coming weakness, starting difficulty, exhaust or black smoke makes environmental performance variation; Lead to the decline of engine power dynamic performance variation; Increase the fuel, oil consumption, economic performance variation; Or will cause type cylinder, cylinder liner broken or even damaged engine safety performance becomes poor. These are directly or indirectly affect the farming, agriculture, farming, delay be mobilized to reduce farmers' income. So regularly check of the cylinder liner is the prerequisite of cylinder liner safety work. Therefore, regularly checking

the cylinder sleeve is the premise to ensure work safety of cylinder sleeve.
 3.LUVI-SP2 tester and testing parts of the connection diagram



Figure4. LUVI-SP2 detector

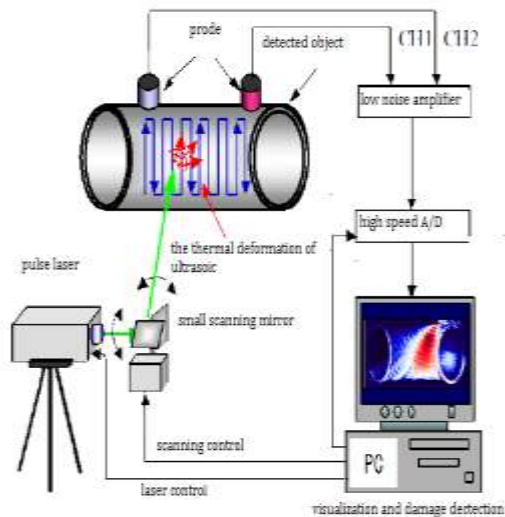


Figure5. LUVI - SP2 and testing a wiring diagram

III. DETECTION EXPERIMENT

A. Detection conditions

1) *The instrument used detection:* the LUVI-SP2 test instrument.

2) *Set the laser parameters*

The laser wavelength: 1064nm (YAG)

Pulse width: 30ns

Laser set capacity: 1ms

The accuracy of detection: the minimum 0.1mm (metal thickness is 5mm)

3) *Scanning range set*

Laser light to detect the distance (specimen to strafe the mirror): 350mm

Scanning interval: 0.26mm (237 x 256)

Scanning speed: 500HZ

Scan time: 121s

4) *The signal acquisition*

The receiving probe: 2MHZ90, 5MZ70

Sampling frequency: 10MHZ

The sampling points: 500

Frequency filter: HPF=500KHZ

B. Experimental content

1) *Detection of external longitudinal crack*

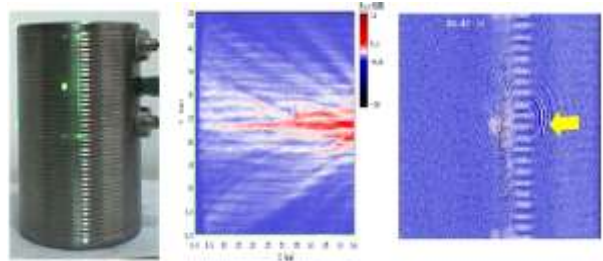


Figure6. Cylinder liner Figure7.Amplitude Figure8.Animation

2) *Cross section of the pipe wall inner hole detection*

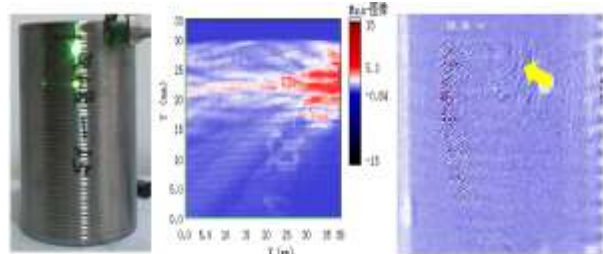


Figure9. Cylinder liner Figure10. Mplitude Figure 11.Animation

3) *External hole (phi 0.8) test results*

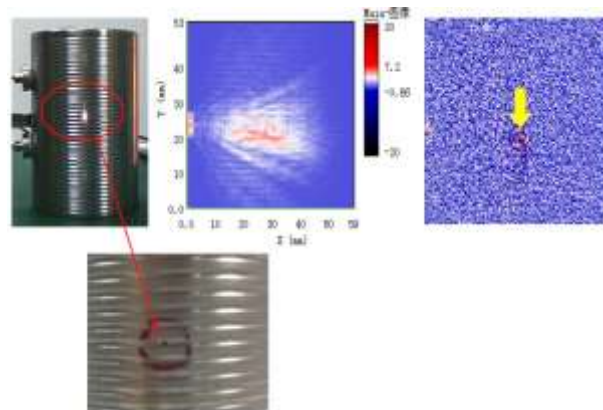


Figure12. Corrosion of Amplification

From the above three experimental phenomena, we know that, in Fig .7, Fig .10 defects strong signal red appearance, the more serious the defects of maximum amplitude red signal is also larger; in Fig .8, Fig .11 in the ultrasound propagation animation display, in the yellow arrow pointing to the site showed that echo is, specimen damage here, not in the normal wave propagates, echo more obvious, suggesting that the defects are also more serious. Corrosion hole in Fig .11 will be detected after amplification, our naked eye can see. If the hole is difficult to be found in the cylinder sleeve, it is easy to cause the failure of cylinder sleeve.

IV. CONCLUSION

Nondestructive testing is a new and comprehensive application technology, it does not harm the tested object as the premise, the basis of the principle of a variety of physical and chemical phenomena, for all kinds of engineering materials, components and structure of convenient and effective inspection and test, to evaluate and assess their integrity, continuity, safety and reliability and some physical properties. Nondestructive testing, therefore, is to implement quality control, saving raw materials, process improvement, reduce costs and improve labor productivity, and the safe operation of the device and the important tool of monitoring and early warning. The Chinese mechanical engineering society is the nondestructive testing NDT academic organization, and TC56 is its standardization organization.

Unique characteristic of laser ultrasonic technique in nondestructive testing technology, combined with the visual effect of monitoring, and make this subject compared with the traditional nondestructive testing method. It has a more intuitive observation results of the detection speed, faster and more reliable test results.

As a new detection technology of efficient, reliable, application of LUVI detection has a good prospect in the field of nondestructive testing. In the introduction of foreign equipment and technology of LUVI-SP2 at the same time, according to the structural damage and corrosion damage of domestic machinery components, to adapt to the development of software technology cooperation, making the detection is simple and intuitive, easy operation, strong adaptability, wide application range and the like. Pipe LUVI detection technology in petroleum, natural gas and power generation equipment damage inspection, parts, internal and external defects of welding defects and other fields are widely used, nondestructive testing and lay a solid theoretical and experimental foundation for the future.

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