



NON-DESTRUCTIVE TESTING METHODS

Today, production non-destructive test methods can be applied on raw materials, semi-finished and finished materials, as well as allowing the necessary tests to be carried out without suspending the works during operation. It is faster and more cost-effective due to its non-destructive nature. As it is used in various fields of industry today, there are many different uses such as health and scientific studies. Since the test results are often obtained during the test without stopping the system, it allows intervention in a short time.

The most important element stated in all NDT methods is that the personnel who will apply the method must have received sufficient training on the subject and have a certain experience.

It is not appropriate to identify one best method among the NDT methods. The appropriate method should be determined according to the place of use.

As a result of the researches, 'Magnetic Particle Inspection Method' and 'Ultrasonic Inspection Method' devices stand out from other methods as the least costly and most suitable for checking the products produced on behalf of our company.

1. Magnetic Particle Inspection Method

The magnetic particle inspection method has a very wide use applied to ferromagnetic materials due to its very simple, fast and low-cost applicability in the detection of surface and near-surface errors and in the determination of locations. In this method, the determination of surface defects depends on the size of the error and its proximity to the surface, and it is applied only to ferromagnetic, that is, magnetizable materials. The basic principle of the method is based on the magnetization of the inspected material. The magnetization process is carried out by transmitting electric current or direct magnetic flux through the workpiece. Ferromagnetic materials contribute to the transmission of this magnetic flux. If there is an error in the magnetic field, the gap in the error will block and deflect the field lines. This creates a dense leakage current on the fault and the size of the leakage current is directly proportional to the size of the fault.

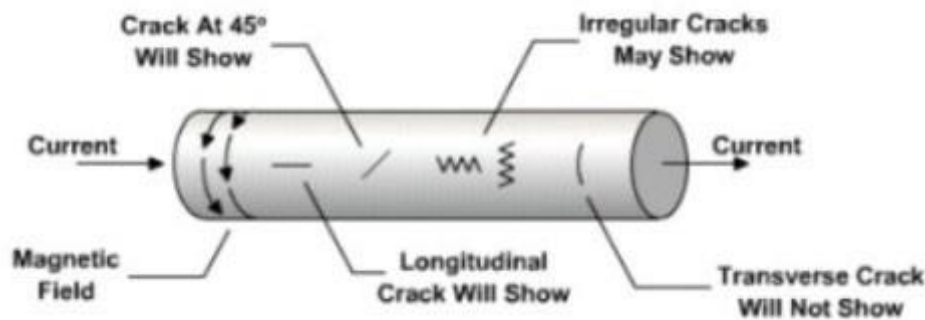


Figure 1: Detection of cracks according to magnetic field



Advantages;

- Easy application and operation.
- It is qualitative.
- Suitable for Automation.

Disadvantages;

- Its applicability is limited to ferromagnetic materials.
- It is suitable only for cracks on or near the surface.

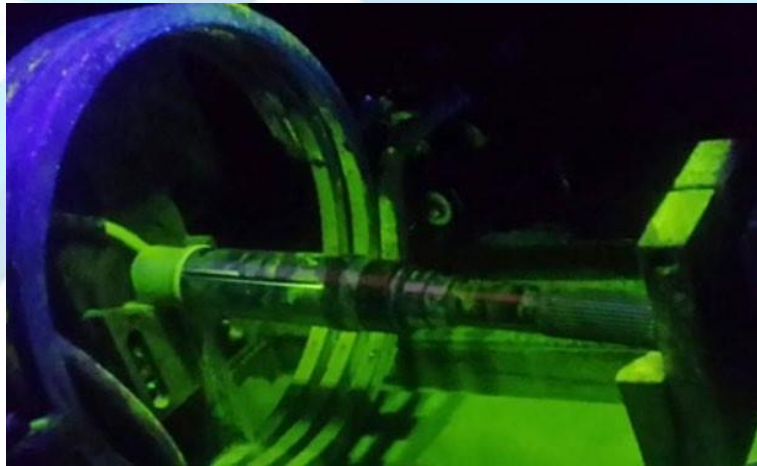


Figure 2: Application of the magnetic particle inspection method on milled shafts



Figure 3: Application of the magnetic particle inspection method on gears



Devices Used in Magnetic Particle Inspection Method and Their Costs

Based on the researches, there are domestic and international sales of the devices. In general, there are two types of measuring devices. Devices that are portable and can be inspected manually are mostly suitable for finished and semi-finished products with flat floors, but considering the production of our company, it is thought that workbench-type inspection devices will provide more appropriate and healthy inspection reports. The price range is set at \$5000 and above. Spare parts and kit equipment to be purchased with the device may increase the price.

Sample Workbench;



Figure 4: Sample Workbench

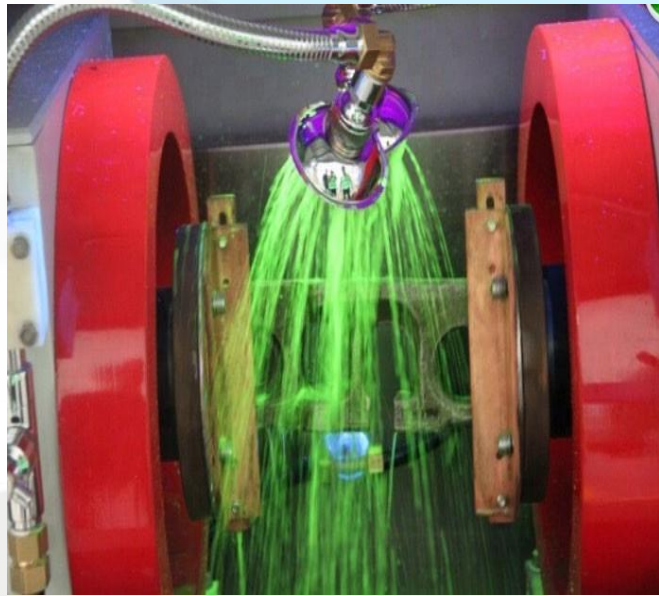


Figure 5: Sample Application on the Workbench

Workbench Information;

Made in: Beijing/CHINA

Brand Name: HUATEC

Model Number: HCDX – 10000B

Product Name: Magnetic Particle Inspection Workbench

Certificates: ISO, CE, GOST

Warranty: 12 Months



Application: The standard magnetic particle inspection bench can be used to detect surface and near-surface defects such as cracks and wear of small or medium-sized ferromagnetic grade workpieces (bolts, pin shafts, shaft sleeves, gears, gear wheels, crankshafts, etc.).

Workbench Characteristics;

- Semi-confined darkroom
- Fixed UV lamp
- Use of phosphorous or non-phosphorous magnetic particles
- Circular and longitudinal magnetization
- Continuous applicable current input
- Optional DC magnetization and demagnetization function
- Anti-spark copper coating for circular magnetization

Configuration Table;

Type Configuration	B-	B	B+
(PLC) Programmable logic controller (PLC)	●	●	●
Digital ammeter	●	○	
Touch screen		○	●
Current preset		○	●
DC magnetization		○	○
Contact detection		○	●
Anti-spark copper pad	○	○	●
Electric/pneumatic clamp	●	●	●

Note: Filled circles are standard, hollow circles are optional features

Useful Videos;

<https://www.youtube.com/watch?v=qpgcD5k1494>

<https://www.youtube.com/watch?v=i6zAPx0XTUI>

<https://www.youtube.com/watch?v=rZBQ5XEUMwk>

2. Ultrasonic Inspection Method

This technique is used to detect internal and external errors in sound transmitting materials. The principle of operation is similar to the reverberation of sound. By applying an electrical charge to a piezoelectric crystal on ultrasound, a short vibration is produced, that is, it is vibrated for a very short time at a frequency proportional to the crystal thickness. In error detection, this frequency is usually between one and six million per second (1 MHz to 6 MHz). At this frequency, vibrations or sound waves can reach sufficient distances in homogeneous elastic materials. The speed of these waves is related to the characteristics of the material and the Young's modulus. For example, the speed is 5900 m/s in steels and 1400 m/s in water.

Ultrasonic energy is quite weak in the air, and a certain amount of energy is reflected if a beam of light encounters an interface (an error or a possible gap, etc.) as it travels through the solid. In the measurements made by contact with the sample, the vibrating crystal is located in a hand-held probe on the material tested. A liquid layer, usually in the form of oil, water or grease, is applied to the surface so that energy passing through a small air gap between the test piece and the crystal can be easily transferred. Especially in welded connections, supersonic waves created in special devices are sent to the workpiece. Where there are cracks, the waves return with a strong reflection. Faulty points are detected by looking at the reflection patterns and locations on the screen of the test device.

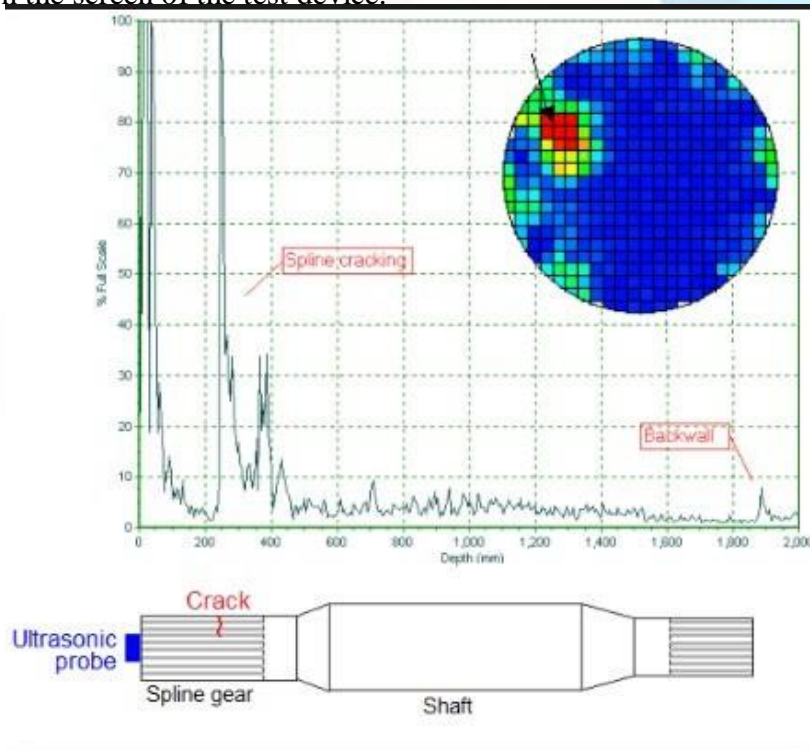


Figure 6: Milled shaft with cracks detected by ultrasonic inspection method



Advantages;

- Parts up to about one meter in thickness and length can be tested.
- The location, size and type of the error can be determined.
- The test gives instant results.
- The devices used are portable.
- It is extremely accurate.
- It can be fully automated.
- Only one edge is enough for entry.
- It is cost-effective.

Disadvantages;

- Records are not permanent unless the test results and the systems used to collect the data are very sophisticated.
- The operator decides at the time of the test whether the test sample is faulty or not.
- The indicators require interpretation.
- It requires quite a high skill to evaluate the test in its entirety.
- It is difficult to apply in very thin sections.



Figure 7: Application of the ultrasonic inspection method on the steel cylinder



Figure 8: Application of the ultrasonic inspection method on the gear wheel

Devices Used in Ultrasonic Inspection Method and Their Costs

Based on the researches, there are domestic and international sales of the devices. In general, smaller and portable devices are used compared to magnetic particle inspection devices. By checking the semi-finished and finished products, unprocessed semi-finished products and semi-finished products provided externally, and also the inspections of the products and semi-finished products going to heat treatment before and after they go, it will be revealed whether the semi-finished and finished products that are still in the heat treatment process are damaged or not. The price range is set at \$2000 and above. Spare parts and kit equipment to be purchased with the device may increase the price.



Sample Device;



Figure 9: Sample Device



Figure 10: Sample Device set and toolbox

Device Information:

Made in Bursa/TÜRKİYE

Brand Name: Bursam NDT

Model Number: UFD-101-T

Product Name: Ultrasonic Inspection Device

Application: This device, which can be used in almost all types of finished and semi-finished products, provided that it is not very thin, can detect deep cracks and deformations in the finished and semi-finished products with depth accuracy up to 1m.

Device Characteristics;

- Step interval measurement and analysis of echo time
- Two input methods: angle and K-value
- Prop auto calibration and auto gain
- Units of measurement mm/inch
- Locking of system parameters
- Door settings and alarm function
- Two measurement display modes, Type A and Type B
- Capable of freezing waveform and detection parameters
- PC communication, measurement information and parameter transfer
- DAC curves and DGV generation
- Data storage memory of 1000 measurements



Useful Videos;

<https://www.youtube.com/watch?v=UM6XKvXWVFA>

<https://www.youtube.com/watch?v=ndXG9VzRQIM>

CONCLUSION

In line with all these researches carried out, the test devices and workbenches required by our company have been determined, and it will be possible to solve the problems such as cracks, fractures, deformation, etc. in any part of the semi-finished products and finished products produced and being produced in line with the supply of these devices, by returning or scrapping those that cannot be eliminated. In other words, a substantial increase in quality in the finished and semi-finished products produced by our company is absolutely foreseen. At the same time, the quality control of the by-products produced and purchased externally can be carried out within the company itself. This will play an important role in determining the problems experienced by our company, if any, caused by the supplier company.