SEP1921-84

Ultrasonic Testing of Forgings and Wrought Materials

1 Inspection purpose and object

This method is suitable for the ultrasonic inspection of forgings and forgings (hereinafter referred to as forgings) with a diameter (side length) of 100mm or more (including 100mm), and is especially suitable for the inspection of internal defects of materials by pulse-reflection technology. The reflected waves generated by defects can determine the exact location, size, continuity and number of defects. For forgings that require flaw detection, this method can be used as a guide, providing the detection range (see 6.2) and the allowable limit (see 6.5 and 6.6). The technical conditions required for the inspection include the inspection system, the condition of the forging and the rating of the results.

2 scope of application

The inspection method includes not only the inspection of unfinished and unprocessed forgings, but also the inspection of forgings without heat treatment and heat treatment, especially suitable for the inspection of non-alloy steel and alloy steel (see Section 6.1)

See SEP0000 for inspection of forgings with higher requirements

If the probe used does not match the forging, the inspection results

may be affected by the attenuation of the sound wave or other reasons. At this time, the deviation of the test results should be marked. Otherwise, the next inspection procedure must be agreed with the buyer or the responsible person of the buyer.

3 ratings

Divided into four inspection groups according to the scope of inspection (see Section 6.2), divided into 5 levels according to the size of the allowable defect and the length indicated by the defect (see Section 6.4 and 6.5, Table 1), and also divided into 5 levels according to the number of allowable defects levels (see 6.4.3)

4 Preparation for inspection

The forging should have a simple shape or rotational symmetry of the detection part (see DIN54126 part 1, section 6), in order to make the probe and the surface of the forging well coupled, the inspection surface and other reflective surfaces should be sloped and rough

degree requirements.

For the inspection of non-oxidized iron scale smooth surface, as long as the appropriate coupling agent is selected, good inspection results can be obtained. If the surface roughness Rq≤20, the surface of the material should be processed according to the requirements of DIN4762.

If the steel has not been heat treated, but the attenuation of the sound energy of the forging is still within the allowable deviation limit (or the specified limit) (as long as the steel is suitable for heat treatment), heat treatment is necessary to reduce the loss of sound energy.

In order to inspect the size class required for defects, it is also necessary to achieve the structure and surface state suitable for inspection through processing and heat treatment. (Table 1)

5 detection system:

5.1 Testing equipment

According to pulse echo technology and echo height measurement relationship, calibration with dB amplitude control, ultrasonic testing device should work within 2dB error range. Gate and saturation need not be displayed if within the sensitivity range used.

The range of inspection requirements must be adjusted to be consistent with the detection device, and the horizontal linearity should be within 2%.

5.2 Probe

The nominal frequency of the probe must be consistent with the tested disk reflector, sound distance length, and sound wave attenuation. Generally, the nominal frequency of the probe is 1-4MHz, but other frequency probes can also be used as long as they meet the allowable limit value indicated in Section 6.5.

Straight probes are usually used for inspection, however, TR probes or angle probes are usually used for inspection of near-surface defects and rings that are difficult to reach by sound waves, or for special calibration of defects in some sectors of forgings with good resolution.

In order to measure the equivalent size of the disk reflector, one should know the method of making the AVG curve of each type of probe.

5.3 Control system

According to the first part of DIN54126, the adjustment of the control system and the probe should be consistent with the requirements of DIN54120.

5.4 Couplant

The couplant (see also DIN 54126 part 1, section 5.6) must have good wetting properties for the surface, so water (with additives), oil and glue are suitable. The same couplant shall be used for the adjustment

device and subsequent inspection. When inspecting the processed forgings, the couplant should not cause corrosion of the forgings. If necessary, the couplant should be removed after the inspection and the testing surface of the forging should be dried.

6 detection

6.1 Detection time

Due to the availability and testability of forgings, pre-inspection should be carried out as early as possible. Forgings delivered for inspection are usually carried out before they are formed into complex shapes. However, due to quality reasons or processing conditions, post-heat treatment inspections are also very necessary.

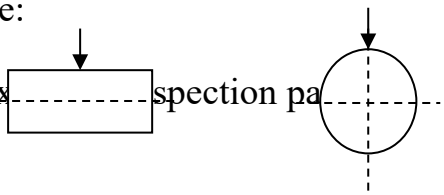
6.2 Inspection scope

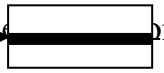
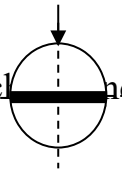
According to different requirements, the inspection range of forgings can be divided into 4 inspection groups. It is not necessary to account for areas removed during machining.

Inspection group 1:

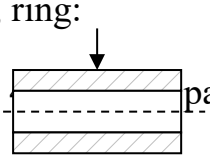
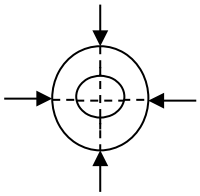
For straight probe inspection, the inspection is carried out on one or several outer surfaces of the total length of the bus bar with a maximum width of 50mm (the circle is on the end surface). Generally speaking, the sound beam should cover the core area of the forging.

example:

Rod: Ax  spection pa

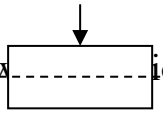
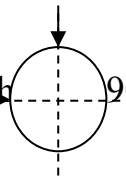
Pie: On  n path each  d faces and surfaces

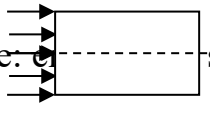
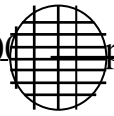
Tube, ring:

Axial  paths 

Test group 2

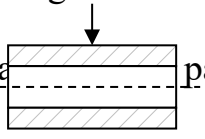
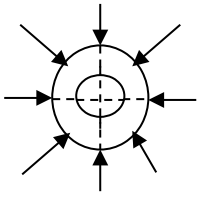
Straight probe inspection is carried out on two or several busbar lengths or arcs with a maximum width of 50mm (the end face is used as a circular track). The sound beam should cover the core area and most of the volume of the forging.

Rod: Tw  ion paths th  90° to each other in the axial direction

Cake: e  surface 200  pacing,

2 or several inspection paths

Tube, ring:

Severa  paths 

Test group 3

Straight probes scan in two mutually perpendicular directions, and different types of probes can be used to scan as much as possible

Inspect the surface of forgings to find different types of defects.

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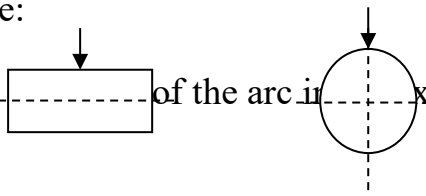
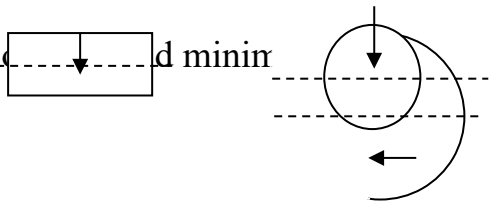
example:

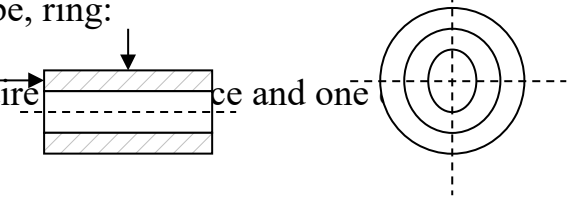
Rod: at  of the arc in xial direction;

The two sides reached an agreement on the end face detection

Pie: wh  d minim

Circumference of arc

Tube, ring:

Entire  ce and one

Test group 4

The total volume of inspection, the scope of inspection and the type of probe used for inspection shall be specified in the contract.

Note: For special inspection requirements, please refer to SEP0000

6.3 Inspection steps

The inspection is carried out according to the second part of DIN54126. According to the different inspection requirements, the surface of the forging is scanned with a probe. The inspection system shall be adjusted and calibrated according to the first calibration point, (horizontal parallel surface) or (rotational symmetry body) shall have sufficient scanning area according to the given structure diagram and selected nominal frequency, at least:

1) AVG curves produced due to sound wave attenuation or loss of propagating sound energy

2) Adjust the sensitivity by comparing the reflection of the test block reflector to eliminate the influence of sound wave attenuation and sound energy loss.

If the signal-to-noise ratio (see Section 6.6) ≤ 6 dB , the following content must be agreed upon by both the supplier and the purchaser: record the diameter of the flat-bottomed hole (circular reflector) or express the height exceeding the echo of the reflector in dB , adjust the sensitivity

The height of the echo reflected by the reflector should not be less than 20% of the full scale of the fluorescent screen. If it does not meet the requirements, it should be noted in the inspection report.

Observe the screen, the scanning speed of the probe does not exceed 100mm/s. For automatic flaw detection, the flaw detection speed and pulse duration should be adapted, and the size and length of the defects shown in (Table 1) should not be missed.

There should be no surface interference waves when testing with the methods of test group 3 and test group 4, and the probe should have 15% repeated coverage for each scan.

6.4 Display

6.4.1 Point defects

The probe scans point-like defects from different directions, and the amplitude of the received echo reduction is consistent. Record acceptable diameters of flat-bottomed holes in Table 1.

6.4.2 Continuous defects

Continuous defects refer to at least one scanning direction in which the amplitude reduction is inconsistent with other directions. The length of the defect is measured by the half-wave height method, and the defect with the largest length is recorded according to Table 1, while considering the characteristics of the sound field of the probe.

6.4.3 Quantity

The number recorded refers to the number of defects in the body of the forging that exceed the specified limit or the area agreed by both parties. (See Section 6.5) Table 2 indicates the quantity of each grade

from a to e grades. The order of magnitude and related dimensions of the defects indicated in the contract (volume section length and area of different forgings).

6.4.4 Backwall echo

If the backwall echo drops (drops to a limited range), use probes with different frequencies to inspect the same area from different surfaces.

6.5 Limit deviation (deviation allowable limit)

The supply and demand parties can reach an agreement within an acceptable range according to the requirements of the diameter grade in Table 1 and the quantity grade in Table 2

Consistent, each area of forgings with different requirements can also reach an agreement between the supply and demand sides within the acceptable range according to the diameter grade in Table 1 and the quantity grade in Table 2.

6.6 Record limit

If there is no other requirement, the recording limit and the allowable limit are the same concept (see Section 6.5). At this time, the statement of the quantity is particularly important. The ratio of the recording limit to the allowable limit is at least 6 dB , and the signal-to-

noise ratio of the recording limit is also at least 6. dB (see Section 2).

7 Inspection report

The inspection report includes the following:

a Quantity of inspection pieces

b test instructions

c Inspection device and probe type

d Inspection surface state

e coupling agent

f test range

g record limit and allowable limit

hConclusion

In addition to the record limit agreed by both parties, the position, size, state and quantity of defects should also be described, and if necessary, a cross-sectional view or a developed sketch of the forging should be drawn according to the contract requirements. In addition, in the application of inspection group 3 and inspection group 4, the adjustment method, sound beam direction, sound beam attenuation and compensation of the device should also be explained. If there is any disagreement, it must be recorded on straw paper.

Table 1 Size classification of allowable limit values

reliability limit			
size class	single defect mm	Strip defect mm	Maximum area mm^2
A	14	10	80
B	10	7	60
C	7	5	40
D.	5	3	30
E.	3	2	30

Table 2 Quantity levels (see Section 6.4.3)

Quantity level	single defect	multiple defects
a	32	16
b	16	8
c	8	4
d	4	2
e	2	1