Remanent magnetism in components

Contents

Changes

2023-03-02:
The following changed in comparison to RN 1567:2020-07-15:

a) Para. 4.2: values for permissible remanence adjusted
b) editorially revised

1 Scope

This factory standard applies to raw parts or components made of ferromagnetic material (e.g. iron/steel). Due to contact with external magnetic fields, these parts can exhibit a level of residual magnetism (remanence) which can lead to particle build-up and thus to faults in testing and production processes and in the operation of the finished product (gearbox).

The aim of this standard is to ensure a sufficiently low remanence for all components in order to avoid such faults.

2 References

There are no normative references for this document.

3 Terms and definitions

The following terms are used in this document.

Magnetism	generic term for all phenomena that are attributed to magnetic forces
Remanence, residual magnetism	magnetisation that remains in a ferromagnetic material after removal/switching off an external magnetic field The numerical value of the remanence indicates how strong the magnetisation is.
Remanence threshold	maximum permissible remanence value measured on a specific area of the blank or component It is formed from the arithmetic mean of the five highest measured values on a measuring line.

4 Determinations and processes

4.1 General

Magnetically adhering particles hold a large error potential in testing and manufacturing processes and in the operation of gearboxes:

- Slide and roller bearings can fail at an early stage
- Components cannot be fitted accurately
- Valves can be functionally affected by particles in hydraulic control channels

Cleaning methods alone cannot remove these particles reliably.

In addition to the use of magnetic lifting and clamping devices, superficial fine-pole remanence can also occur through direct contact with tools, fixtures and other components with increased remanence.

Measures

- After all processes producing residual magnetism (see appendix A, without claim for completeness) a demagnetisation has to be carried out. The remanence is then to be checked on a random basis.
- Raw parts or components that are found having too high remanence must be demagnetized before further production steps or assembly.
- Avoid direct contact between components during transport processes (danger of remanence hotspots).

4.2 Permissible remanence

Table 1 Remanence thresholds for rotationally symmetrical parts

diameter D mm	perm. remanence A/cm[1)]
D ≤ 1000	6
1000 < D	7

ⓘ high remanence values can be expected at corners, edges and tapered surfaces of ferromagnetic components, also local hotspots on other surfaces are possible

[1)] conversion factors between commonly used magnetic units, see Appendix C

Permissible remanence for generic geometric bodies (without rotationally symmetrical parts): 6 A/cm

4.3 Remanence check

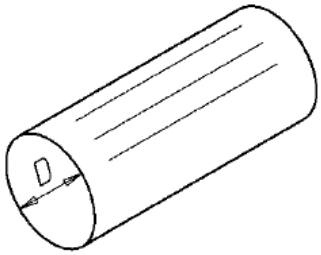
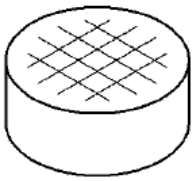
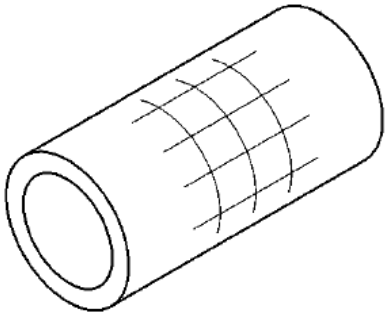
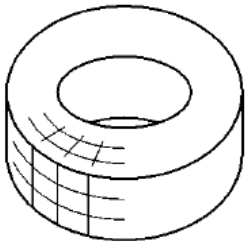
In general, a component is considered to be sufficiently demagnetized if a metallic paper clip suspended from a thread is no longer attracted to the component nor does it adhere magnetically to it.

In case of doubt or on request, the size of the remanence is determined by measuring with a teslameter.

To obtain meaningful and comparable measured values, the following specifications must be observed:

- Units to be declared: A/m or A/cm (for conversions see Appendix C)
- Measurement by a suitable teslameter with active transverse probe, linearity error < 0.2 % (± 0.1 mT) at 20° C
- Measurement without influence of induced magnetic fields (external magnetic fields, earth's magnetic field), i.e. shielding, e.g. by a zero-gauss chamber or a suitable steel construction
- residual magnetism is highly position-dependent and does not only occur at corners and edges of a component, i.e. during a measurement the entire surface should be scanned if possible Measurement in a line or cross grid
    - rotationally symmetric bodies: see table 2
    - general bodies: see Table 3, straight lines with L = max. dimension of the test surface
- Measurement by qualified personnel

Table 2 Testing the residual magnetism of rotationally symmetrical components

Type	Grid per area		Scope of testing
1		scanning in line grid Diameter — Test tracks D ≤ 200 — 3 200 < D ≤ 500 — 4 500 < D ≤ 1000 — 6 1000 < D — 8	scanning over 360° of the cylindrical surface and on both end faces
2		scanning in a cross grid over 360° on the outer surface and on one end face	scanning over at least 180° on the lateral surface and on one end face
3a		scanning in cross grid over 360° on the outer surface	scanning over 360° on the outer surface and on both end faces
3b		scanning in a cross grid over 360° on the outer surface and on one end face	scanning over 360° on the outer surface and on one end face

Measurement lines:

- Division into individual measuring points (MP), no sliding measurement
- Distance from body edges: approx. 10 mm, but at least 1 measuring line/area

Table 3 Measuring points in the grid

straight lines	measuring points	circular lines	measuring points
L ≤ 1000	approx. 1 MP / 100 mm	D ≤ 200	min. 1 MP / 120°
1000 < L ≤ 2000	approx. 1 MP / 200 mm	200 < D ≤ 500	min. 1 MP / 90°
2000 < L	approx. 1 MP / 300 mm	500 < D ≤ 1000	1 MP / 60°
		1000 < D	1 MP / 45°

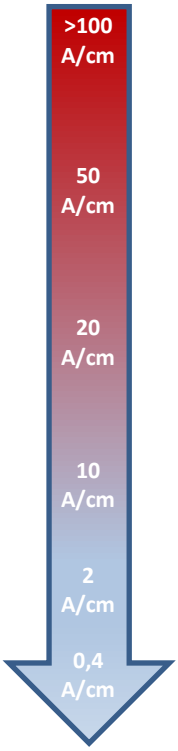
4.4 Demagnetisation

Raw parts or components that have been magnetised must subsequently be demagnetized so that the permissible remanence is no longer exceeded.

Appendix A

(informative)

Processes generating residual magnetism



- crack testing (magnetic particle inspection)
- use of load lifting or handling magnets (permanent and electrical)
- use of clamping devices (permanent and electrical)
- setting down magnetic stands (e.g. dial gauges)
- welding methods (high DC or AC currents)
- machining with magnetized tools, clamping devices etc.
- handling with magnetized tools, holders, grippers etc.
- galvanic and electro-erosive processes (chromium plating, ECM, eroding, ...)
- some PVD coating processes (e.g. magnetron sputtering)
- forming processes (structural changes in the material)

typical threshold values for automotive 2...5 A/cm

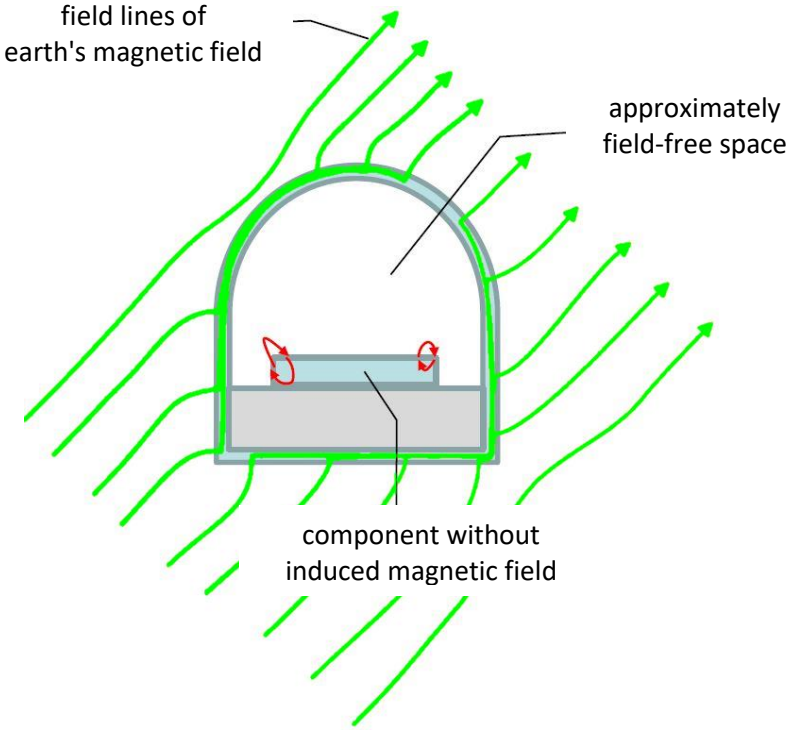
- vibrations + earth's magnetic field
- earth's magnetic field

(Source: Maurer Magnetic)

Appendix B

(informative)

Operating principle of a passive shielding chamber



Residual magnetism measurements are no longer influenced by induced magnetic fields if the component is measured in an environment shielded from earth's magnetic field (or other surrounding fields).

External magnetic fields are dissipated in the wall of the shielding chamber and the influence of the geomagnetic field inside the chamber decreases significantly. This is sufficient for reproducible measurements of residual magnetism.

(Source: Maurer Magnetic)

Appendix C

(informative)

Conversion table for magnetic units of measurement

Unit	A/cm	A/m	mT	Gauss
1 A/cm =	1	100	0,1256	1,256
1 A/m =	0,01	1	0,001256	0,01256
1 mT =	7,96	796	1	10
1 Gauss =	0,796	79,6	0,1	1

Literature

Maurer Magnetic AG. (2016). *Restmagnetismus auf ferromagnetischen Werkstücken.* 8627 Grüningen / Schweiz

Remanenz. (2020, April 16). Retrieved from Wikipedia: https://de.wikipedia.org/wiki/Remanenz

Schmitt, D. P.-J. (2015). *Glossar Magnetismus von A-Z.* Retrieved Jun 15, 2020, from Webcraft GmbH: https://www.supermagnete.de/magnetismus