

Residual magnetism of steel products

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Residual magnetism of steel products

- **Quality criterion low residual magnetism**

Modern production methods are increasingly based on complex and highly sensitive fabrication processes which are dependent on highest quality in intermediates. Examples like coating, welding, molding or punching processes require lowest possible residual magnetism values in parts as well as in tools.

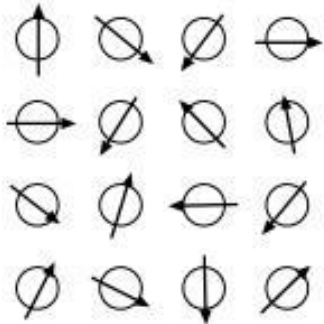
Assembly of state-of-the-art internal combustion engines, precision roller bearings, gearbox components, electronics parts or medical products are subject to strict cleanness criteria. The trend to increased technical cleanliness of products calls for lowest possible residual magnetism in parts. This guarantees an efficient performing of industrial cleaning methods.

Manual or automated handling of microscopic ferromagnetic components such as injection needles for medical applications or miniaturized parts for the watchmaker industry is already disturbed or even impractical at low residual magnetism.

These are the main reasons why the call for low residual magnetism values in a range from 0 to 4 A/cm (0 to 5 Gauss) has become a decisive quality criterion.

Residual magnetism of steel products

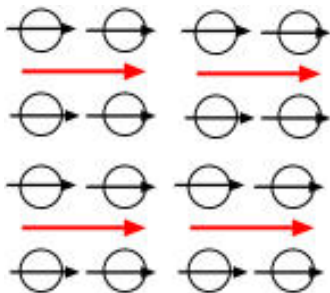
- Magnetism – Where does it come from?
 - Orientation of magnetic moments in ferromagnetic materials on atomic scale



Demagnetized

The magnetic moments of atoms have random orientation and thus cancel each other out

-> No magnetism, or very low residual magnetism detectable on the surface of the part



Magnetized

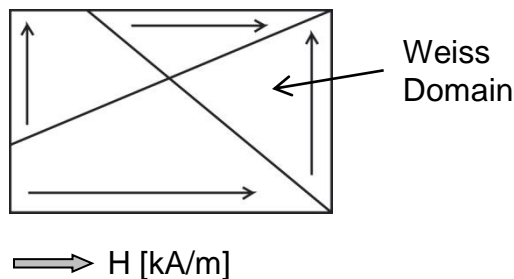
The magnetic moments are aligned by majority in one direction; they add up to an overall magnetic flux

-> Increased magnetism appears on the surface of the part

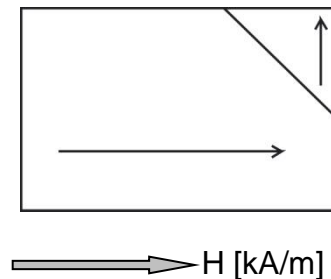
Residual magnetism of steel products

- Magnetism – Where does it come from?

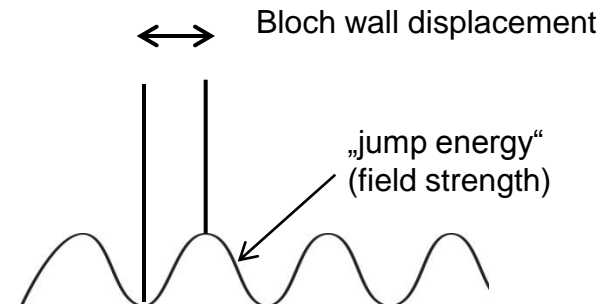
- Groups of saturated magnetic moments form the so-called Weiss domains
- Magnetization/Demagnetization takes place by the displacement of Bloch walls



Slight wall displacement due to the effect of a weak external magnetic field H . This state is reversible; the Bloch walls have not 'jumped'.



Sizable wall displacement due to the effect of a strong external magnetic field H . This state is irreversible; the Bloch walls have 'jumped'.



Bloch walls jump in a rasterized way. For this reason, demagnetization or magnetization occurs in small, discontinuous steps.

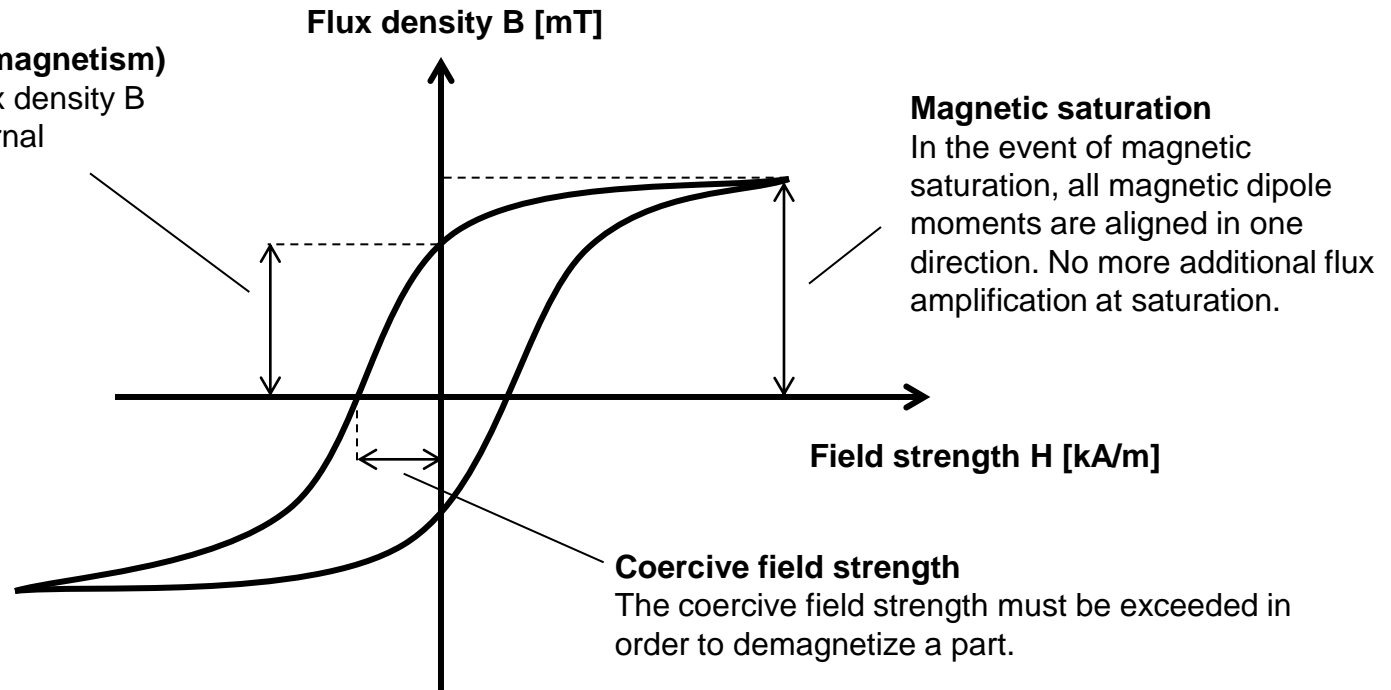
Residual magnetism of steel products

- Hysteresis curve

- Description of magnetic properties

Remanence (residual magnetism)

Remaining magnetic flux density B after removal of an external magnetic field H .



Residual magnetism of steel products

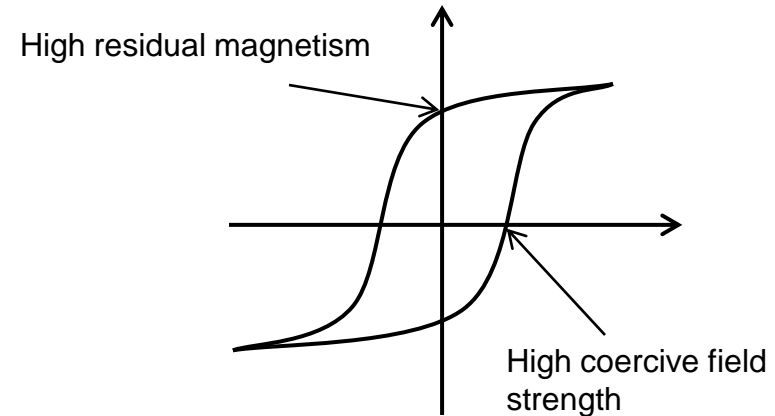
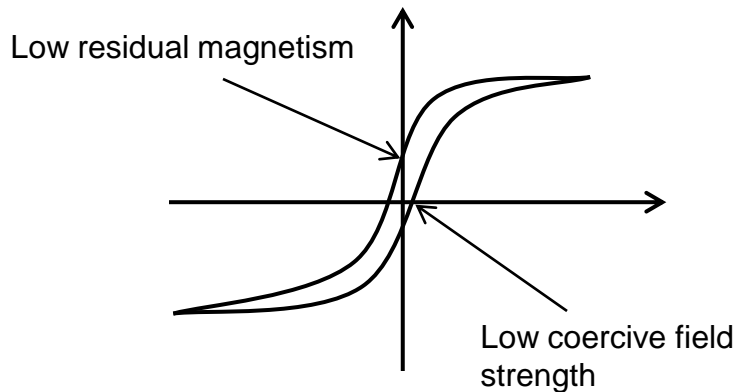
- Hard or soft magnetic steel grades

Magnetically soft (residual magnetism up to ~20A/cm)

- Generally: low-alloyed steel grades
- Generally: mechanically soft steel grades
- Machining steel
- Case hardened steel grades Ck15 etc.
- Construction steel grades S235, S355 etc.
- ...

Magnetically hard (Residual magnetism up to ~60A/cm)

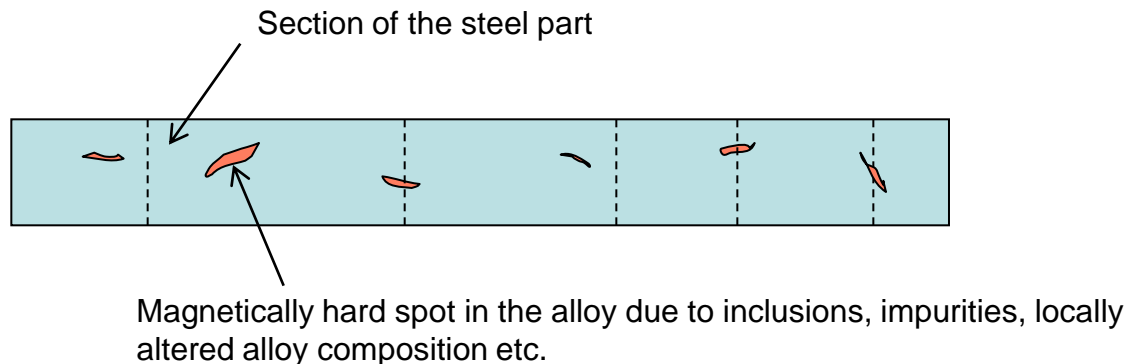
- Generally: high-alloyed steel grades
- Generally: mechanically hard steel grades
- Chromium-Nickel steel alloys
- Roller bearing steel
- Hard metal materials
- stainless steel grades (e.g. after plastic deformation, residual magnetism typically <10 A/cm)
- ...



Residual magnetism of steel products

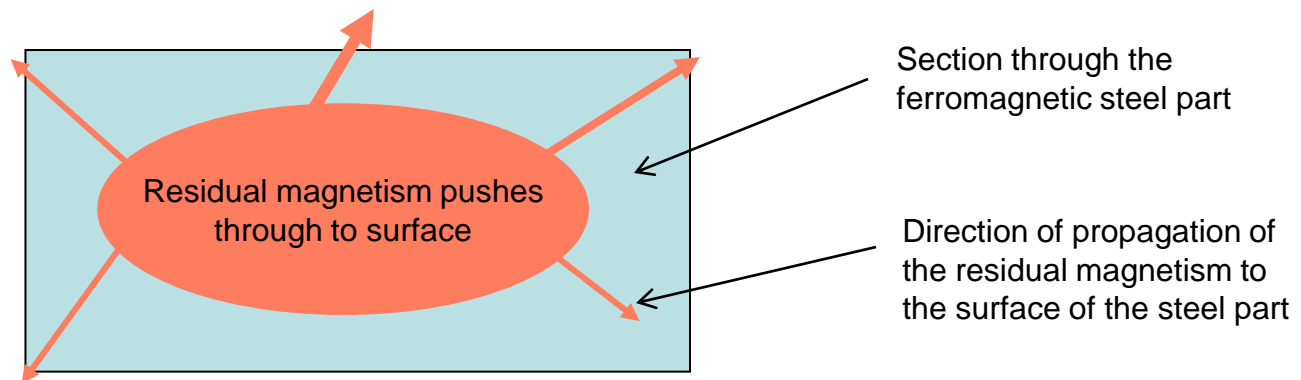
- **Magnetically hard spots in steel parts**

- local areas in the part with high coercive field strengths
- increased residual magnetism is detectable in hard magnetic areas
- demagnetization requires much higher magnetic field strength
- hard magnetic areas can cause the re-magnetization of the part
- detection of hard magnetic areas require a suitable search method (scanning of the surface)



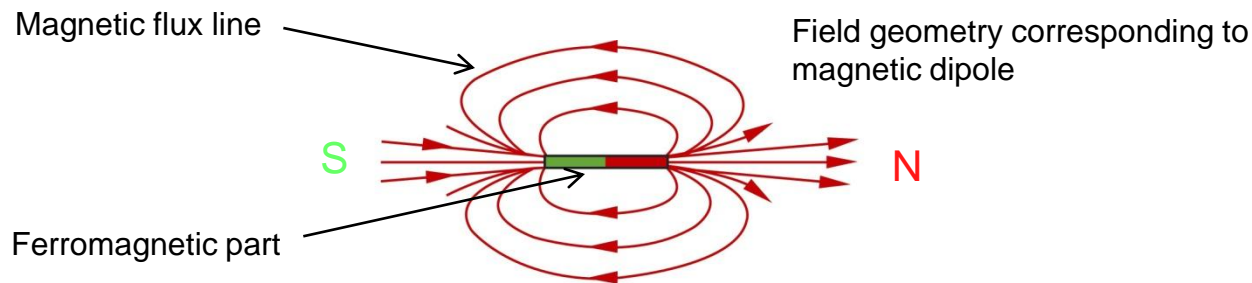
Residual magnetism of steel products

- Reasons for the reoccurrence of residual magnetism
 - incomplete or no demagnetization
 - insufficient penetration depth of the demagnetization process
 - effects from unwanted induced magnetic fields (effects of magnetic field of earth etc.)
 - conditions beneficial to re-magnetization:
 - mechanical factors: shock, vibration
 - material properties: soft magnetic steel grade
 - geometry factors: high slenderness ratio (pipes, bars)
 - storage factors: points of contact and close proximity between steel parts (flux density concentration)



Residual magnetism of steel products

- Extended range stray field

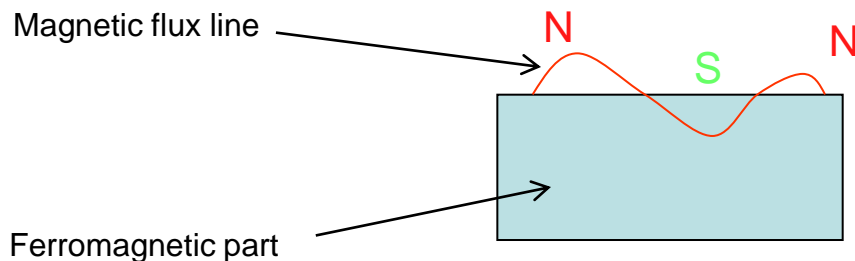


- Typical causes

- magnetic crack detection (magnetic particle- and eddy current method)
- welding processes
- storage and transport of pipes or bars parallel to the magnetic field of earth
- demagnetization of elongated parts without static field compensation
- 'freezing' the magnetic field of earth during the annealing of steel (in the mill)
- plastic deformation (deep drawing, punching, bending, rolling, molding, etc.)
- strong lifting magnets
- ...

Residual magnetism of steel products

- Short range stray field



Fine pole residual magnetism close to the part surface

- Typical causes

- Use of lifting magnets
- Use of magnetic clamping systems
- Cutting parts with magnetic tools (e.g. magnetic inserts, drills, etc.)
- Contact points with magnetic tools (e.g. magnetic screw driver tips, etc.)
- Cutting parts made of alloyed materials with blunt tools -> cutting pressure leads to structural change and often to magnetization
- attaching of gauge stands to parts...
- ...

Residual magnetism of steel products

- Maurer Magnetic AG, the specialist for
 - Industrial demagnetizers
 - Magnetic field instruments
 - Demagnetization services
 - Troubleshooting in magnetism
 - Magnets and magnet systems