Non-magnetism in stainless steels

The demands on stainless steels can be traced in several directions:

- Non-magnetic (paramagnetic) steels - austenitic steels meet these properties
- Magnetic steels (with magnetic properties) - especially ferritic steels
- Duplex steels are the middle way, for comparison we also list selected martensitic steels

1. Non-magnetic steels

Non-magnetic steels are most often austenitic steels. For these steels, their permeability (the influence of the material on the effects of the magnetic field) is monitored (in addition to their corrosion and mechanical properties). It is monitored mainly in the form of relative permeability (i.e. in relation to the permeability of the vacuum), i.e. a value of 1 is met by the vacuum, steels have higher values as standard, but depending on the type of material.

Non-magnetic steels are close to the value 1 - thus their influence on the applied magnetic field is very low - in the state without cold hardening they are up to the value 1.02. Depending on the amount and intensity of cold working, they not only harden but also form partial martensitic phases which already exhibit magneticity. The growth of permeability as a function of the degree of cold hardening is shown in the following table:

Tab. 1:

Grade	Relative permeability for a given level of hot working			
	0	10	20	30
305 (1.4303)	1,004	1,004	1,004	1,005
304Cu (1.4301Cu)	1,005	1,005	1,012	1,082
304 (1.4301)	1,012	1,046	1,626	3,090
303 (1.4305)	1,003	1,05	1,62	3,42

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2. Magnetic steels

Magnetic steels are mainly ferritic steels. The individual grades are then designed with the target properties in mind. In some cases, there is a trade-off between the individual properties, both with regard to the magnetic (or electrical) properties of each other and with regard to the mechanical and corrosion properties.

A comparison of the properties and standard applications of the main magnetic steels is summarised in the following table:

Tab.2:

Grade	1.4106Mod	1.4105Si	P12FM	P17	1.4511
Saturation (T)	1,60	1,60	1,70	1,65	1,67
Coercivity (A/m)	150-200	130-200	100-125	150-200	100-150
Max. relative permeability	1100-2000	1200-2200	2000-3000	1000-2000	2000-3000
Remanence (T)	0,25-0,8	05-0,9	0,5-0,7	0,5-1	0,5-1
Resistance (μΩ.cm)	76	77	78	60	60
Machinability	increased	increased	increased	standard	standard
Environment / other properties	mildly chlorinated aquatic environments	compromise between corrosion resistance and magnetic properties / 2 levels of magnetic properties	gasoline, fuels / excellent permeability and coercivity	fuel/magnetic properties comparable to 1.4105Si, lower resistance, better mechanical properties	fuels, more aggressive environment / better weldability, mag. properties comparable to P12FM, excellent compromise between corrosion resistance and mag. properties

Application	electric valves e.g. machines beverage production	electric valves and injectors (automotive)	electro injectors electrovalves magnetic sensors magnetic brakes	automotive	electrovalves automotive

3. Martensitic and duplex steels

The magnetic properties of martensitic and duplex steels are summarized in the table below:

Tab. 3:

Grade	1.4005	1.4313	1.4418	1.4542	1.4362	1.4462	1.4507
Saturation (T)	1,75	1,6	1,3-1,5	1,3-1,5	0,55	0,55	0,50
Coercivity (A/m)	800-1000	1200-1500	1650-2600	1800-3400	600	700	750
Max. relative permeability	180-380	200-300	100-200	50-200	50	40	30
Remanence (T)	0,9-1,2	0,7	0,5-0,7	0,4-0,7	0,05	0,04	003
Resistance (μΩ.cm)	57	60	80	70-80	80	80	85