Ferro-Titanit®
Powder-metallurgical carbide-alloyed materials

Deutsche
Edelstahlwerke

Member of Swiss Steel Group

Contents

Data sheets

Highly wear-resistant, light, machinable, hardenable

Ferro-Titanit® is the trademark used by Deutsche Edelstahlwerke GmbH (WK) for ultrahighalloyed, machinable and hardenable alloys made by powder metallurgy techniques. The materials combine the properties of steel and tungsten-carbide alloys and are highly wear-resistant.

Ferro-Titanit® has a titanium carbide content of around 45% by volume, embedded in an alloyed steel binder phase.

In as-delivered condition, this material can be machined by conventional methods. In heat-treated, hardened condition (up to 69 HRC), Ferro-Titanit® can be used to solve many wear problems economically.

- Ferro-Titanit® is hardenable up to 69 HRC.

A simple heat treatment brings about a considerably higher hardness than for steel.
The tools have exceptionally long service lives.
Appreciable savings are achieved as a result of lower tool costs. Tool changeover costs are reduced through longer machine operating times.

- Ferro-Titanit® can be hardened with extremely little distortion, since titanium carbide has a low thermal expansion and no transformation.

The microstructure is free from segregations and fibering due to the powder metallurgy process. Vacuum hardening is advisable, as otherwise the negative influence zones on the tools require a greater machining allowance.
In the case of C-Spezial, hardening and tempering cause an increase in the original dimensions.
WFN and S grades are shrink in dimensions due to retained austenite. Deep cooling in liquid nitrogen, on the other hand, increases the dimensions of these grades. The dimensional change is in each case less than 0.1%.

- Ferro-Titanit® offers good possible combinations with steel (e.y. high temperature brazing).

When used in combination, Ferro-Titanit® is applied only in areas exposed to wear.
The steel, as the substrate, permits material savings, offers higher toughness, and can be machined more cost-effectively.

- Ferro-Titanit® allows reutilisation of used tools.

Used tools and wearing parts can be annealed as often as required and processed into new parts (no change in the microstructure).
Minimum remachining in the soft-annealed condition permits swift replacement of failed tool or wearing components (example: remachining of a drawing tool to produce a larger profile).

- Ferro-Titanit® is machinable according to given guidelines (siehe Seiten 20, 21).

It can be machined in the annealed as-delivered condition by conventional methods, such as turning, planing, milling, drilling, and other means.
Company-own tool shops can be employed, producing long-life tools at a relatively low total cost.

- Ferro-Titanit® exhibits minimum pick-up.

The titanium carbides in Ferro-Titanit® (45% by vol.) do not alloy with other materials.
The hardly detectable pick-up with well-polished tools and dies – especially deep-drawing tools – and the high wear resistance lead to high outputs between remachinings, combined with a best-quality surface finish.

- Ferro-Titanit® has a low specific weight.

Ferro-Titanit® is 50% lighter than tungsten carbide and still 15% lighter than steel.

Ferro-Titanit® C-Spezial

Chemical composition

Carbide phase	Binder phase (main components)			
TiC	C	Cr	Mo	Fe
33	0.65	3.0	3.0	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + martensite

Characteristic properties

The binder phase consists of a cold work steel containing 3% chromium and 3% molybdenum. The relatively low alloy content brings about a low tempering resistance. The hardness decreases above approximately 200 °C. In comparison with the other grades, C-Spezial has the best machining properties.

Mechanical properties
hardened + tempered

Density g/cm^3	Compression strength MPa	Bending fracture MPa	Modulus of elasticity MPa	Shear modulus MPa	Service hardness HRC	Further data on the mechanical properties upon request
6.5	3800	1500	292000	117000	approx. 69	

Physical properties

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

100	200	300
9.2	9.1	9.8

Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$
0.205

Measuring frequency (Hz)	Damping Q^{-1} (10^{-5})
2600	14
7000	22
22000	16

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$
0.75

Magnetic properties

Magnetic saturation polarisation mT	Coercive field strength $kA \cdot m^{-1}$	Remanence mT
920	5.0	315

Use

All cold work applications in cutting and forming engineering, e.g. for cutting and blanking tools, bending jaws, extrusion punches, deep-drawing dies, form and hobbing punches, clamping jaws, blanking sleeves, tools for the processing of steel, non-ferrous metals, aluminium, etc., as well as machine elements such as pulleys, rollers and guides exposed to heavy wear.

Ferro-Titanit® C-Spezial

Annealing

Annealing temperature °C	Cooling	Hardness after annealing HRC	Transformation range °C
Soft 750 (10 h)	Furnace	approx. 49	800 – 852

Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

Hardening

Hardening temperature °C	Hardening medium	Quenching	Transformation range °C
980 – 1100	Vacuum	min 1 bar N_2	800 – 852

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

Tempering

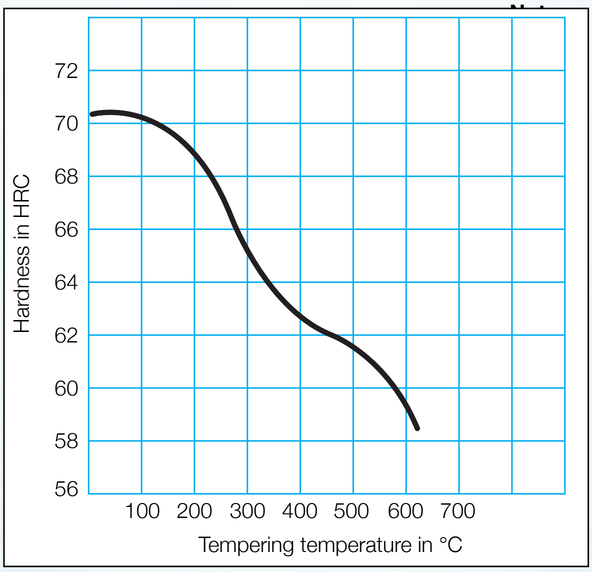
Tempering temperature °C	Service hardness HRC
150	approx. 69

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

Dimensional changes

Due to the hardening and tempering of C-Spezial, the original dimensions increase. The change in dimensions is less than 0.1%.

Tempering curve



No tempering temperature other than the one indicated should be selected, as the strong, negative influence on the resistance to wear and pick-up does not justify the minor benefit of toughness improvement.

Ferro-Titanit® WFN

Chemical composition

Carbide phase	Binder phase (main components)			
TiC	C	Cr	Mo	Fe
33.0	0.75	13.5	3.0	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + martensite

Characteristic properties

Because of its 13.5% chromium and 3% molybdenum content, WFN has a high tempering resistance up to around 450 °C, as well as high-temperature hardness and good corrosion resistance. The thermal expansion coefficient is adjusted to that of steel through the 1% aluminium alloy addition. Lower stresses thereby occur when non-permanent and permanent joints are heated, reducing the risk of cracking.

Mechanical properties
hardened + tempered

Density g/cm³	Comp-pression strength MPa	Bending fracture MPa	Modulus of elasticity MPa	Shear modulus MPa	Service hardness HRC	Further data on the mechanical properties upon request
6.5	3600	1200	294000	122000	approx. 69	

Physical properties

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

100	200	300	400	500	600
10.6	11.6	12.2	12.4	12.7	12.9

Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$
0.182

Measuring frequency (Hz)	Damping Q^{-1} (10^{-5})
2600	27
7100	33
22000	27

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$
0.91

Magnetic properties

Magnetic saturation polarisation mT	Coercive field strength $kA \cdot m^{-1}$	Remanence mT
590	9.2	160

Use

All cold work applications in cutting and forming engineering. In particular for tools and wearing parts required to have a high tempering resistance up to 450 °C as well as elevated corrosion resistance, e.g. guide rollers for wire rod and bar steel rolling, injection moulds for plastics processing, jets for steam-jet equipment, valve components, tube drawing dies, extrusion dies for the manufacture of aerosol cans, cold rollers.

Ferro-Titanit® WFN

Annealing

Annealing temperature °C	Cooling	Hardness after annealing HRC	Transformation range °C
Soft 750 (10 h)	Furnace	approx. 51	890 – 970

Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

Hardening

Hardening temperature °C	Hardening medium	Quenching	Transformation range °C
1080	Vacuum	min 1 bar N_2	890 – 970

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

Tempering

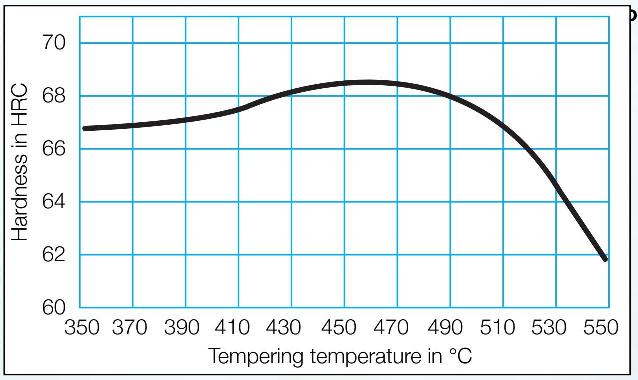
Tempering temperature °C	Service hardness HRC
460	approx. 69

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

Dimensional changes

The WFN grade exhibits a reduction in dimensions due to retained austenite. The dimensions are increased in this grade, however, by deep-cooling in liquid nitrogen or also repeated tempering. The change in dimensions is less than 0.1% in each case.

Tempering curve



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No tempering temperature other than the one indicated should be selected, as the strong, negative influence on the resistance to wear and pick-up does not justify the minor benefit of toughness improvement.

Ferro-Titanit® S

Chemical composition

Carbide phase	Binder phase (main components)			
TiC	**C**	**Cr**	**Mo**	**Fe**
32.0	0.5	19.5	2.0	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + martensite

Characteristic properties

Because of its high chromium and reduced carbon content, this grade is recommended in cases requiring elevated corrosion resistance.

Mechanical properties
hardened + tempered

Density g/cm^3	Compression strength MPa	Bending fracture MPa	Modulus of elasticity MPa	Shear modulus MPa	Service hardness HRC	Further data on the mechanical properties upon request
6.5	3700	1050	290000	116000	approx. 67	

Physical properties

Thermal expansion coefficient between 20 and 400 °C in 10^{-6} · °C^{-1}
9.7

Thermal conductivity at 20 °C in W · cm^{-1} · °C^{-1}
0.188

Measuring frequency (Hz)	Damping Q^{-1} (10^{-5})
2600	19
7100	25
22300	18

Electrical resistivity at 20 °C in Ω · mm^2 · m^{-1}
0.77

Magnetic properties

Magnetic saturation polarisation mT	Coercive field strength kA · m^{-1}	Remanence mT
620	9.8	108

Use

For parts requiring a high resistance to corrosion as well as to wear, e.g. pumps, measuring tools, thrust disks, bearings, etc.

Ferro-Titanit® S

Annealing

Annealing °C temperature °C	Cooling	Hardness after annealing HRC	Transformation range °C
Soft 750 (10 h)	Furnace	approx. 51	800 – 850

Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

Hardening

Hardening °C temperature °C	Hardening medium	Quenching	Transformation range °C
1080	Vacuum	min 1 bar N_2	800 – 850

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

Tempering

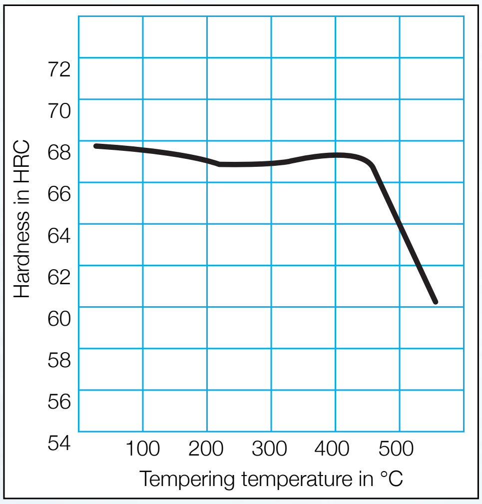
Tempering temperature °C	Service hardness HRC
180	approx. 67

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

Dimensional changes

The S grade exhibits a reduction in dimensions due to retained austenite. The dimensions are increased in this grade, however, by deep-cooling in liquid nitrogen or also repeated tempering. The change in dimensions is less than 0.1% in each case.

Tempering curve



Ferro-Titanit® Nikro 128

Chemical composition

Carbide phase	Binder phase (main components)				
TiC	**Cr**	**Co**	**Ni**	**Mo**	**Fe**
30	13.5	9	4	5	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + nickel martensite

Characteristic properties

The matrix structure consists of a highly tough, age-hardenable nickel martensite. The chromium content of 13.5 % provides good corrosion resistance. Finish-machining is performed in the solution-annealed, as-delivered condition. Subsequent age-hardening takes place at a relatively low temperature of 480 °C and can be conducted, for example, in a convection air furnace or an electrically heated chamber furnace. The workpiece remains extremely true-to-size and little prone to distortion due to the low age-hardening temperature.

Mechanical properties
age-hardened

Density g/cm^3	Com-pression strength MPa	Bending racture MPa	Modulus of elasticity MPa	Shear modulus MPa	Service hardness HRC	Further data on the mechanical properties upon request
6.6	2750	1200	294000	117000	approx. 62	

Physical properties

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

100	200	300	400	500	600	700	800
8.3	8.9	9.3	9.6	9.9	10.2	9.2	9.5

Thermal conductivity at … °C in $W \cdot cm^{-1} \cdot °C^{-1}$

100	150	200	250	300	350	400	450	500	550	600
0.171	0.178	0.188	0.199	0.212	0.226	0.242	0.259	0.276	0.295	0.315

Measuring frequency (Hz)	Damping Q^{-1} (10^{-5})
2600	10.0
7100	15.2
14000	11.9
22000	10.9

Electrical resistivity at … °C in $\Omega \cdot mm^2 \cdot m^{-1}$

20	100	200	300	400	500	600
1.10	1.12	1.17	1.21	1.25	1.31	1.67

Magnetic properties
magnetically clampable

Magnetic saturation polarisation mT	Coercive field strength $kA \cdot m^{-1}$	Remanence mT
740	3.7	190

Use

Good possibilities of use in the processing of abrasive plastics – as pelletizer knives, injection moulding nozzles, dies, worms and bushes. Also as wear-resistant rings in centrifugal pumps, charging heads and circular cutters in preservecan filling machines.

Nikro 128

Solution annealing

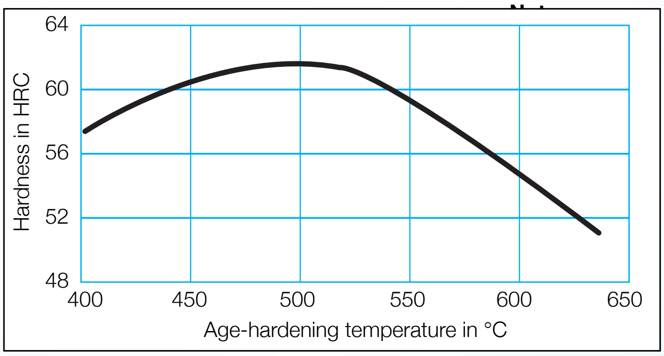
Annealing temperature °C	Cooling	Hardness after annealing HRC
850 (2 – 4 h vacuum)	1 – 4.5 bar N_2	approx. 53

The material is supplied in solution-annealed condition by the producer. Due to this fact, only ageing at 480 °C is still required after finish-machining.

Age-hardening

Age-hardening temperature °C	Hardness after age-hardening HRC
480 (6 – 8 h)	approx. 62

Age-hardening curve



Carburising atmospheres are to be avoided during heat treatment. Linear shrinkage during age-hardening is generally 0.02 mm/m.

Ferro-Titanit® Nikro 143

Chemical composition

Carbide phase	Binder phase (main components)			
TiC	**Ni**	**Co**	**Mo**	**Fe**
30	15.0	9.0	6.0	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + nickel martensite

Characteristic properties

The matrix structure consists of a highly tough, age-hardenable nickel martensite.
Finishing is performed in the solution-annealed, as-delivered condition. Subsequent age-hardening takes place at a relatively low temperature of 480 °C and can be conducted, for example, in a convection air furnace or an electrically heated chamber furnace. The workpiece remains extremely true-to-size and little prone to distortion due to the low age-hardening temperature.

Mechanical properties
age-hardened

Density	Compression strength	Bending fracture	Modulus of elasticity	Shear modulus	Service hardness	Further data on the mechanical properties upon request
g/cm^3	MPa	MPa	MPa	MPa	HRC	
6.7	2400	1450	280000	117000	approx. 63	

Physical properties

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

100	200	300	400	500	600	700	800	900	1000
8.0	8.7	8.9	9.1	9.4	9.8	9.4	8.5	9.2	9.7

Thermal conductivity at $W \cdot cm^{-1} \cdot °C^{-1}$

20 – 80 °C
0.181 – 0.189

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$

0.806

Magnetic properties
magnetically clampable

Magnetic saturation polarisation	Coercive field strength	Remanence
mT	$kA \cdot m^{-1}$	mT
1580	1.8	230

Use

For all types of forming tools, etc. exposed to particularly heavy wear and bending at temperatures up to 500 °C. For wearing parts of machinery and apparatus. Used especially in plastics processing as pelletizer knives, extruder worms, injection moulding nozzles, etc.

Ferro-Titanit® Nikro 143

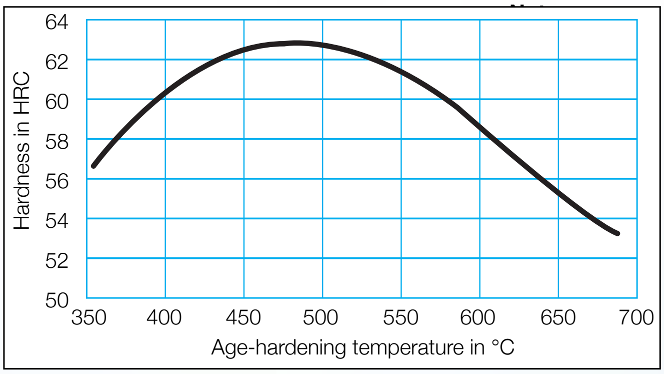
Solution annealing

Annealing temperature °C	Cooling	Hardness after annealing HRC
850 (2 – 4 h vacuum)	1 – 4.5 bar N_2	approx. 53

Age-hardening

Age-hardening temperature °C	Hardness after age-hardening HRC
480 (6 – 8 h)	approx. 63

Age-hardening curve



Carburising atmospheres are to be avoided during heat treatment. Linear shrinkage during age-hardening is generally 0.02 mm/m.

Ferro-Titanit® Cromoni

Chemical composition

Carbide phase	Binder phase (main components)		
TiC	**Cr**	**Mo**	**Ni**
22.0	20.0	15.5	Balance

(guideline values % by weight)

Microstructure

Titanium carbide + austenite

Characteristic properties

Supplied in solution-annealed condition. Ferro-Titanit® Cromoni is non-magnetisable, even after ageing at temperatures up to 900 °C. Besides having a high wear resistance, this alloy is extremely resistant to corrosion and scaling, as well as highly tempering-resistant. This corrosion resistance is at its best with finely ground or polished surfaces.

Mechanical properties
age-hardened

Density g/cm^3	Compression strength MPa	Bending fracture MPa	Modulus of elasticity MPa	Service hardness HRC	Further data on the mechanical properties upon request
7.4	1500	1300	277000	approx. 54	

Physical properties

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

100	200	300	400	500	600
9.0	10.0	10.5	10.8	11.1	11.5

Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$
0.124

Measuring frequency (Hz)	Damping Q^{-1} (10^{-5})
2400	6
6600	7
21000	11

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$
1.53

Magnetic properties

Permeability μ
< 1.01

Use

This austenitic grade is used for applications requiring complete non-magnetisability, a high wear resistance and maximum corrosion resistance.

Solution annealing

Annealing temperature °C	Cooling	Hardness after annealing HRC
1200 (2 h vacuum)	4 bar N_2	approx. 52

Age-hardening

Age-hardening temperature °C	Hardness after age-hardening HRC
800 (6 h vacuum)	approx. 54

Note
Machining according to guidelines, at lowest cutting speeds.

Ferro-Titanit® U

Chemical composition

Carbide phase	Binder phase (main components)			
TiC	**Cr**	**Ni**	**Mo**	**Fe**
34	18	12	2	Balance

(guideline values in % by weight)

Microstructure

Titanium carbide + austenite

Characteristic properties

The binder phase of Ferro-Titanit® U is roughly equivalent to the austenitic CrNiMo steel X 10 CrNiMoNb 18 10 (Mat. No. 1.4580). The material is non-magnetisable and, because of its high Cr and Mo contents, possesses excellent resistance to pitting corrosion in media containing chlorine ions. Its high titanium carbide content of 34 % by weight, or 45 % by volume, provides it with outstanding wear resistance. The Cr and Ni contents simultaneously give the material good scaling resistance and high-temperature strength.

The material requires no later postheat treatment.

Mechanical properties
age-hardened

Density g/cm^3	Compression strength MPa	Bending fracture MPa	Service hardness HRC	Further data on the mechanical properties upon request
6.6	2200	950	approx. 51	

Physical properties

Thermal expansion RT-800 °C
12.5

Thermal conductivity at 20 °C in W · cm^{-1} · °C^{-1}
0.180

Electrical resistivity at 20 °C in Ω · mm^2 · m^{-1}
0.96

Magnetic properties

Permeability μ
< 1.01

Use

Ferro-Titanit® U is used where non-magnetisable material with a high wear resistance is required.
Its excellent corrosion resistance, in particular in media containing chlorine ions, gives it a broad range of applications in the chemical industry.

Machining of Ferro-Titanit®

As a rule, the machinable and hardenable Ferro-Titanit® alloys are supplied as semi-finished material in soft-annealed condition. Despite a titanium carbide content of around 45% by vol. and a hardness of 48 – 53 HRC after annealing, it is possible to machine these materials by conventional methods, such as turning, planing, milling, sawing and drilling, according to the guidelines given below.

Any tool shop therefore has the possibility to machine tools and other wear-exposed parts on equipment normally used for machining steels.

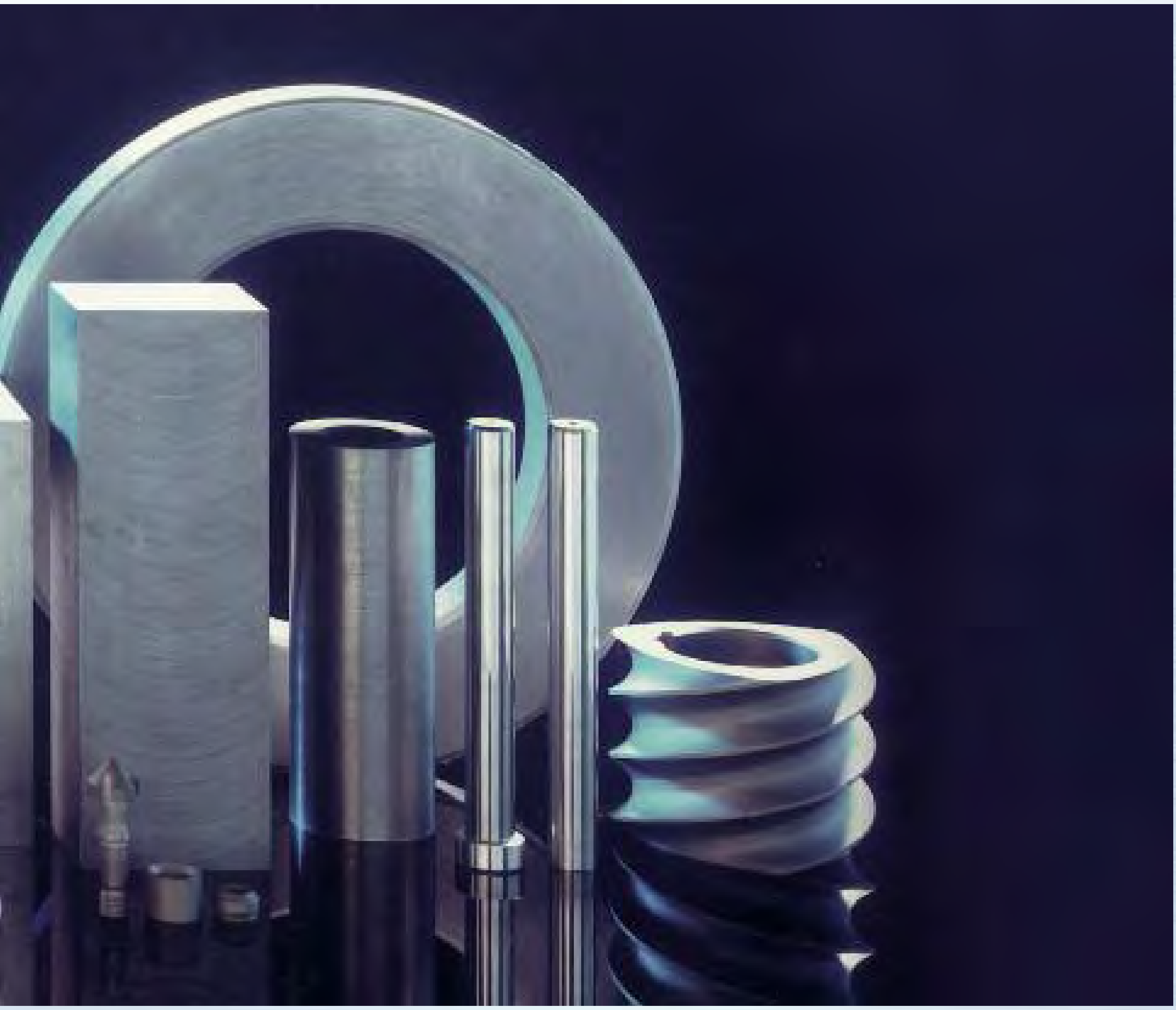
Ferro-Titanit® can be hardened with very little distortion. There is, consequently, extremely little change in the dimensions. Where C-Spezial is concerned, hardening and tempering brings about an increase in the original dimensions.

With the WFN and S grades, retained austenite leads to a reduction in the dimensions. Deep-cooling in liquid nitrogen makes it possible to increase the dimensons in these grades after hardening.

The dimensional changes are less than 0.1% in each case.

Machining in the annealed, as-delivered condition can consequently approximate the nominal size very closely, such that re-machining in hardened condition need amount to only a few hundredths of a millimetre. A precondition in this respect is that the hardening treatment to achieve the optimum service properties is performed preferably in a vacuum furnace. The machining of Ferro-Titanit® can only be done with greatly reduced cutting speeds, compared with steel.

All machining operations mentioned on pages 20-23 have to be applied without lubricants or coolants.



Turning

Ferro-Titanit® grades	tool quality alernatively	feed rate	cutting edge angle			cutting speed m/min
			rake angle	inclination angle	clearance angle	
C-Spezial	tungsten carbide coated, K 10 / K 30, high-speed steel	0.02 – 0.1 mm/rev.	6 ° / 15 °	0 ° / – 6 °	6 ° / – 11 °	10
WFN						8
S						8
Nikro 143						5
Nikro 128						5
U						5
Cromoni		0.02 – 0.04 mm/rev.				2.5
all grades	ceramics, fiber-reinforced	~ 0.1 – 0.5 mm/rev.	– 6 °	– 6 °	+ 6 °	> 25

Milling

Ferro-Titanit® grades	tool quality alernatively	feed rate	cutting speed m/min
C-Spezial	tungsten carbide coated, K 10 / K 30, high-speed steel	0.01 – 0.07 mm/tooth	6 – 12
WFN			
S			
Nikro 143			
Nikro 128			
U			
Cromoni		~ 0.01 mm/tooth	2 – 5

Drilling

Ferro-Titanit® grades	tool quality alernatively	feed rate		cutting speed m/min
all grades	tungsten carbide coated, K 10 / K 30, high-speed steel	0.05 mm/U	rake angel 90 – 120 °	2 – 4

Thread cutting

Ferro-Titanit® grades	tool quality alernatively	feed rate	rake angle		cutting speed m/min
all grades	tungsten carbide high-speed steel		0	cutting edge champfer 1.5 – 2 mm wide, extensive undercut	2 – 4

Sawing*

Ferro-Titanit® grades	tool quality alernatively	feed rate	constant "a" for calculation of feed rate	cutting speed m/min
C-Spezial WFN S	bimetall M 42	$\frac{\text{constant a}}{\text{length of saw notch}}$	800 mm²/min	~10
Nikro 143 Nikro 128 U			600 mm²/min	
Cromoni			200 mm²/min	< 5

* band saw (preferably) hack saw (in exceptional cases)

recommended partition of saw bands	length of saw notch	conventional toothing	combi toothing
	up to 30 mm	10 teeth/inch	8/12 teeth/inch
	30 – 70 mm	8 teeth/inch	5/8 teeth/inch
	7 – 120 mm	4 teeth/inch	4/6 teeth/inch
	> 120 mm	3 teeth/inch	2/3 teeth/inch

Grinding

The high carbide content and the titanium carbide's high hardness make it self-evident that special attention must be paid when grinding. In this respect, it is of decisive importance whether the carbides are present in a soft-annealed or in a hardened steel binder phase. Grinding in hardened condition leads to significantly higher grinding wheel wear.

Corundum wheels with a ceramic bond, porous structure and fine grain have proven a suitable medium. In case of special questions, the grinding wheel manufacturer should be consulted.

Diamond wheels made from plastic-bonded, nickel-coated synthetic diamonds with a concentration of 75 c – 100 c in a diamond grit size of D 107 - D 151 are recommended particularly for the finish-grinding of Ferro-Titanit® in hardened condition.

Attention must be paid to the following basic rules when grinding:

1. Grind with a powerful, rinsing stream of coolant directed as close as possible to the wheel/workpiece contact point.
2. Select the smallest possible in-feed rate.

Polishing

The surface quality of the high-grade Ferro-Titanit® carbide-alloyed materials is important for tool and machine part durability. Grinding to a best possible surface quality should generally be followed by polishing with a diamond polishing paste in order to achieve an ideal surface quality.

Rough-polishing is performed with diamond fine grit D 15 (10 – 25 µm), and finish-polishing with D 3 (2 – 5 µm). If necessary, this may be followed by polishing with D 1 (1 – 2 µm).

Spark-erosion machining

During spark erosion, Ferro-Titanit® carbide alloys, tool steels and tungsten carbide alloys are subjected to the same influences. The overall behaviour when Ferro-Titanit® is eroded tends to be similar to that of tool steels.

As spark erosion leads to generally strong, negative influences being exerted on tool surfaces, depending on the amperage applied, Ferro-Titanit® should be finish-eroded with a low pulse energy.

Spark-erosion roughing should be followed by a finishing and a fine-finishing operation in order to achieve the lowest possible surface roughness and freedom from cracking. Re-machining is necessary after such erosion including, where possible, stress-relieving treatment to reduce the stresses that have come about during the sintering process.

General note (liability)

All statements regarding the properties or utilisation of the materials or products mentioned are for the purposes of description only. Guarantees regarding the existence of certain properties or a certain utilisation are only ever valid if agreed upon in writing.

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