ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

CONTENTS

PASSION FOR TRADITION. FOR GENERATIONS.

The Eisenwerk Sulzau-Werfen is a privately owned Austrian company and one of the market leaders for the production of rolls for rolling mills.
In order to meet the demands of being a market leader, our production is flexible, our processes are optimized and our customer service is individual.

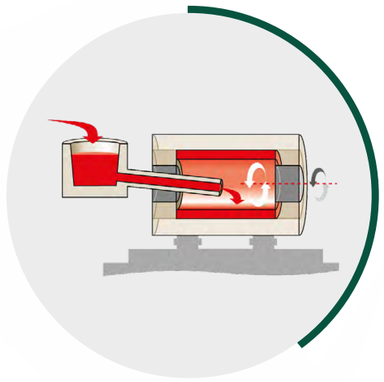
PRODUCT OVERVIEW

THE PRODUCTION OF ESW ROLLS:

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

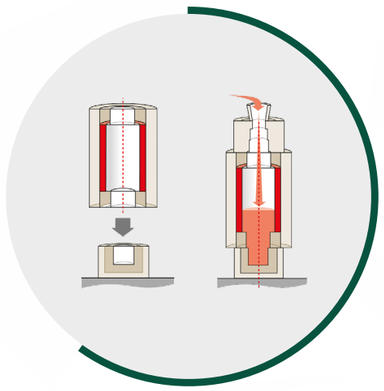
THE PRODUCTION OF THE ROLL:

Planned quality in all stages of production and processing guarantees an excellent product.

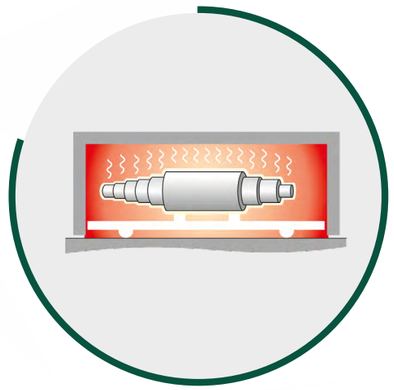


Steel and roll scrap, pig iron and alloys are fused in five induction furnaces with a capacity of between 3 and 24 tonnes.

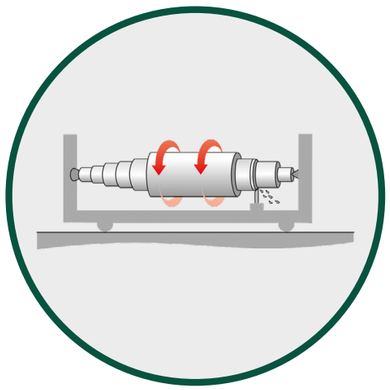
In horizontal spin casting the highly alloyed, liquid roll shell iron is poured horizontally into a revolving forged steel mould.



The core is cast in the solidified roll shell. This later forms the bearing area and the driving connection. The gross weight of a roll can amount to as much as 60 tonnes; a finished processed roll weighs up to 42 tonnes.



The duration and course of the heat treatment are decisive in ensuring that the finished roll has exactly the material qualities as required in the client's rolling mill. Depending on the type of the roll, heat treatment can last up to six weeks.



Rolls produced by ESW are up to 9 metres long and their diameter can amount to 1,500 mm. The rolls are given their final measurements and their specific surface through turning, milling and grinding in mechanical processing. Measurement accuracy of the finished rolls is tested to 1/1000 mm.

PRODUCT OVERVIEW

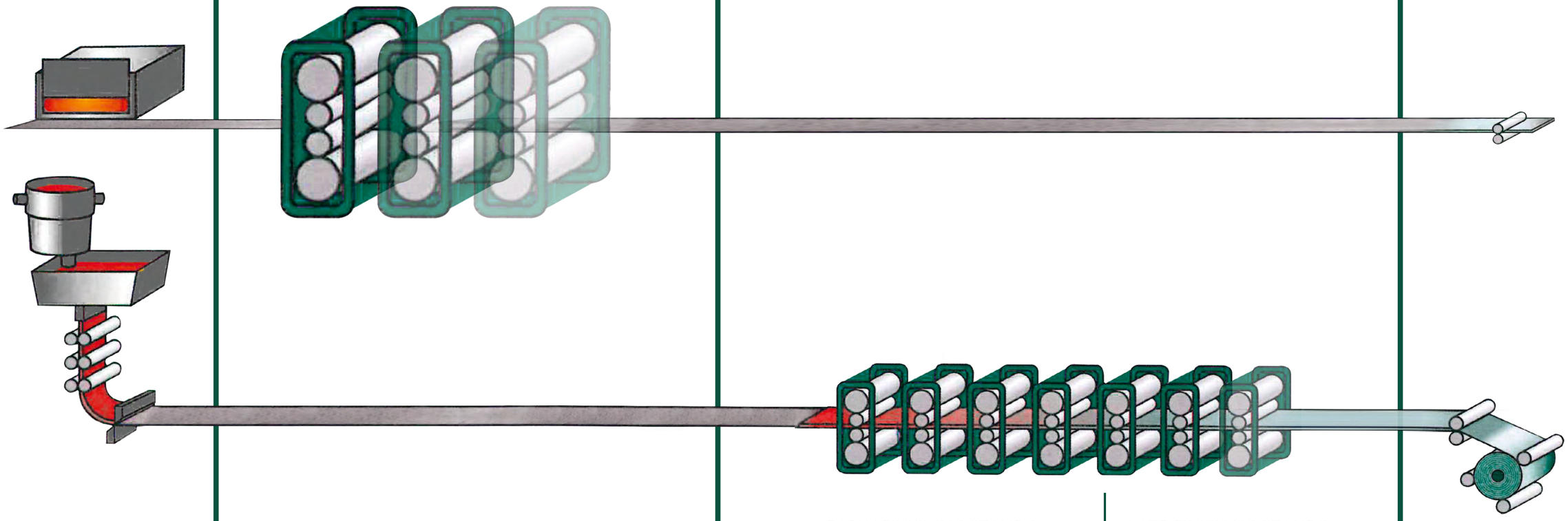
THE STANDARD APPLICATION OF ESW ROLLS

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

FEEDING

ROUGHING SECTION OR PLATE MILL

FINISHING SECTION



OUR GRADES:

CROMEA
(High Chrome Steel) previously VY/VYSG

CROMEA PLUS
(Carbide Enhanced High Chrome Steel) previously VYS

SEMIRA
(Semi-High Speed Steel)

RAPIDA / AMADEA
(High Speed Steel) previously VCSG

EARLY FINISHING STANDS

CROMEA
(High Chrome Steel) previously VY/VYSG

CROMEA PLUS
(Carbide Enhanced High Chrome Steel) previously VYS

CROMAXA
(High Chrome Iron) previously VX/VXSG

CROMAXA PLUS
(Carbide Enhanced High Chrome Iron) previously VXS

RAPIDA / AMADEA
(High Speed Steel) previously VCSG

LATE FINISHING STANDS

VI (ICDP)

VIS (Carbide Enhanced ICDP)

VANIC (Special ICDP)

VANIMO / VANIS (Graphitic HSS)

SHELL MATERIAL SPECIFICATION

WORK ROLLS FOR CONTINUOUS OR REVERSING ROUGHING STANDS

FROM AUSTRIA
TO THE WORLD

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

CROMEA (High Chrome Steel)

CROMEA is a high chromium steel material. The microstructure consists of a tempered bainitic and martensitic matrix with a network of eutectic M_7C_3 carbides. Rolls with this shell are characterized by good thermal crack resistance combined with excellent grip and good wear resistance.

CROMEA PLUS (Carbide Enhanced High Chrome Steel)

The CROMEA PLUS quality is a further development of the standard CROMEA grade. The presence of special carbide-forming elements promotes the precipitation of MC carbides resulting in increased wear resistance while retaining the other characteristics of the standard alloy.

SEMIRA (Semi-High Speed Steel)

The Semi-HSS grade, SEMIRA, is a high alloyed steel with a low carbon content. This combination results in a reduced carbide network which improves the fire crack resistance. In addition to the standard alloying elements, the presence of special carbide-forming elements produces a high wear resistant microstructure consisting of M_7C_3, M_2C, $M_{23}C_6$ and MC carbides homogeneously precipitated in a tempered bainitic and martensitic matrix. This quality is beneficial in cases where higher grip is needed.

RAPIDA / AMADEA (High Speed Steel)

The microstructure of HSS material RAPIDA consists of a high amount of MC, M_2C and M_6C carbides. The carbides are finely dispersed in a tempered martensitic matrix. The typical carbide network of the ICDP or the high chromium shell does not exist in this material. The hardness of the special carbides is significantly higher than the hardness of M_7C_3 or M_3C.

The AMADEA grade is the next generation within this family. The alloying concept is modified to achieve even longer campaigns compared to the classic RAPIDA grade.

Outstanding properties of HSS material are:
Excellent smooth surface, improved high temperature strength and hot hardness, very fine fire crack pattern and high fire crack resistance, excellent wear and oxidation resistance. Under suitable testing conditions even multiple campaigns without the need to regrind are possible.

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
High Chrome Steel CROMEA	Min	1,00	0,50	0,50	9,00	1,00	0,50	0,00		
	Max	2,30	1,50	1,50	15,00	2,00	1,50	0,50		
CE High Chrome Steel CROMEA PLUS	Min	1,00	0,50	0,50	10,00	1,30	1,00	1,00		
	Max	2,30	1,50	1,50	15,00	2,20	3,00	3,00		
Semi - High Speed Steel SEMIRA	Min	0,50	0,50	0,20	4,00	0,50	2,00	2,00	0,50	
	Max	1,50	1,00	0,80	9,00	3,00	5,00	5,00	3,00	
High Speed Steel RAPIDA / AMADEA	Min	1,30	0,40	0,40	2,00	0,80	2,00	2,00	0,00	0,00
	Max	2,00	1,00	3,00	8,00	5,00	8,00	8,00	4,00	2,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	CROMEA	CROMEA PLUS	SEMIRA	RAPIDA / AMADEA
Typical hardness	LD LE ShC	720-770 700-745 65-75	760-805 735-780 73-82	770-820 745-790 75-85	770-820 745-790 75-85
Tensile strength	MPa	>700	>700	>700	>700
Bending strength	MPa	>1200	>1200	>1200	>1200
Impact strength	J	2-4	2-4	2-4	2-4
Modulus of elasticity	GPa	215-225	215-225	220-230	220-230
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	13	13	13	13
Thermal conductivity (25-100 °C)	W/m°C	16-18	16-18	16-18	16-18
Specific heat (25-100 °C)	J/kg°C	520	520	520	520
Density	kg/m^3	7600	7600	7600	7700
Thermal diffusivity	m^2/s	$4,3x10^{-6}$	$4,3x10^{-6}$	$4,3x10^{-6}$	$4,2x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	Gripping
CROMEA	3	4	4	5
CROMEA PLUS	3-4	4	4	5
SEMIRA	4-5	4-5	4	5
RAPIDA / AMADEA	5	4	5	4

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance.
As regards sensitivity towards mechanical overload 5 means less sensitivity. In case of gripping, 5 signifies good bite performance.

WORK ROLLS FOR THE EARLY FINSHING STANDS OF HOT STRIP MILLS

BAKED
WITH LOVE

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

CROMEA (High Chrome Steel)

The shell material of high chromium cast steel rolls CROMEA has a less pronounced carbide network compared to high chromium cast iron. The grade is mainly used in the early stands of thin slab casting, inline or endless rolling, thus ensuring improved biting properties, strong fire crack resistance and a very fine fire crack pattern.

CROMEA PLUS (Carbide Enhanced High Chrome Steel)

The carbide-enhanced high chromium cast steel CROMEA PLUS shows higher hardness, due to the presence of special carbide-forming elements. The material shows the same properties as the standard quality CROMEA like good biting properties, fire crack resistance and the fine fire crack pattern. Compared to the standard grade the wear resistance is clearly improved.

CROMAXA (High Chrome Iron)

The microstructure of the high chromium cast iron grade CROMAXA consists of a high amount of chromium carbides (M_7C_3) embedded in a matrix of tempered martensite. This grade shows very good wear and oxidation resistance.

CROMAXA PLUS (Carbide Enhanced High Chrome Iron)

The enhanced quality CROMAXA PLUS has higher carbide hardness, due to the presence of special carbide- forming elements like Vanadium in the shell material. Besides the M_7C_v carbides the microstructure contains a higher amount of MC carbides. This carbide-enhanced type shows higher wear resistance and a better wear profile compared to the standard grade CROMAXA. The risk of slippage is significantly reduced compared to other high chromium iron qualities with higher chromium content.

RAPIDA / AMADEA (High Speed Steel)

The microstructure of HSS material RAPIDA consists of a high amount of MC, M_2C and M_6C carbides. The carbides are finely dispersed in a tempered martensitic matrix. The typical carbide network of ICDP- or high chromium shell material does not exist. The hardness of the special carbides is significantly higher than M_7C_3 or M_3 C.

The AMADEA grade is the next generation within the HSS family. The corresponding alloying concept is modified to achieve even longer campaigns compared to the RAPIDA grade.

Outstanding properties of HSS material are:
Excellent smooth surface, improved high temperature strength and hot hardness, very fine fire crack pattern and high fire crack resistance, excellent wear and oxidation resistance. Under suitable testing conditions even multiple campaigns without the need to regrind are possible.

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
High Chrome Steel CROMEA	Min	1,00	0,50	0,50	9,00	1,00	0,50	0,00		
	Max	2,30	1,50	1,50	15,00	2,00	1,50	0,50		
CE High Chrome Steel CROMEA PLUS	Min	1,00	0,50	0,50	10,00	1,30	1,00	1,00		
	Max	2,30	1,50	1,50	15,00	2,20	3,00	3,00		
High Chrome Iron CROMAXA	Min	2,50	0,20	0,50	15,00	0,80	0,70	0,00		
	Max	3,10	0,80	1,50	20,00	1,70	1,70	0,50		
CE High Chrome Iron CROMAXA PLUS	Min	2,50	0,20	0,50	15,00	0,80	0,70	1,00		
	Max	3,10	0,80	1,50	20,00	1,70	1,70	3,00		
High Speed Steel RAPIDA / AMADEA	Min	1,50	0,70	0,20	3,00	0,50	1,00	2,00	0,00	0,00
	Max	2,50	1,30	3,00	7,00	5,0	8,00	8,00	4,00	2,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

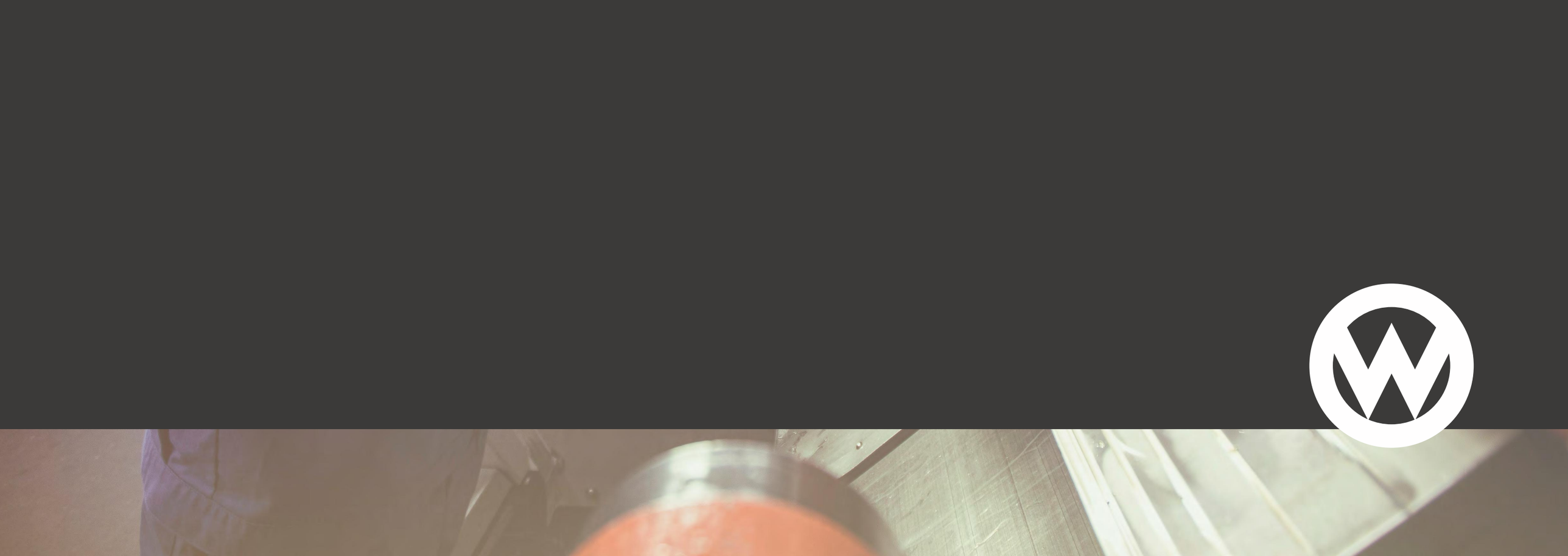
	Unit	CROMEA	CROMEA PLUS	CROMAXA	CROMAXA PLUS	RAPIDA / AMADEA
Typical hardness	LD LE ShC	720-770 700-745 65-75	760-810 735-780 73-83	720-820 700-790 65-85	760-820 735-790 73-85	770-820 745-790 75-85
Tensile strength	MPa	>700	>700	>700	>700	>700
Bending strength	MPa	>1200	>1200	>1000	>1000	>1200
Impact strength	J	2-4	2-4	2-4	2-4	2-4
Modulus of elasticity	GPa	215-225	215-225	215-225	215-225	220-230
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	13	13	13	13	13
Thermal conductivity (25-100 °C)	W/m°C	16-18	16-18	18-20	18-20	16-18
Specific heat (25-100 °C)	J/kg°C	520	520	530	530	520
Density	kg/m^3	7600	7600	7600	7600	7700
Thermal diffusivity	m^2/s	$4,3x10^{-6}$	$4,3x10^{-6}$	$4,2x10^{-6}$	$4,2x10^{-6}$	$4,2x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	Banding & Peeling
CROMEA	3	4	4-5	3-4
CROMEA PLUS	3-4	4	4-5	4
CROMAXA	3	3-4	4	3-4
CROMAXA PLUS	3-4	3-4	4	4
RAPIDA / AMADEA	5	5	5	5

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance. As regards sensitivity towards mechanical overload, 5 means less sensitivity; as regards friction, 5 means lower friction; as regards banding/peeling 5 means a reduced tendency to banding/peeling.

WORK ROLLS FOR THE LATE FINISHING STANDS OF HOT STRIP MILLS



ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

VI (ICDP)

The microstructure of our standard indefinite chill quality VI consists of eutectic carbides M_3C type and free graphite in a tempered bainitic martensitic matrix. This alloy is characterized by good wear resistance and very good resistance towards mill accidents.

VIS (Carbide Enhanced ICDP)

The enhanced ICDP type VIS is a family of a basic enhanced indefinite chill grade. Depending on the mill stability, different VIS grades with increasing alloying elements can be chosen. Besides the standard alloying elements the VIS contains different amounts of special carbide-forming elements which promote the precipitation of hard MC carbides. The result is a microstructure containing MC and M_3C carbides in a tempered bainitic martensitic matrix. The VIS grades give better wear resistance compared to the standard grade because of the very high hardness of the special carbides and the lack of a hardness drop, typical for the conventional IC type.

VANIC (Special ICDP)

The VANIC grade represents a differing alloying concept within the indefinite chill family. It contains a combination of special carbide-forming elements such as Nb, V and W in higher amounts. The microstructure gives increased wear resistance due to the presence of different MC carbides through the whole shell thickness additional to the M_3C, all embedded in a tempered bainitic martensitic matrix.

VANIS / VANIMO (Graphitic HSS)

The VANIMO grade is the highest alloyed shell material within the IC family and therefore this grade shows the highest performance. Due to the high alloy content the microstructure is partially comparable to an HSS alloy with very finely distributed graphite nodules. The VANIMO grade achieves the best results in the case of a stable running mill with low cobble and incident rate. To obtain the maximum performance it is essential to carry out EC and US testing regularly after each service/campaign. Superior performance combined with excellent surface quality is the highlight of this grade.

VANIS, our special solution for intermediate stands shows a fine and well distributed free graphite in the microstructure, which provides a good surface quality of the rolled product and reduces the sticking tendency between roll and rolled strip.

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
ICDP VI	Min	3,00	0,60	0,10	1,30	4,00	0,10			
	Max	3,70	1,30	0,90	2,00	4,90	0,50			
CE ICDP VIS	Min	3,00	0,70	0,50	1,50	4,00	0,20	0,10	0,00	0,00
	Max	3,60	1,70	1,50	3,00	6,00	3,00	3,00	1,00	1,00
Special ICDP VANIC	Min	3,20	1,00	0,70	1,50	4,00	0,20	0,00	0,00	0,50
	Max	3,70	1,50	1,20	2,00	5,00	2,20	2,50	2,00	2,50
Graphitic HSS VANIMO / VANIS	Min	2,50	1,00	0,50	1,50	4,00	0,20	1,00	0,00	0,00
	Max	3,50	2,00	1,50	3,00	6,00	6,00	4,00	3,00	2,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	VI	VIS	VANIC	VANIMO / VANIS
Typical hardness	LD LE ShC	745-810 725-782 70-83	770-810 745-782 75-83	770-810 745-782 75-83	770-810 745-782 75-83
Tensile strength	MPa	>400	>400	>400	>400
Bending strength	MPa	>800	>800	>800	>800
Impact strength	J	2-4	2-4	2-4	2-4
Modulus of elasticity	GPa	170-180	180-190	180-190	180-190
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	12	12	12	12
Thermal conductivity (25-100 °C)	W/m°C	20-22	20-22	20-22	20-22
Specific heat (25-100 °C)	J/kg°C	540	540	540	540
Density	kg/m^3	7600	7600	7600	7600
Thermal diffusivity	m^2/s	$5,1x10^{-6}$	$5,1x10^{-6}$	$5,1x10^{-6}$	$5,1x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	km ultra thin gauge rolling
VI	3	5	5	2
VIS	3-4	5	4-5	3
VANIC	4-5	5	4-5	4
VANIMO / VANIS	5	5	4	5

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance. As regards sensitivity towards mechanical overload, 5 means reduced sensitivity.

WORK ROLLS FOR PLATE MILLS

GROWING
AND DEVELOPING
SINCE 1770

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

VI (ICDP)

The microstructure of our standard indefinite chill quality VI consists of eutectic carbides M_3C type and free graphite in a tempered bainitic martensitic matrix. This alloy is characterized by good wear resistance and very good resistance towards mill accidents.

VIS (Carbide Enhanced ICDP)

The enhanced ICDP type VIS is a family of a basic enhanced indefinite chill grade. Depending on the mill stability, different VIS grades with increasing alloying elements can be chosen. Besides the standard alloying elements the VIS contains different amounts of special carbide-forming elements which promote the precipitation of hard MC carbides. The result is a microstructure containing MC and M_3C carbides in a tempered bainitic martensitic matrix. The VIS grades give better wear resistance compared to the standard grade because of the extremely high hardness of the special carbides and the lack of hardness drop, typical for the conventional IC type.

CORDIA (Low Carbon Chrome Steel)

The CORDIA grade is a chromium steel material. The microstructure consists of a tempered bainitic and martensitic matrix with a minimum of network M_7C_3 carbides. These rolls are characterized by excellent thermal crack resistance combined with good wear resistance. This grade is a prime selection for surface critical plates.

CROMEA (High Chrome Steel)

The CROMEA quality is a high chromium steel roll. The microstructure consists of a tempered bainitic and martensitic matrix with a network of eutectic M_7C_3 carbides. These rolls are characterized by good thermal crack resistance combined with excellent grip and good wear resistance.

CROMEA PLUS (Carbide Enhanced High Chrome Steel)

The CROMEA PLUS quality is a further development of the standard CROMEA grade. The presence of special carbide-forming elements promotes the precipitation of MC carbides resulting in increased wear resistance while retaining the other characteristics of the standard alloy.

CROMAXA (High Chrome Iron)

The microstructure of high chromium cast iron rolls CROMAXA consists of a high amount of chromium carbides (M_7C_3) embedded in a matrix of tempered martensite. This grade shows very good wear and oxidation resistance.

CROMAXA PLUS (Carbide Enhanced High Chrome Iron)

The enhanced quality CROMAXA PLUS has higher carbide hardness, due to the presence of special carbide- forming elements like Vanadium in the shell material. Besides the M_7C_v carbides the microstructure contains a higher amount of MC carbides. This carbide-enhanced type shows higher wear resistance and a better wear profile compared to the standard grade CROMAXA. The risk of slippage is significantly reduced compared to other high chromium iron qualities with higher chromium content.

RAPIDA (High Speed Steel)

The microstructure of HSS material RAPIDA consists of a high amount of MC, M_2C and M_6C carbides. The carbides are finely dispersed in a tempered martensitic matrix. The typical carbide network of ICDP or the high chromium shell does not exist in this material. The hardness of the special carbides is significantly higher than M_7C_3 or M_3 C.

Outstanding properties of HSS material are:
Excellent smooth surface, improved high temperature strength and hot hardness, very fine fire crack pattern and high fire crack resistance, excellent wear and oxidation resistance. Under suitable testing conditions even multiple campaigns without the need to regrind are possible.

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
ICDP VI	Min	3,00	0,60	0,10	1,30	4,00	0,10			
	Max	3,70	1,30	0,90	2,00	4,90	0,50			
CE ICDP VIS	Min	3,00	0,70	0,50	1,5	4,00	0,20	0,10	0,00	0,00
	Max	3,60	1,70	1,50	3,0	6,00	3,00	3,00	1,00	1,00
LC Chrome Steel CORDIA	Min	0,50	0,50	0,50	7,0	0,50	0,50	0,00		
	Max	1,50	1,50	1,50	13,0	1,50	1,50	0,50		
High Chrome Steel CROMEA	Min	1,00	0,50	0,50	9,0	1,00	0,50	0,00		
	Max	2,30	1,50	1,50	15,0	2,00	1,50	0,50		
CE High Chrome Steel CROMEA PLUS	Min	1,00	0,50	0,50	10,0	1,30	1,00	1,00		
	Max	2,30	1,50	1,50	15,0	2,20	3,00	3,00		
High Chrome Iron CROMAXA	Min	2,50	0,20	0,50	15,0	0,80	0,70	0,00		
	Max	3,10	0,80	1,50	20,0	1,70	1,70	0,50		
CE High Chrome Iron CROMAXA PLUS	Min	2,50	0,20	0,50	15,00	0,80	0,70	1,00		
	Max	3,10	0,80	1,50	20,00	1,70	1,70	3,00		
High Speed Steel RAPIDA	Min	1,30	0,40	0,40	2,00	0,80	2,00	2,00	0,00	0,00
	Max	2,00	1,00	3,00	8,00	5,00	8,00	8,00	4,00	2,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	VI	VIS	CORDIA
Typical hardness	LD LE ShC	745-810 725-782 70-83	770-810 745-782 75-83	745-810 725-782 70-83
Tensile strength	MPa	>400	>400	>700
Bending strength	MPa	>800	>800	>1200
Impact strength	J	2-4	2-4	2-4
Modulus of elasticity	GPa	170-180	180-190	215-225
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	12	12	13
Thermal conductivity (25-100 °C)	W/m°C	20-22	20-22	16-18
Specific heat (25-100 °C)	J/kg°C	540	540	520
Density	kg/m^3	7600	7600	7600
Thermal diffusivity	m^2/s	$5,1x10^{-6}$	$5,1x10^{-6}$	$4,3x10^{-6}$

PROPERTIES:

	Unit	CROMEA	CROMEA PLUS	CROMAXA	CROMAXA PLUS	RAPIDA
Typical hardness	LD LE ShC	720-770 700-745 65-75	745-810 725-782 70-83	720-770 700-745 65-75	760-820 735-790 73-85	770-820 745-790 75-85
Tensile strength	MPa	>700	>700	>700	>700	>700
Bending strength	MPa	>1200	>1200	>1000	>1000	>1200
Impact strength	J	2-4	2-4	2-4	2-4	2-4
Modulus of elasticity	GPa	215-225	215-225	215-225	215-225	220-230
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	13	13	13	13	13
Thermal conductivity (25-100 °C)	W/m°C	16-18	16-18	18-20	18-20	16-18
Specific heat (25-100 °C)	J/kg°C	520	520	530	530	520
Density	kg/m^3	7600	7600	7600	7600	7700
Thermal diffusivity	m^2/s	$4,3x10^{-6}$	$4,3x10^{-6}$	$4,2x10^{-6}$	$4,2x10^{-6}$	$4,2x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	Gripping
VI	2	5	5	5
VIS	2-3	5	4-5	5
CORDIA	3-4	4-5	4	5
CROMEA	3	4	4	5
CROMEA PLUS	3-4	4	4	5
CROMAXA	4-5	4-5	4	5
CROMAXA PLUS	5	4	4	5
RAPIDA	5	4	5	4

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance.
As regards sensitivity towards mechanical overload, 5 means less sensitive; as regards gripping, 5 signifies the best bite performance.

WORK ROLLS FOR STECKEL MILLS

INNOVATION
QUALITY
RESPONSIBILITY

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

VI (ICDP)

The microstructure of our standard indefinite chill quality VI consists of eutectic carbides M_3C type and free graphite in a tempered bainitic martensitic matrix. This alloy is characterized by good wear resistance and very good resistance towards mill accidents.

VIS (Carbide Enhanced ICDP)

The enhanced ICDP type VIS is a family of a basic enhanced indefinite chill grade. Depending on the mill stability, different VIS grades with increasing alloying elements can be chosen. Besides the standard alloying elements the VIS contains different amounts of special carbide-forming elements which promote the precipitation of hard MC carbides. The result is a microstructure containing MC and M_3C carbides in a tempered bainitic martensitic matrix. The VIS grades give better wear resistance compared to the standard grade because of the extremely high hardness of the special carbides and the lack of hardness drop, typical for the conventional IC type.

VANIC (Special ICDP)

The VANIC grade represents a differing alloying concept within the indefinite chill family. It contains a combination of special carbide-forming elements such as Nb, V and W in higher amounts. The microstructure gives increased wear resistance due to the presence of different MC carbides through the whole shell thickness additional to the M_3C, all embedded in a tempered bainitic martensitic matrix.

VANIMO (Graphitic HSS)

The VANIMO grade is the highest alloyed shell material within the IC family and therefore this grade shows the highest performance. Due to the high alloy content the microstructure is partially comparable to an HSS alloy with very finely distributed graphite nodules. The VANIMO grade achieves the best results in the case of a stable running mill with low cobble and incident rate. To obtain the maximum performance it is essential to carry out EC and US testing regularly after each service/campaign. Superior performance combined with excellent surface quality is the highlight of this grade.

RAPIDA / AMADEA (HSS)

The microstructure of HSS material RAPIDA consists of a high amount of MC, M_2C and M_6C carbides. The carbides are finely dispersed in a tempered martensitic matrix. The typical carbide network of ICDP or the high chromium shell does not exist in this material. The hardness of the special carbides is significantly higher than M_7C_3 or M_3 C.

The AMADEA grade is the next generation within this family. The alloying concept is modified to achieve even longer campaigns compared to the classic RAPIDA grade.

Outstanding properties of HSS material are:
Excellent smooth surface, improved high temperature strength and hot hardness, very fine fire crack pattern and high fire crack resistance, excellent wear and oxidation resistance. Under suitable testing conditions even multiple campaigns without the need to regrind are possible.

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CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
ICDP VI	Min	3,00	0,60	0,10	1,30	4,00	0,10			
	Max	3,70	1,30	0,90	2,00	4,90	0,50			
CE ICDP VIS	Min	3,00	0,70	0,50	1,50	4,00	0,20	0,10	0,00	0,00
	Max	3,60	1,70	1,50	3,00	6,00	3,00	3,00	1,00	1,00
Special ICDP VANIC	Min	3,20	1,00	0,70	1,50	4,00	0,20	0,00	0,00	0,50
	Max	3,70	1,50	1,20	2,00	5,00	2,20	2,50	2,00	2,50
Graphitic HSS VANIMO	Min	2,50	1,00	0,50	1,50	4,00	0,20	1,00	0,00	0,00
	Max	3,50	2,00	1,50	3,00	6,00	3,00	4,00	3,00	2,00
High Speed Steel RAPIDA / AMADEA	Min	1,20	0,40	0,20	2,00	0,50	1,00	2,00	0,00	0,00
	Max	2,50	1,30	3,00	8,00	5,00	8,00	8,00	4,00	2,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	VI	VIS	VANIC	VANIMO	RAPIDA / AMADEA
Typical hardness	LD LE ShC	745-810 725-782 70-83	770-810 745-782 75-83	770-820 745-790 75-85	770-810 745-782 75-83	770-820 745-790 75-85
Tensile strength	MPa	>400	>400	>400	>400	>700
Bending strength	MPa	>800	>800	>800	>800	>1200
Impact strength	J	2-4	2-4	2-4	2-4	2-4
Modulus of elasticity	GPa	170-180	180-190	180-190	180-190	220-230
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	12	12	12	12	13
Thermal conductivity (25-100 °C)	W/m°C	20-22	20-22	20-22	20-22	16-18
Specific heat (25-100 °C)	J/kg°C	540	540	540	540	520
Density	kg/m^3	7600	7600	7600	7700	7700
Thermal diffusivity	m^2/s	$5,1x10^{-6}$	$5,1x10^{-6}$	$5,1x10^{-6}$	$5,1x10^{-6}$	$4,2x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	km ultra thin gauge rolling
VI	3	5	5	2
VIS	3-4	5	4-5	3
VANIC	4-5	5	4-5	4
VANIMO	5	5	4	5
RAPIDA / AMADEA	5	5	5	5

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance. As regards sensitivity towards mechanical overload, 5 means less sensitivity.

ROLLS FOR SKIN PASS AND TEMPER MILLS

OUR TRADTION:
SHAPING THE FUTURE

ESW
EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

DESCRIPTION OF SHELL MATERIAL:

CROMAXA (High Chrome Iron)

Its microstructure consists mainly of eutectic M_7C_3 carbides in a bainitic / martensitic matrix. Due to the presence of eutectic chromium rich carbides, wear is low and the campaign length can be increased.

VIS (Carbide Enhanced ICDP)

The enhanced ICDP type VIS roll grade is characterized by the presence of eutectic M_3C and special precipitated MC carbides and free graphite in a matrix consisting of tempered bainite and martensite. Due to the graphite content and the microstructure characteristics a very smooth surface of the rolled product is guaranteed.

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
High Chrome Iron CROMAXA	Min	2,50	0,20	0,50	15,00	0,80	0,70			
	Max	3,10	0,80	1,50	20,00	1,70	1,70			
CE ICDP VIS	Min	3,00	0,70	0,50	1,50	4,00	0,20	0,10	0,00	0,00
	Max	3,60	1,70	1,50	3,00	6,00	3,00	3,00	1,00	1,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	CROMAXA	VIS
Typical hardness	LD LE ShC	720 - 815 700 - 790 65 - 85	770 - 810 745 - 780 75 - 83
Tensile strength	MPa	>700	>400
Bending strength	MPa	>1000	>800
Impact strength	J	2-4	2-4
Modulus of elasticity	GPa	215-225	180-190
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	13	12
Thermal conductivity (25-100 °C)	W/m°C	18-20	20-22
Specific heat (25-100 °C)	J/kg°C	530	540
Density	kg/m^3	7600	7600
Thermal diffusivity	m^2/s	$4,2x10^{-6}$	$5,1x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Fire crack resistance	Sensitivity towards mechanical overload	Friction
CROMAXA	5	-	5	4
VIS	4	-	4	5

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance.
As regards sensitivity towards mechanical overload 5 means less sensitive; as regards friction, 5 means lower friction.

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DESCRIPTION OF SHELL MATERIAL:

VIS (Carbide Enhanced ICDP)

The enhanced grade VIS also contains MC carbides besides the eutectic M_3C type. The additional special carbide-forming elements such as V, W, and Nb in the shell material ensure better wear resistance and a uniform wear profile. Due to the constant graphite content and the homogeneously distributed special carbides in the shell, the roll does not show any hardness drop during the entire lifespan.

VIS back-up rolls show advantages compared to back-up rolls with steel-based shell material (cast steel or forged steel): if the percentage of 'dry rolling' is high, BURs with steel-based shell material build up so called 'leaf flakes' on the surface. These are very small steel particles (wear), which adhere to the BUR surface and gradually build up a coating. If the flakes disperse, this leads consequently to surface defects on the strip. Back-up rolls with a high carbon content working layer such as VIS do not generally show 'flaking' since there is no adhesion of very small steel particles.

CHEMICAL COMPOSITION*:

		C	Si	Mn	Cr	Ni	Mo	V	W	Nb
CE ICDP VIS	Min	3,00	0,70	0,50	1,50	4,00	0,20	0,10	0,00	0,00
	Max	3,60	1,70	1,50	3,00	6,00	3,00	3,00	1,00	1,00

* The figures shown in the table cover the whole range of the different roll qualities within a roll family.

PROPERTIES:

	Unit	VIS
Typical hardness	LD LE ShC	745-810 725-782 70-83
Tensile strength	MPa	>400
Bending strength	MPa	>800
Impact strength	J	2-4
Modulus of elasticity	GPa	180-190
Thermal exp. coeff. (25-100 °C)	$1/°C x10^{-6}$	12
Thermal conductivity (25-100 °C)	W/m°C	20-22
Specific heat (25-100 °C)	J/kg°C	540
Density	Kg/m^3	7600
Thermal diffusivity	m^2/s	$5,1x10^{-6}$

COMPARATIVE PROPERTIES**:

	Wear resistance	Flake formation during dry rolling	Sensitivity towards mechanical overload
VIS	4	5	3
Cast- or forged steel	5	1	4

** Comparative properties are evaluated from 0 to 5, where 5 shows the best performance. As regards sensitivity towards mechanical overload, 5 means less sensitive.

CORE MATERIAL SPECIFICATION

ESW
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NODULAR CORE.

CHEMICAL COMPOSITION:								
	C	**Si**	**Mn**	**P**	**S**	**Cr**	**Ni**	**Mo**
Min	2,60	2,00	0,30	0,00	0,00	0,00	0,00	0,00
Max	3,50	3,00	1,10	0,15	0,02	0,60	1,50	0,30

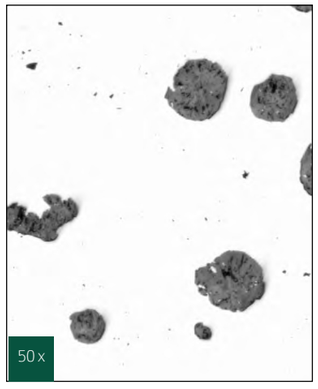
HARDNESS RANGE (36–44 ShC).

PHYSICAL PROPERTIES			
Tensile strength	≥ 400 MPa	**Torsional strength**	≥ 350 MPa
Bending strength	min. 800 MPa	**Thermal exp. coeff.** (25C-100°C)	12,5 1/°Cx10^{-6}
Bending fatigue strength	100 - 180 MPa	**Thermal conductivity** (25C-100°C)	28-30 W/m°C
Young´s modulus*	160 - 190 GPa	**Specific heat** (25C-100°C)	530 J/kg°C
Shear modulus	65 - 75 GPa	**Density**	7200 kg/m^3
Elongation	<3 %	**Thermal diffusivity**	7.3x10-6 m^2/s

*calculated on basis of an ultrasonic test

MICROSTRUCTURE.

Graphite



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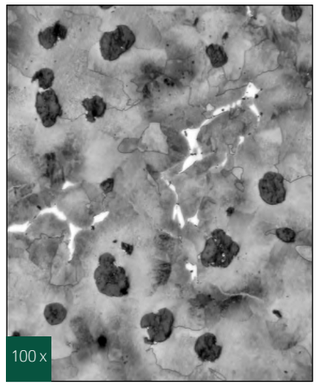

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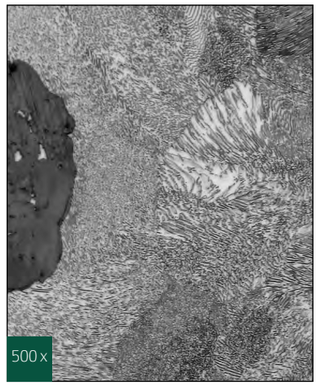


LAMELLAR CORE.

CHEMICAL COMPOSITION:								
	C	**Si**	**Mn**	**P**	**S**	**Cr**	**Ni**	**Mo**
Min	2,50	1,20	0,40	0,00	0,00	0,30	0,20	0,10
Max	3,40	2,90	1,00	0,15	0,10	1,30	2,00	0,30

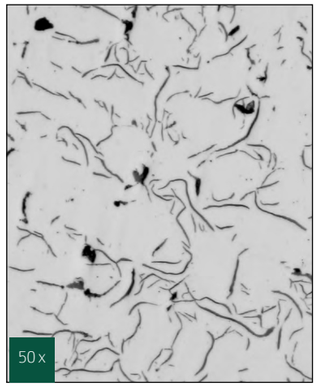
HARDNESS RANGE (36–44 ShC).

PHYSICAL PROPERTIES			
Tensile strength	≥ 200 MPa	**Torsional strength**	>250 MPa
Bending strength	> 400 MPa	**Thermal exp. coeff.** (25C-100°C)	10,5 1/°Cx10^{-6}
Bending fatigue strength	80 - 130 MPa	**Thermal conductivity** (25C-100°C)	35 – 45 W/m°C
Young´s modulus*	100 - 140 GPa	**Specific heat** (25C-100°C)	540 J/kg°C
Shear modulus	40 - 55 GPa	**Density**	7200 kg/m^3
Elongation	<2 %	**Thermal diffusivity**	10,8x10-6 m^2/s

*calculated on basis of an ultrasonic test

MICROSTRUCTURE.

Graphite



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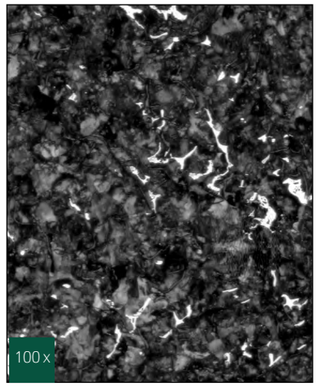

Matrix

EISENWERK SULZAU-WERFEN
R. & E. WEINBERGER AG

CONTACT

Bundesstraße 4
A-5451 Tenneck
AUSTRIA

TEL +43 / 6468 / 5285 - 0
FAX +43 / 6468 / 5285 - 555
MAIL office@esw.co.at
WEB www.esw.co.at