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PROTOTYPE
FLAPPER VALVE

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FLAPPER VALVE STEELS

FLAP-X | UHB SS716 | UHB 20C

Flap-X has been developed in close cooperation with leading flapper valve manufacturers and compressor OEM's, and has shown the highest fatigue strength among all flapper valves steels, both in reverse bending and impact mode.

It has proven superior performance compared to any other flapper valve material available, in internal and external testing.

UHB SS716 is a martensitic stainless steel grade designed where toughness and impact fatigue strength are essential, even at temperatures as high as 400°C.

It has been used as the flapper valve material by the world leading compressor manufacturers for many years. The reliability and the performance is proven by decades of usage in the market.

UHB 20C is a 1% carbon steel with high tensile strength. It is hardened and tempered to a fine martensitic structure providing the highest fatigue strength in high carbon steels.

UHB 20C is an excellent choice for applications where corrosion resistance is not so critical and economical volume production of flapper valves is the main criteria, compared to our stainless flapper valve steels. It is frequently used in segments such as automotive air conditioning, refrigerators and household air conditioning.

SMALL BATCH VALVE PRODUCTION FOR NEW COMPRESSOR DESIGNS

As a service to our customers we supply small batch production of valves, serving as protoypes ready to be tested for new compressor designs. Deep commitment of skilled specialists and state of the art testing services ensure early evalutation of compressor valve performance.

Uddeholmstrip supplies market leading flapper valve steels for compressor valve applications out of our cold rolling mill in Munkfors, Sweden.

Our product portfolio consists of a number of well-known and established steel grades that are specifically designed and developed for high-end compressor reed valves.

As a part of the value added services package we offer impact fatigue tests, fracture investigations, XRD measurements of residual stresses and material microstructure examinations to the direct customers and compressor OEM's.

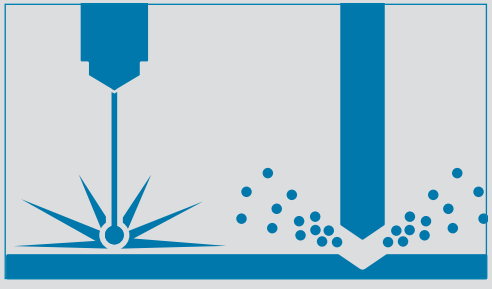
Now, we also supply the finished prototype valves ready to be tested in the compressors right away.

PRODUCTION

Prototype valves are made in two stages

1 ETCHING

A photochemical etching process is used for the production of the valves. The finished parts are subjected to a visual and dimensional test, ensuring a valve design according the drawing provided by the compressor OEM.



2 TUMBLING

The tumbling process is specialized for specific valve design and ensures that the prototypes are delivered with the desired design criteria such as edge rounding, surface roughness, flatness and dimensional tolerances.

Dimensions

We offer prototype valves in all standard thicknesses of *udde-holmstrip flapper valve steel*.

Lead time

The normal lead time, after receiving the drawing of the valves, is up to 6 weeks for us to supply the finished prototypes.

Archive

Master prototype samples are archived. This is to ensure a detailed metallurgical examination of the valves "before and after" the compressor tests, if required by the compressor OEM's.

BENEFITS

FOR COMPRESSOR OEM'S

- Small batch valve production for new compressor designs, new developments
- Early involvement of metallurgical specialists
- Neutral approval process of new designs
- Neutral evaluation of mechanical and metallurgical aspects
- Direct communication and R&D partnership with the material experts
- State of the art testing equipment/ services available for verification of compressor valve performance

THE PROTOTYPE PROCESS

ORDER — DRAWING — CONFIRMATION — PRODUCTION — DELIVERY

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FLAP-X

Revision 4
Issued April 2024

LONG-LIFE COMPRESSOR VALVE STEEL

FLAP-X is a martensitic stainless steel grade that is designed specifically for long-life valve components, where toughness and impact fatigue strength are essential. The 13% chromium micro-alloyed steel is delivered in the hardened and tempered condition with good corrosion resistance and superior life in such fatigue intensive applications.

PROVEN PERFORMANCE

Important characteristics are: *high tensile strength, excellent surface finish*, high levels of *compressive residual stresses* and a *very low level of non-metallic inclusions*, which together contribute to excellent bending and impact fatigue resistance.

FLAP-X is used in ever increasing volumes for flapper valves, reed valves and check valves after being adopted by world leading compressor manufacturers, for their toughest applications.

MICROSTRUCTURE

The microstructure of FLAP-X consists of a chromium rich tempered martensite with a controlled amount of small evenly dispersed carbides. The high content of alloying elements results in the presence of retained austenite, normally in the range of 5 – 8%*.

* Measured by XRD using an internally developed correction method.

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CHEMICAL COMPOSITION

	C	Si	Mn	P	S	Cr	Mo	N	V
Nominal composition (% by mass)	0.39	0.45	0.55	0.020	0.005	13.5	1.00	+	+
Specified Range (% by mass)	0.36-0.40	0.35-0.50	0.45-0.65	≤0.020	≤0.015	13.10-13.90	0.90-1.10	-	-

The chemical composition and other critical characteristics of Flap-X are protected by patents so there are no similar grade designations.

NOMINAL MECHANICAL PROPERTIES

Proof Strength ($Rp_{0.2\%}$)		Tensile strength (Rm)		Elongation	Hardness		Young's Modulus	
MPa	KSI	(Rm)	KSI	A_{50} %	Hv	HRc	MPa	KSI
1 580	229	2 100±60	305±8.7	≥6	613 - 643	56 - 58	220 000	31 900

Tensile testing carried out in accordance with SS-EN ISO 6892-1, Method A1.
KSI values and hardness values were determined by conversion.

SURFACE FINISH

FLAP-X is manufactured using a specific process route that gives a very smooth surface which also exhibits a very high level of compressive residual stresses (typically –550 MPa), ideal for production of components used in fatigue intensive applications.

Transverse roughness values, using a standard 0.8mm cut-off for all measurements, are shown below.

	Ra		Rt		Rz	
	µm	µin	µm	µin	µm	µin
Typical values	0.06	2.4	0.66	26	0.51	20.1

SURFACE IMPERFECTIONS

Intrusive imperfections that have the potential to act as crack initiators, such as 'pits' or scratches, are permitted up to 1µm (40µin). Less damaging positive marks, such as 'roll marks', are allowed to a maximum height of 3µm.

NON-METALLIC INCLUSIONS

The melting and casting of FLAP-X is specifically designed to produce material with a consistently low level of potentially damaging non-metallic inclusions. Regular inclusion counting is extensively used to monitor the continued effectiveness of these production measures.

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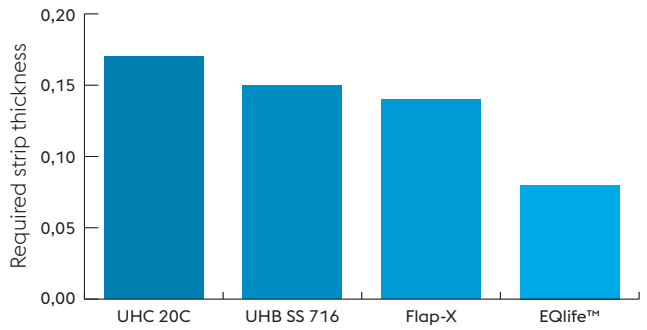
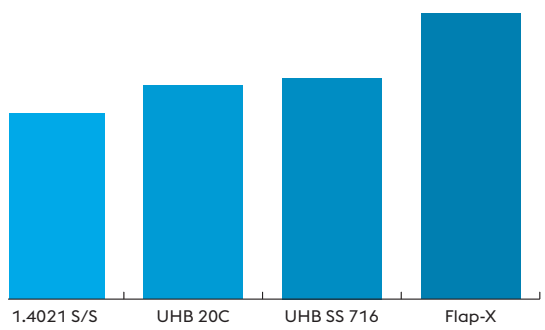
FATIGUE PROPERTIES

The design of FLAP-X is focused on producing a material that gives a very long life in compressor valve applications, even at thinner gauges. For this application, the most critical fatigue strength measurement regimes are: Impact fatigue and Bending fatigue. The relative fatigue properties of different compressor valve steel grades are shown schematically.



Normalised strip thickness needed to give an equivalent fatique life



Bending Fatique Strength of the valve steel grades at 5% probability of failure & 95% confidence level (data valid for 0.381 mm thickness)

MATERIAL DIMENSIONS

FLAP-X is available in a wide range of standard precision thicknesses from 0.10mm to 1.0mm, with the thickness tolerance depending on the nominal thickness. Custom thicknesses are also available on request, all manufactured to tight tolerances. FLAP-X is available at a maximum width of 320 mm or slit to customer specified widths.

The flatness of the strip is controlled to a tolerance of 0.2% of the width, both across and along the rolling direction.

EDGE CONDITION

The edges of the strip are supplied in the deburred condition as standard.

PHYSICAL PROPERTIES

Property	Temperature	Values
Density	20 °C / 68 °F	7.70 g/cm^3 (0.278 lb/in^3)
Mean Coefficient of Linear Thermal Expansion	20 - 100 °C (68 -210 °F)	10.6 x 10^{-6} °C-1 (5.9 x10^{-6} °F-1)
	20 - 200 °C (68 - 390 °F)	11.1 x 10^{-6} °C-1 (6,2 x 10^{-6} °F-1)
	20- 300 °C (68—570 °F)	11.4 x 10^{-6} °C-1 (6.3 x 10^{-6} °F-1)
Thermal Conductivity	20 °C / 68 °F	24 W/m °C (14 BTU/ft hr °F)
Specific Heat Capacity	20 - 100 °C (68 -210 °F)	460 J/kg °C (0,11 BTU/lb °F)
Electrical Resistivity	20 °C (68 °F)	0,66 Ωmm^2/m
Coercive Force	200 °C (90 °F)	0,75 Ωmm^2/m
	20 °C / 68 °F	5900 A/m

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UHB SS716

Revision 4
Issued April 2024

COMPRESSOR VALVE STEEL

UHB SS716 is a martensitic stainless steel grade that is designed specifically for the medium and thinner thickness ranges of valve components, where toughness and impact fatigue strength are essential.
The 13% chromium steel is delivered in the hardened and tempered condition with good corrosion resistance and superior life in such fatigue intensive applications.

PROVEN PERFORMANCE

Important characteristics are: high tensile strength, excellent surface finish, high levels of compressive residual stresses and low level of non-metallic inclusions, which together contribute to very good bending and impact fatigue resistance, even at temperatures as high as 400°C (750°F).

UHB SS716 has been used for flapper valves, reed valves and check valves for many years, by world leading compressor manufacturers.

MICROSTRUCTURE

The microstructure of UHB SS716 consists of a chromium rich tempered martensite with a controlled amount of small evenly dispersed carbides. The high content of alloying elements results in the presence of retained austenite, normally in the range of 4 – 6%*.

* Measured by XRD using an internally developed correction method.

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CHEMICAL COMPOSITION

	C	Si	Mn	P	S	Cr	Mo
Nominal composition (% by mass)	0.38	0.44	0.55	0.020	0.005	13.5	1.00
Specified Range (% by mass)	0.36 - 0.40	0.30 - 0.50	0.40 - 0.65	≤0.025	≤0.015	13.10 - 13.90	0.90 - 1.10

The closest steel grade designations to UHB SS716 are: UNS S42026 / EN 1.4031

NOMINAL MECHANICAL PROPERTIES

Proof Strength ($Rp_{0.2\%}$)		Tensile strength (Rm)		Elongation	Hardness		Young's Modulus	
MPa	**KSI**	**MPa**	**KSI**	**A_{50} %**	**Hv**	**HRc**	**MPa**	**KSI**
1 450	210	1810 ±80	263 ±11.6	≥4	529 - 573	51 - 54	220 000	31 900

Tensile testing carried out in accordance with SS-EN ISO 6892-1, Method A1.
Hardness testing carried out in accordance with SS-EN ISO 6507-1, KSI values and HRc determined by conversion.

SURFACE FINISH

UHB SS716 is manufactured using a specific process route that gives a very smooth surface which also exhibits a high level of compressive residual stresses (typically -450 MPa), ideal for production of components used in fatigue intensive applications.

Transverse roughness values, using a standard 0.8mm cut-off for all measurements, are shown below.

	Ra		Rt		Rz	
	µm	**µin**	**µm**	**µin**	**µm**	**µin**
Typical values	0.06	2.4	0.66	26	0.51	20.1

SURFACE IMPERFECTIONS

Intrusive imperfections that have the potential to act as crack initiators, such as 'pits' or scratches, are permitted up to 1µm (40µin). Less damaging positive marks, such as 'roll marks', are allowed to a maximum height of 3µm.

NON-METALLIC INCLUSIONS

The melting and casting of UHB SS716 is specifically designed to produce material with a consistently low level of potentially damaging non-metallic inclusions. Regular inclusion counting is used to monitor the continued effectiveness of these production measures.

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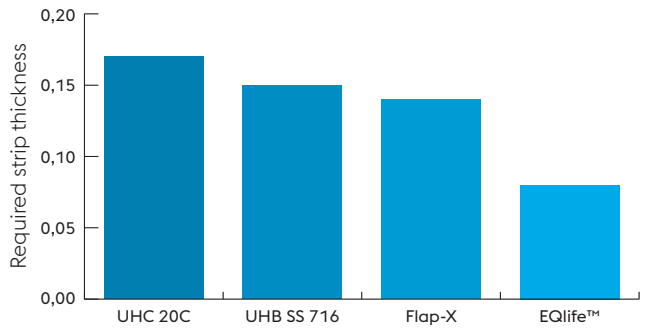
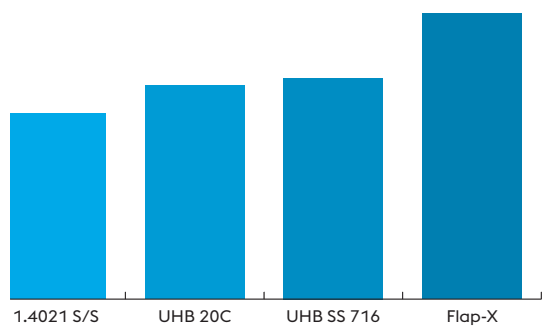
FATIGUE PROPERTIES

The design of UHB SS716 is focused on producing a material that yields a long life in compressor valve applications. For this application, the most critical fatigue strength measurement regimes are: Impact fatigue and Bending fatigue.

The relative fatigue properties of different compressor valve steel grades are shown schematically.



Normalised strip thickness needed to give an equivalent fatique life



Bending Fatique Strength of the valve steel grades at 5% probability of failure & 95% confidence level (data valid for 0.381 mm thickness)

MATERIAL DIMENSIONS

UHB SS716 is available in a wide range of standard precision thicknesses from 0.10 mm to 1.0 mm. The thickness tolerance depends on the nominal thickness. Custom thicknesses are also available on request with similarly tight tolerances. UHB SS716 is available 320 mm width or can be slit to customer required widths.

The flatness of the strip is controlled to a tolerance of 0.2% of the width, both across and along the rolling direction.

EDGE CONDITION

The edges of the strip are supplied in the deburred condition as standard.

PHYSICAL PROPERTIES

Property	Temperature	Values
Density	20 °C / 68 °F	7.70 G/CM^3 (0.278 IB/IN^3)
Mean Coefficient of Linear Thermal Expansion	20 - 100 °C (68 -210 °F)	10.6 X 10^{-6} °C-1 (5.9 X10^{-6} °F-1)
	20 - 200 °C (68 - 390 °F)	11.1 X 10^{-6} °C-1 (6,2 X 10^{-6} °F-1)
	20- 300 °C (68—570 °F)	11.4 X 10^{-6} °C-1 (6.3 X 10^{-6} °F-1)
Thermal Conductivity	20 °C / 68 °F	24 W/M °C (14 BTU/FT HR °F)
Specific Heat Capacity	20 - 100 °C (68 -210 °F)	460 J/KG °C (0,11 BTU/IB °F)
Electrical Resistivity	20 °C (68 °F)	0,66 ΩMM^2/M
	200 °C (90 °F)	0,75 ΩMM^2/M
Coercive Force	20 °C / 68 °F	5900 A/M

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UHB 20C

Revision 3
Issued April 2024

COMPRESSOR VALVE STEEL

UHB 20C is a high carbon steel grade that has been specifically modified for use in valve components, where toughness and impact fatigue strength are key properties.
This carbon steel is delivered in the hardened and tempered condition providing relatively long life in fatigue intensive applications.

PROVEN PERFORMANCE

Important characteristics are: high tensile strength, excellent surface finish, high levels of compressive residual stresses and a controlled level of non-metallic inclusions, which together contribute to high bending and impact fatigue resistance.

UHB 20C has been used for flapper valves, reed valves and check valves by world leading compressor manufacturers, for many years.

MICROSTRUCTURE

The microstructure of UHB 20C consists of tempered martensite with a controlled amount of evenly dispersed undissolved carbides.

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CHEMICAL COMPOSITION

	C	Si	Mn	P	S	Cr
Nominal composition (% by mass)	1.00	0.30	0.45	0.010	0.003	0.15
Range (% by mass)	0.95-1.05	0.15 - 0.35	0.35 - 0.50	≤0.015	≤0.005	0.12 - 0.25

The closest steel grade designations to UHB 20C are: UNS G10950 / EN 1.1274

NOMINAL MECHANICAL PROPERTIES

Thickness	Proof Strength (Rp0.2%)		Tensile strength (Rm)		Elongation	Hardness	
mm	MPa	KSI	MPa	KSI	A_{50} %	Hv	HRc
<0.125	1900	276	2110 ±80	306 ±11.6	>2	592 - 644	55 - 57
0.125 - <0.175	1850	268	2060 ±80	299 ±11.6	>2	579 - 631	54.5 - 57
0.175 - <0.225	1810	263	2010 ±80	292 ±11.6	>2.5	566 - 618	54 - 56
0.225 - <0.275	1765	256	1960 ±80	284 ±11.6	>2.5	552 - 605	53 - 55.5
0.275 - <0.375	1720	249	1910 ±80	277 ±11.6	>3	539 - 592	52 - 55
0.375 - <0.425	1675	243	1860 ±80	270 ±11.6	>3	525 - 579	51 - 54
0.425 - <0.475	1630	236	1810 ±80	263 ±11.6	>3.5	511 - 566	50 - 53

The Young's Modulus for UHB 20C is 205 000 MPa or 30 500 KSI

Tensile testing carried out in accordance with SS-EN ISO 6892-1, Method A1.
Hardness testing carried out in accordance with SS-EN ISO 6507-1, KSI values Hv and HRc determined by conversion.

SURFACE FINISH

UHB 20C is manufactured using a specific process route that gives a very smooth surface which also exhibits high compressive residual stresses (typically –190 MPa), ideal for production of components used in fatigue intensive applications.

Transverse roughness values, using a standard 0.8mm cut-off for all measurements, are shown below.

	Ra		Rt		Rz	
	µm	µin	µm	µin	µm	µin
Typical values	0.07	2.8	0.75	30	0.56	22.0

SURFACE IMPERFECTIONS

Intrusive imperfections that have the potential to act as crack initiators, such as 'pits' or scratches, are permitted up to 1µm (40µin). Less damaging positive marks, such as 'roll marks', are allowed to a maximum height of 3µm

NON-METALLIC INCLUSIONS

The steelmaking of UHB 20C is designed to produce material with a consistently low level of potentially damaging non-metallic inclusions. Regular inclusion counting is used to as a control mechanism during material selection and allocation.

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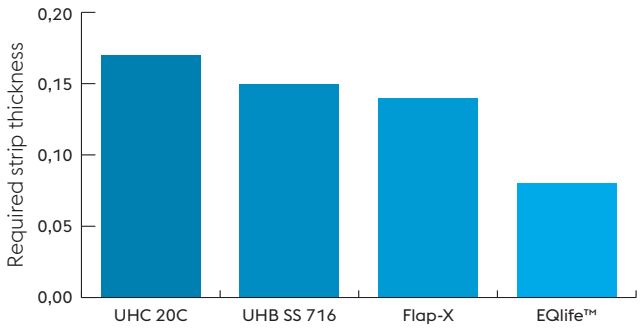
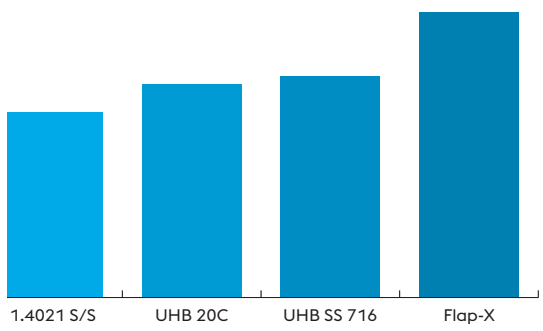
FATIGUE PROPERTIES

The design of UHB 20C is focused on producing a material that gives a long life in compressor valve applications. For this application, the most critical fatigue strength measurement regimes are: Impact fatigue and Bending fatigue.

The relative fatigue properties of different compressor valve steel grades are shown schematically.



Normalised strip thickness needed to give an equivalent fatique life



Bending Fatique Strength of the valve steel grades at 5% probability of failure & 95% confidence level (data valid for 0.381 mm thickness)

MATERIAL DIMENSIONS

UHB 20C is available in a wide range of standard precision thicknesses from 0.10mm to 1.0mm. The thickness tolerance depends on the nominal thickness. Custom thicknesses are also available on request with similarly tight tolerances. UHB 20C is available at a maximum width of 390 mm or can be slit to customer required widths.

EDGE CONDITION

The edges of the strip are supplied in the deburred condition as standard.

PHYSICAL PROPERTIES

Property	Temperature	Values
Density	20 °C / 68 °F	7.85 G/CM^3 (0.28 IB/IN^3)
Mean Coefficient of Linear Thermal Expansion	20 - 100 °C (68 -210 °F)	10.5 X 10^{-6} °C-1 (5.8 X10^{-6} °F-1)
	20 - 200 °C (68 - 390 °F)	11.5 X 10^{-6} °C-1 (6,4 X 10^{-6} °F-1)
	20- 300 °C (68—570 °F)	12.0 X 10^{-6} °C-1 (6.7 X 10^{-6} °F-1)
Thermal Conductivity	20 °C / 68 °F	49 W/M °C (28 BTU/FT HR °F)
Specific Heat Capacity	20 - 100 °C (68 -210 °F)	460 J/KG °C (0,11 BTU/IB °F)
Electrical Resistivity	20 °C (68 °F)	0.18 ΩMM^2/M

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