

### CHEMICAL COMPOSITION

C	Cr	Mo	W	V
1.50	4.00	2.50	2.50	4.00

### STANDARDS

- Europe: HS 3-3-4
- Germany: 1.3377

### DELIVERY HARDNESS

Soft annealed max. 260 HB  
Cold drawn max. 310 HB

### DESCRIPTION

ASP<sup>®</sup>2005 is the best choice for high toughness, hardness and wear resistance.

### APPLICATIONS

- Cold work tools: Powder compacting tools, cold extrusion tools, cold-heading dies, fine blanking tools
- Plastic injection moulders
- Rolls
- Warm applications: extrusion dies, forging dies and punches

### FORM SUPPLIED

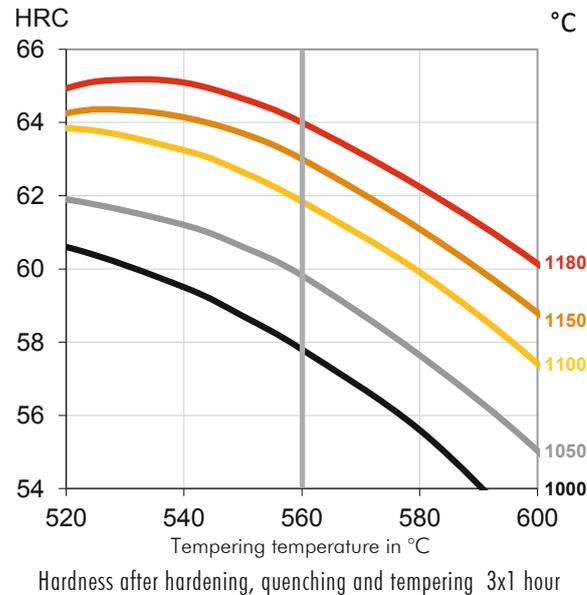
- Round bars
- Flat & square bars

Available surface conditions: drawn, ground, peeled, rough machined, hot rolled.

### HEAT TREATMENT

- Soft annealing in a protective atmosphere at 850-900°C for 3 hours, followed by slow cooling at 10°C/h down to 700°C, then air cooling.
- Stress-relieving at 600-700°C for approximately 2 hours, slow cooling down to 500°C.
- Hardening in a protective atmosphere at a temperature suitable for chosen working hardness. Pre-heating in 2 or 3 steps depending on tool dimension-design and austenitising temperature, last step 50°C below chosen austenitising temperature. Cooling down to 40-50°C.
- Tempering at 560°C three times for at least 1 hour each time. Cooling to room temperature (25°C) between temperings.

### GUIDELINES FOR HARDENING



### PROCESSING

ASP<sup>®</sup>2005 can be worked as follows:

- Machining (grinding, turning, milling)
- Polishing
- Plastic forming
- Electrical discharge machining
- Welding (special procedure including preheating and filler materials of base material composition).

### GRINDING

During grinding, local heating of the surface, which may alter the temper, must be avoided. Grinding wheel manufacturers can furnish advice on the choice of grinding wheels.

### SURFACE TREATMENT

The steel grade is a good substrate material for PVD and CVD coating. If nitriding is requested a small zone of 2-15 µm is recommended. The steel grade can also be steam-tempered if so desired.



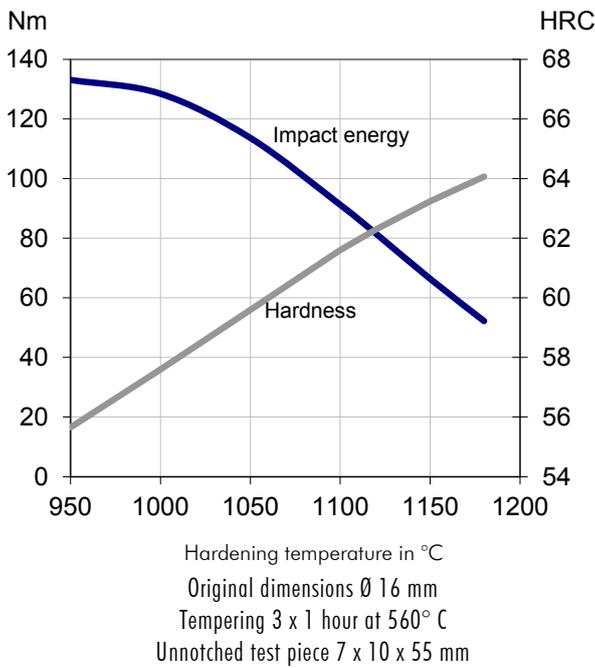
PHYSICAL PROPERTIES

Temperature	20°C	400°C	600°C
Density g /cm <sup>3</sup> (1)	7.8	7.7	7.6
Modulus of elasticity kN/mm <sup>2</sup> (2)	220	195	175
Thermal expansion coefficient from 20°C per °C (2)	-	12,1x10 <sup>-6</sup>	12,7x10 <sup>-6</sup>
Thermal conductivity W/m°C (2)	24	28	27
Specific heat J/kg °C (2)	420	510	600

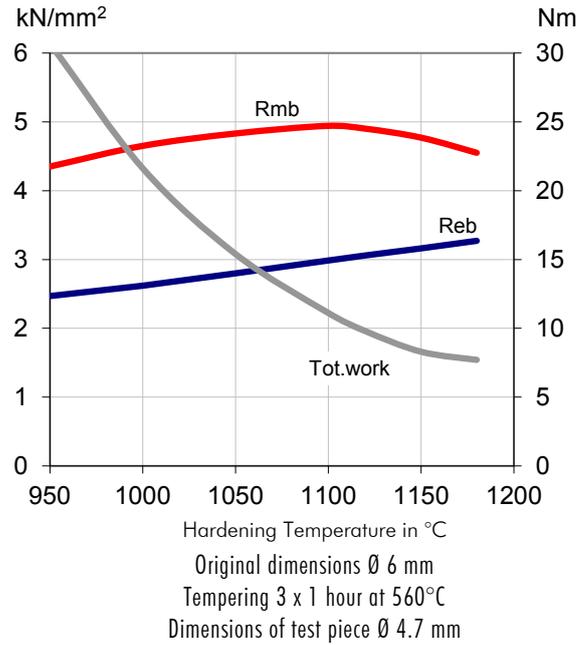
(1)=Soft annealed

(2)=Hardened 1180°C and tempered 560°C, 3x1 hour

IMPACT ENERGY

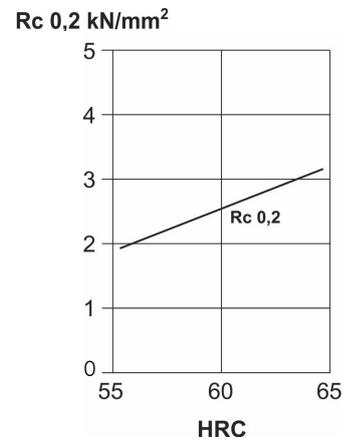


4-POINT BEND STRENGTH



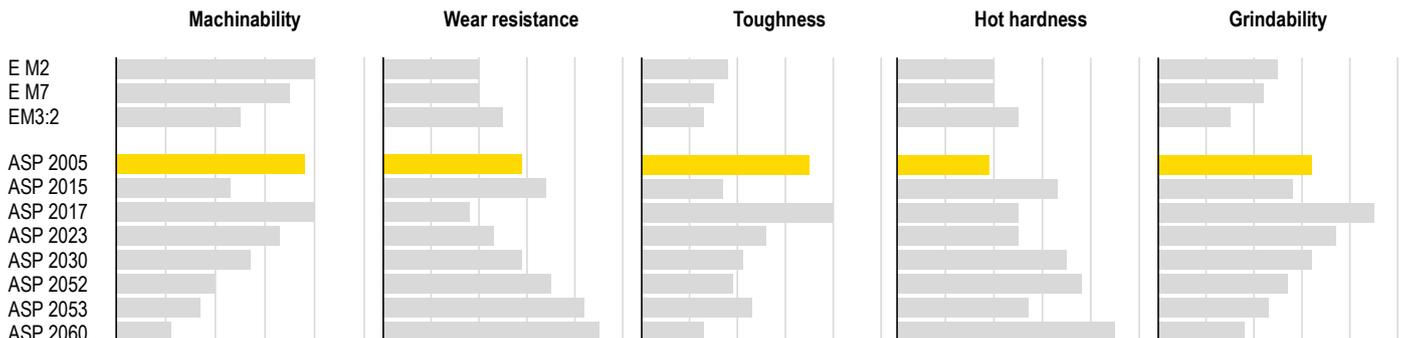
Rmb = Ultimate bend strength in kN/mm<sup>2</sup>  
Reb = Bend yield strength in kN/mm<sup>2</sup>  
Tot. work = Total work in Nm

COMPRESSION YIELD STRESS



Test piece with 10 mm waist diameter

COMPARATIVE PROPERTIES



**Recommendations for machining in soft annealed condition, 260-300 HB**

TURNING 	CEMENTED CARBIDE		HSS
	Medium turning	Finishing turning	
Cutting speed, $v_c$ (m/min)	130-170	170-220	18-25
Feed, $f$ (mm/rev)	0.2-0.4	0.05-0.2	0.05-0.3
Cutting depth, $a_p$ (mm)	2-4	0.5-2	0.5-3
Tools according to ISO	coated carbide P10-P20	coated carbide P10	coated

Use a wear resistant coated cemented carbide e.g Coromant 4015 or Seco TP 100.

Black ceramics are usually the best tools at finish turning, e.g. Coromant 650 or Feldmühle SH20.

END MILLING 		DIAMETER (mm)				
SLOT MILLING		3-5	5-10	10-20	20-30	30-40
Coated HSS	Cutting speed, $v_c$ (m/min)	18-25	18-25	18-25	18-25	18-25
	Feed, $f_z$ (mm/tooth)	0.015-0.030	0.03-0.04	0.04-0.05	0.05-0.06	0.07-0.08
Coated solid cemented carbide	Cutting speed, $v_c$ (m/min)	70-100	70-100	70-100	-	-
	Feed, $f_z$ (mm/tooth)	0.006-0.01	0.01-0.02	0.02-0.04	-	-
Indexable carbide tips	Cutting speed, $v_c$ (m/min)	-	-	130-180	130-180	130-180
	Feed, $f_z$ (mm/tooth)	-	-	0.06-0.10	0.10-0.12	0.15-0.20
Suitable tools	-	coated carbide, K15, P25				

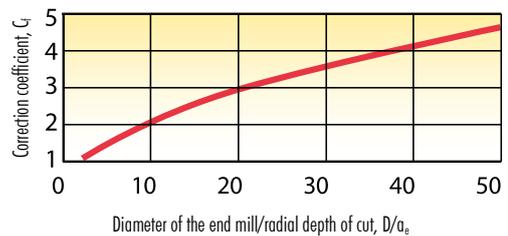
**SIDE MILLING**

The same cutting speed can be used in side milling as in slot milling. However, the feed has to be adjusted to produce an adequate chip thickness.

The diameter of the mill (D) over the radial depth of cut ( $a_e$ ) is used as a parameter. Read the correction coefficient ( $C_f$ ) from the diagram and multiply by the feed for slot milling from the table above.

**Comments (slot and side milling)**

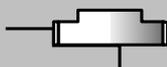
1. Coated tools are always recommended for end milling both with HSS tools and cemented carbide tools. TiCN, TiAlN or multilayer (Futura) is preferred.
2. The cutting speed must be decreased considerably if uncoated tools are used.



**Example**

Tool	End mill with indexable tips
Diameter of the end mill	D=40 mm
Radial depth or cut	$a_e=2$ mm
$D/a_e$	$40/2=20$
Correction coefficient	$c_f=2.8$
Feed	$f_z=2.8 \times 0.17=0.48$ mm/tooth
Cutting speed	$v_c=160$ m/min

FACE MILLING 	CEMENTED CARBIDE TOOL	
	Rough machining	Finishing machining
Cutting speed, $v_c$ (m/min)	120-150	150-200
Feed, $f_z$ (mm/tooth)	0.2-0.3	0.1-0.2
Cutting depth, $a_p$ (mm)	2-4	1-2
Tools according to ISO	coated cemented carbide K15, P25	

SQUARE SHOULDER MILLING 	RADIAL DEPTH OF CUT, $a_e$		
	$a_e = 0.1 \times D$	$a_e = 0.5 \times D$	$a_e = 1 \times D$
Cutting speed, $v_c$ (m/min)	130-160	120-150	110-140
Feed, $f_z$ (mm/tooth)	0.25	0.15	0.10
Tools according to ISO	coated cemented carbide K15, P25		

Use a wear resistant coated cemented carbide e.g Coromant 3150 or Seco T15M.

DRILLING 		DRILL DIAMETER (mm)				
		1-5	5-10	10-20	20-30	30-40
HSS	Cutting speed, $v_c$ (m/min)	8-14	8-14	8-14	8-14	8-14
	Feed, $f_z$ (mm/rev)	0.05-0.15	0.15-0.25	0.25-0.35	0.35-0.40	0.40-0.45
Coated HSS	Cutting speed, $v_c$ (m/min)	25-30	25-30	25-30	25-30	25-30
	Feed, $f_z$ (mm/rev)	0.05-0.15	0.15-0.25	0.25-0.35	0.35-0.40	0.40-0.45
Short hole drill indexable (cemented carbide)	Cutting speed, $v_c$ (m/min)	-	-	-	140-160	140-160
	Feed, $f_z$ (mm/rev)	-	-	-	0.08-0.12	0.10-0.14
Solid cemented carbide	Cutting speed, $v_c$ (m/min)	-	-	80-110	80-110	80-110
	Feed, $f_z$ (mm/rev)	-	-	0.1-0.15	0.1-0.15	0.1-0.15
Brazed cemented carbide	Cutting speed, $v_c$ (m/min)	-	-	45	45	45
	Feed, $f_z$ (mm/rev)	-	-	0.1-0.2	0.1-0.2	0.1-0.2

TiCN or TiAlN multi layer are recommended coatings for HSS drilling.

**MACHINING IN HARDENED CONDITION**

ASP® 2005 has been machined in hardened condition up to 64 HRC. CBN tools are recommended. Whisker reinforced ceramics (Coromant 670 or Kennametal 4300) can be used in turning, but the tool life is shorter and more difficult to predict.