LUCCHINI P20
LUCCHINI P20HH

PRE-HARDENED MOULD STEEL FOR WIDE RANGE APPLICATION

General characteristics

LUCCHINI P20 and LUCCHINI P20HH are pre-hardened tool steels dedicated to the plastic injection and compression moulds application.

LUCCHINI P20 and LUCCHINI P20HH have been developed to meet all the demands of the reference market and can cover a wide range of products; can be considered a reference point for general application in injection moulding market.

Thanks to fabrication process and dedicated heat treatment phase the characteristics of steel are enhanced and LUCCHINI P20 and LUCCHINI P20HH are characterized by excellent hardenability across the block.

Delivery conditions

LUCCHINI P20 and LUCCHINI P20HH are supplied in quenched and tempered condition in a wide dimensional range, from 200 mm up to 1000 mm in thickness.

LUCCHINI P20 is supplied with an hardness range of 290 – 330 HB, LUCCHINI P20HH with an hardness value of 320 – 360 HB.

The mid-thickness hardness value is guaranteed in section up to 1000 mm, according to the following correlation: $(HB_{Surface,min\ required} - HB_{Core}) \leq 20HB$.

Main features

- Excellent hardness (at both sub-surface and mid-thickness)
- Excellent through-thickness homogeneity
- Excellent machinability
- Excellent polishability and photo-engraving-ability
- Excellent wear resistance
- Good weldability

Main application

LUCCHINI P20 and LUCCHINI P20HH are suitable for the manufacture of plastic moulds in a wide range of application, from small size to medium-big size.

Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]
LUCCHINI P20 LUCCHINI P20HH Alloying [% in weight]	min	0,30	0,30	0,60	1,40	0,30
	max	0,40	0,80	1,00	2,00	0,55

Comparison with international classifications:
W. Nr. 1.2738 mod.
AISI: P20

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Physical and mechanical properties

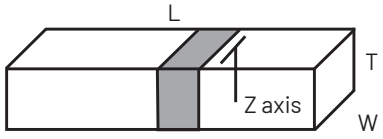
Main physical properties

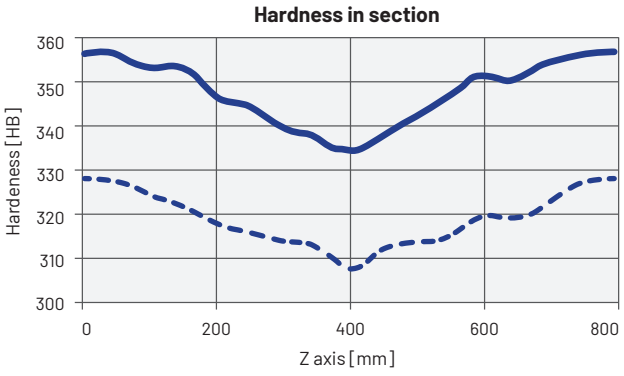
LUCCHINI P20 LUCCHINI P20HH	20°C	250°C	500°C
Young modulus E [GPa]	209	193	177
Coefficient of linear thermal expansion α [10-6/K]	-	13.4	13.8
Thermal conductivity λ [W/mK]	33.1	32.6	32.4

Main mechanical properties

	LUCCHINI P20		LUCCHINI P20HH	
	20°C	200°C	20°C	200°C
Ultimate tensile strength UTS [MPa]	980	890	1110	1030
Yield strength YS [MPa]	890	760	970	875
Elongation A [%]	16	18	15	16
Reduction in area Z [%]	55	55	50	50

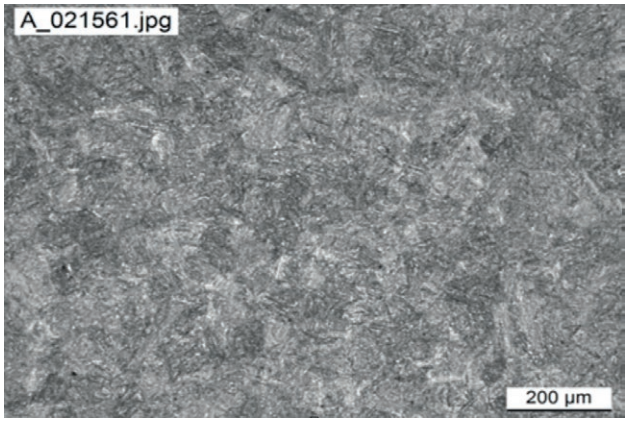
Hardness profile



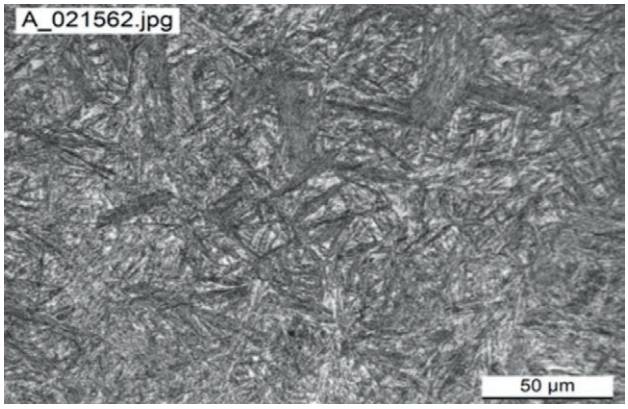


Microstructure

The main microstructure of LUCCHINI P20 and LUCCHINI P20HH is tempered martensite.



100x – Tempered martensite



500x – Tempered martensite

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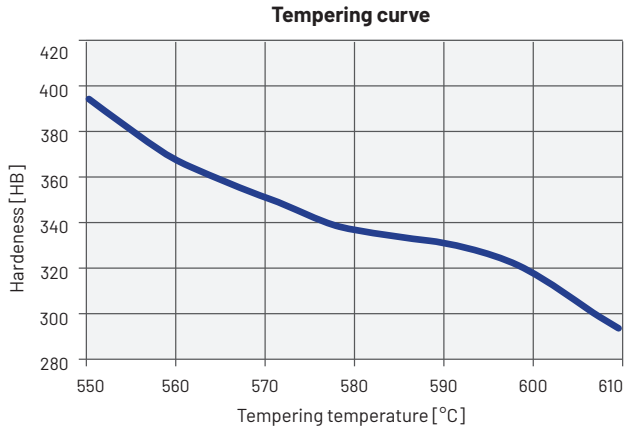
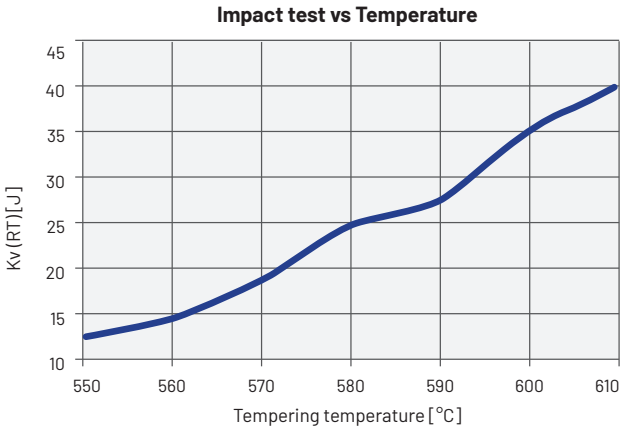
Surface hardness vs tempering temperature



Toughness (Charpy V-notch test at 20°C) vs tempering temperature



Remark: the above data are representative of the typical behaviour of a 800 mm thick block made in LUCCHINI P20 / LUCCHINI P20HH and are reported for information only

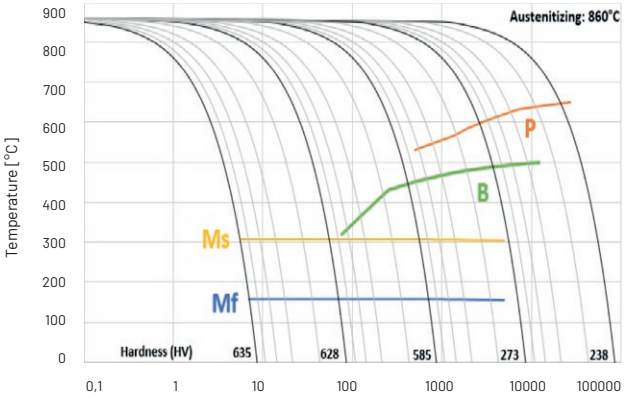
Heat treatment

LUCCHINI P20 and LUCCHINI P20HH are supplied in quenched and tempered conditions with no need for additional heat treatment operations.

However, if different hardness/heat treatment procedure are required, we recommend the following parameters.

Note that the reported data are for information purpose only and must be adjusted to the heat treatment facility and the dimensions of the block therefore, before carrying out any heat treatment operation, it is strongly recommended to contact Lucchini RS for help and support.

Continuous cooling transformation curve (CCT)



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Soft annealing

Suggested temperature	700 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow cooling in furnace (20°C/h)

Soft annealing is useful to improve machinability reducing hardness at 250 HB.

Stress relieving

Suggested temperature	500 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow cooling in furnace (20°C/h)

Stress relieving is recommended to reduce the tensions generated by certain manufacturing operations (e.g. machining) without affecting the hardness in the as-delivered conditions.

If the suggested temperature is lower than the tempering temperature, the stress relieving temperature will be 50° C lower than the tempering temperature previously applied.

Hardening

Suggested temperature	860 °C
Soaking time	60 min every 25 mm thickness
Cooling	Polymer or water quench

Tempering

Suggested temperature	Depending on the required mechanical properties
Soaking time	120 min every 25 mm thickness
Cooling	Still air

The tempering temperature should be selected form the graph "Tempering curve" reported above.

After tempering we suggest to carry out stress relieving at temperature 50 °C lower than the last tempering temperature.

Induction hardening

LUCCHINI P20 and LUCCHINI P20HH are suitable for induction hardening.

We recommend cooling at room temperature and tempering after induction hardening.

Nitriding

LUCCHINI P20 and LUCCHINI P20HH are suitable for ionic and gas nitriding. This treatment is very useful for moulds subjected to extremely stressful applications.

The increase of the surface hardness, following nitriding, extends the component life cycle.

Up-to-date nitriding procedures allow to minimize the dimensional variation of the piece.

In order to obtain the best results, we recommend the following manufacturing procedure:

- rough machining;
- stress relieving;
- finish machining;
- nitriding.

Other properties can be deeper analysed against specific Customer request: please contact our Metallurgy Department.

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Polishing and photo-engraving

LUCCHINI P20 and LUCCHINI P20HH are characterized by a high degree of purity, making them suitable to be polished and photoengraved.

Polishing for graining: 4 Excellent
Suitability for medium gloss polishing: 4 Excellent
Suitability for mirror polishing: 3 Very Good – SPI A2
Suitability for engraving: 3 Very Good

Rating scale:
4 Excellent – 3 Very good – 2 Good – 1 Normal – 0 Unsuitable

Guidance for machining

The following parameters are approximate only and must be adjusted to the specific application and machine tool.

Turning

	Rough machining	Finish machining		
Type of insert	P20-P40 coated	HSS	P10-P20 coated	Cermet
V_c cutting speed [m/min]	150 ÷ 190	(*)	190 ÷ 230	260 ÷ 320
a_r cutting depth [mm]	5	(*)	< 1	< 0,5

Milling

	Rough machining		
Type of insert	P25-P35 not coated	P25-P35 coated	HSS
V_c cutting speed [m/min]	120 ÷ 140	160 ÷ 180	(*)
f_z feed [mm]	0,15 ÷ 0,3	0,15 ÷ 0,3	(*)
a_r cutting depth [mm]	2 ÷ 4	2 ÷ 4	(*)

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	Pre-finishing		
Type of insert	P10-P20 not coated	P10-P20 coated	HSS
V_c cutting speed [m/min]	140 ÷ 160	180 ÷ 200	(*)
f_z feed [mm]	0,2 ÷ 0,3	0,2 ÷ 0,3	(*)
a_r cutting depth [mm]	< 2	< 2	(*)

	Finishing		
Type of insert	P10-P20 not coated	P10-P20 coated	Cermet P15
V_c cutting speed [m/min]	200 ÷ 240	250 ÷ 270	300 ÷ 340
f_z feed [mm]	0,05 ÷ 0,2	0,05 ÷ 0,2	0,05 ÷ 0,2
a_r cutting depth [mm]	0,5 ÷ 1	0,5 ÷ 1	0,3 ÷ 0,5

(*) not advisable

Drilling

Type of insert	tip with interchangeable inserts	HSS	brazed tip
V_c cutting speed [m/min]	130 ÷ 160	(*)	90 ÷ 120
f_z feed per turn [mm/turn]	0,05 ÷ 0,15	(*)	0,15 ÷ 0,25

(*) not advisable

General formulae

Type of machining	**Drilling**	**Milling**
n: number of turns of mandrel	$V_c * 1000 / \pi * D_c$	$V_c * 1000 / \pi * D_c$
V_f: feed speed [m/min]	$V_f = f_z * n$	$V_f = f_z * n * z_n$
f_z feed per turn [mm/turn]	-	$f_n = V_f / n$
Note	D_c: Milling cutter or tip diameter [mm] V_c: cutting speed [m/min] f_z: feed [mm]	f_n: feed per turn [mm/turn] z_n: No. of milling cutter inserts

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Welding

In order to obtain the best results, we recommend the following procedure:

Welding technique	TIG	MMA
Pre-heating at	250 - 300 °C	
Heat treatment	Stress relieving (see heat treatment paragraph)	

Electrical Discharge Machining (EDM)

LUCCHINI P20 and LUCCHINI P20HH can be machined by EDM to obtain complex shape. Afterwards we advise to carry out the stress relieving procedure

Process and materials selection for product recyclability

According to the potential of steel recycling, Lucchini RS is adopting a strategy for environmental excellence in designing and manufacturing its tool steel grades, putting eco-effectiveness into practice.

The main adopted steps are:

- to carry out an environmental assessment on processes and products, with the minimum use of virgin materials and non-renewable forms of energy;
- to move toward zero-waste manufacturing processes, considering that the ultimate destination of scrapped steel moulds becomes food for the next steel making process, that is the "waste equals food" philosophy;
- to carry out a life cycle assessment for each product and process, minimizing the environmental cost of product and service over its complete life cycles, from creation to disposal, that is the "Cradle to Cradle" philosophy

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Quick comparison guide among the different steel grades

The following table shows a quick comparison among the main characteristics of pre-hardened steel grades traditionally used in plastic moulding.

Tool Steels for plastic														
		LUCCHINI							KEYLOS					
		1730	7225	2311	2312	2738	P20	P20HH	UP	30	35	40	35 EVO	40 EVO
HB	Min	-	220	280	280	290	290	320	280	290	320	360	320	360
	Max	250	270	330	330	340	330	360	330	330	360	400	360	400
Maximum thickness [mm]		300	400	500	500	1.000	1.000	1.000	800	1.000	1.000	500	1.300	800
Wear Resistance		1	1	2	2	2	2	3	2	2	3	4	3	4
Through Hardening in the section		1	1	2	2	3	3	3	3	4	4	4	4	4
Toughness		1	2	2	2	2	2	2	2	3	3	2	3	3
Machinability		3	2	2	3	2	2	2	2	2	2	2	2	2
Polishing		1	1	2	0	2	2	2	2	3	3	3	3	3
Photo-engraving		2	2	3	0	3	3	3	3	4	4	4	4	4
Welding (reparing)		3	3	2	2	2	3	3	2	3	3	3	3	3

4 Excellent **3 Very Good** **2 Good** **1 Normal** **0 Unsuitable**

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