LUCCHINI 2340

THE NEW APPROACH IN THE WORLD OF HOT WORK TOOLS AND HIGHLY RESISTANT PLASTIC MOULDS

General characteristics

Lucchini 2340 is a high alloyed Chromium-Molybdenum- Vanadium Hot Work Tool steel characterized by a low Silicon content and by other special micro-alloying elements. Lucchini 2340 has been expressly designed for tools that have to work in a wide temperature range without compromising toughness.

Lucchini 2340 is the ideal choice in hot applications where it is necessary to maintain unaltered the mechanical properties of the material in all the phases of the process, including the most critical moments on start-up. Constant development in hot processing technologies require the use of Lucchini 2340 thanks to its high resistance to thermal fatigue and to high temperature wear.

LUCCHINI 2340 is demonstrating impressive resistance to fatigue in many applications and a significantly longer mould life than conventional Hot Work Tool steel grades.

Delivery conditions

LUCCHINI 2340 is supplied in annealed condition in dimensional range up to 500 mm thickness.

The surface hardness value is lower than 220 HB, guaranteeing a good machinability.

Main features

- high resistance to thermal shock and to heat cracking;
- good mechanical characteristics in hot and cold condition;
- excellent mechanical properties in the ductile-brittle transitional phases;
- excellent toughness in hot and cold conditions;
- high resistance to tempering;
- excellent machinability in annealed conditions.

Main application

- dies for aluminium stamping;
- low pressure dies;
- moulds for gravity casting;
- containers for presses;
- matrices for aluminium extrusion;
- heels for extrusion presses;
- jackets for extrusion presses;
- injection moulds;
- dies and gauges for PVC extrusion.

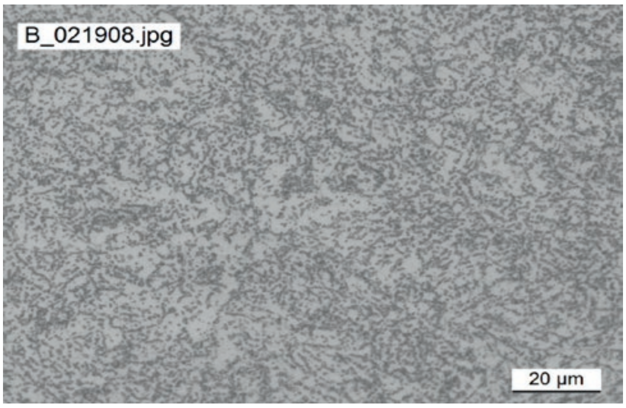
Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]	V [%]
LUCCHINI 2340 Alloying [% in weight]	min	0,32	0,10	0,30	4,80	1,20	-	0,30
	max	0,40	0,30	0,50	5,50	1,50	-	0,50

Physical and mechanical properties

Main physical properties

LUCCHINI 2340	20°C	400°C	600°C
Young modulus E [MPa]	210	186	167
Coefficient of linear thermal expansion α [10-6/K]	-	12,0	12,8
Thermal conductivity λ [W/mK]	24,7	27,8	29,5



500x

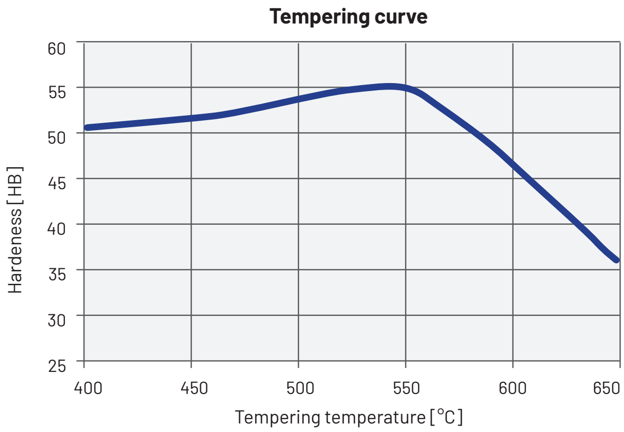
Main mechanical properties

LUCCHINI 2340	400°C	500°C	600°C
Ultimate tensile strength UTS [MPa]	1170	970	660
Yield strength YS [MPa]	920	760	485

The above mentioned are average values of a sample hardened at 980 °C, quenched and tempered to achieve hardness value of 44 HRC.

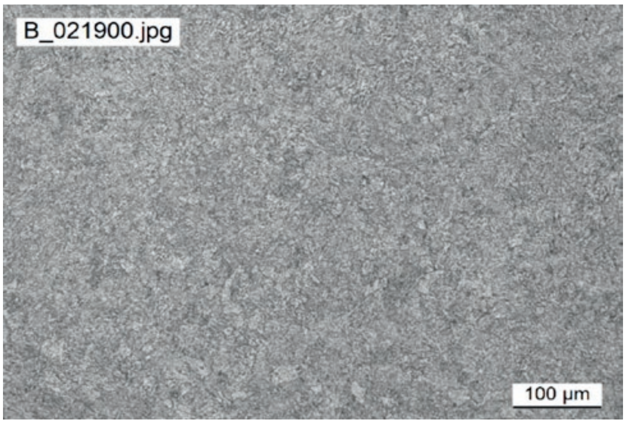
Surface hardness vs tempering temperature

Tempering curve of a sample austenitized at 980°C. The diagram shows values obtained after the second tempering; the first tempering is performed at 550°C.



Microstructure

The main microstructure of LUCCHINI 2340 consist of a ferritic matrix with a homogeneous distribution of spheriodized carbides.

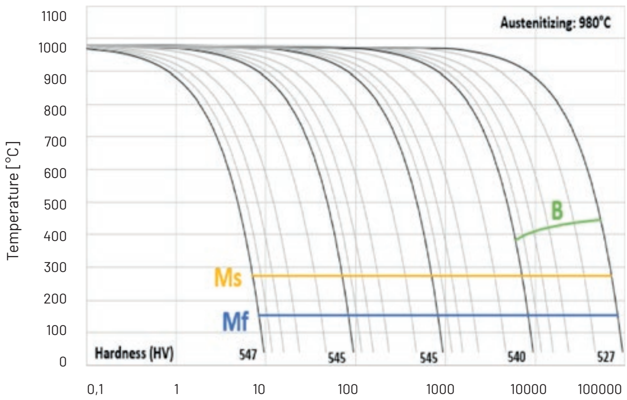


100x

Heat treatment

Lucchini 2340 is supplied in annealed condition with a hardness value below 220 HB. Heat treatment shall be carried out using the parameters recommended and given below..

Continuous cooling transformation curve (CCT)



Soft annealing

Heating	Max 50°C/h
Suggested temperature	850°C
Soaking time	120 min from the temperature's settlement
Cooling	Slow cooling in furnace (20°C/h)

Soft annealing is useful to improve machinability reducing hardness at 220 HB.

Stress relieving

Heating	Max 100°C/h
Suggested temperature	Annealed condition: 650°C QT condition: 50°C lower than the last tempering
Soaking time	120 min from the temperature's settlement
Cooling	Slow cooling in furnace (20°C/h)

We strongly recommend to perform the stress relieving:

- After rough machining in order to minimize distortions and avoid quenching cracks by hardening treatment;
- After the finish machining, before the very first sampling, to avoid possible damages to cavity surface and sub-surface caused by not optimized hard milling.

Hardening

We suggest to carry out the hardening process on material supplied in the annealed condition and to temper it immediately afterwards.

Hardening should be carried out after the material pre-heating according to the following table.

Heating	Max 150°C/h
First pre-heating temperature	400°C
Soaking time	25 min / 25 mm in thickness or $(T_{SURFACE} - T_{CORE}) < 90°C$

Heating	Max 150°C/h
Second pre-heating temperature	600°C
Soaking time	20 min / 25 mm in thickness or $(T_{SURFACE} - T_{CORE}) < 90°C$

Heating	Max 150°C/h
Third pre-heating temperature	800°C
Soaking time	20 min / 25 mm in thickness or $(T_{SURFACE} - T_{CORE}) < 90°C$

The aim of the first pre-heat at 400 °C is to eliminate stresses caused by machining: if stress relieving is performed earlier, this step could be avoided.

The following pre-heating cycles at 600 °C and 800 °C are necessary to homogenize the temperature of the piece. We recommend an heating rate of 150 °C/h max.

The time of the different stages of pre-heating is calculated on the basis of the thickness of the piece and the temperature, as described in the above attached table.

Alternatively, the time can be adjusted on the basis of the difference between the internal temperature (T_{CORE}) and the Surface temperature ($T_{SURFACE}$) of the piece, measured by two thermocouples.

After the third pre-heating at 800°C, the austenitizing temperature should be reached as quickly as possible and maintained for 30 min from when ($T_{SURFACE}$ – T_{CORE}) < 15 °C or on the basis of the following formula:

$t = (x + 39) / 2$
t = soaking time [min]
x = thickness [mm]

Heating	Max 150°C/h
temperature	980°C
Soaking time	t=(x+39)/2 or 30 min from ($T_{SURFACE}$ – T_{CORE}) < 15°C
Cooling	Air, vacuum cooling, salt bath, polymer

Tempering

It is recommended to set the temperature of the first tempering at 550°C, close to the secondary peak hardness.

The temperature of the second tempering must be set according to the required mechanical properties and must be higher than the temperature of the first tempering.

The soaking time for the first and the second tempering are calculated by the following empirical formula:

t' = t'' = 0,8 x + 120
t' = t'' = soaking time [min]
x = thickness [mm]

A third tempering at 30-50 °C less than the maximum temperature previously used will work as a stress relieving process.

Tempering at a temperature between 400 and 550 °C is not advisable, as it may reduce the material toughness. Tempering at a temperature lower than 200 °C should not be carried out.

The soaking time for the third tempering is calculated by the following empirical formula:

t''' = 0,8 x + 120
t''' = soaking time [min]
x = thickness [mm]

First tempering temperature	550°C
Soaking time	t' = 0,8 x + 120
Cooling	Still air

Second tempering temperature	Based on mechanical properties required
Soaking time	t'' = 0,8 x + 120
Cooling	Still air

Third tempering temperature	30-50 °C less than the maximum temperature previously used
Soaking time	t''' = 0,8 x + 180
Cooling	Still air

Chrome plating

LUCCHINI 2340 can be Chrome plated in order to enhance the mechanical characteristics on the surface.

In order to prevent Hydrogen embitterment, within 4 hours of Chrome plating it is advisable to carry out heat treatment at 200 °C for about 4 hours.

Nitriding

LUCHINI 2340 is 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.

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

Polishing and photo-engraving

LUCCHINI 2340 is the suitable material when polishing and photoengraving are needed. Thanks to its integrated manufacturing process, those material manufactured by Lucchini RS are characterized by a high degree of purity.

Polishing for graining: 4 Excellent
Suitability for medium gloss polishing: 4 Excellent
Suitability for mirror polishing: 3 Very good
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	(*)

	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

Welding

Welding LUCCHINI 2340 can give good results if it is carried out using the recommended procedure.

As steel with high Carbon Equivalent content, LUCCHINI 2340 is very sensitive to cracking.

We recommend to carry out pre-heating and heat treatment after welding.

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

Material condition	Annealed	
Welding technique	TIG	MMA
Pre-heating at	330 – 380°C	
Recommended Heat treatment	Heating of the material at 850 °C, cooling in the furnace to 600 °C at a rate of 20 °C/h, cooling at room temperature	

Material condition	Hardened and tempered	
Welding technique	TIG	MMA
Pre-heating at	330 – 380°C	
Recommended Heat treatment	650 °C or 50 °C lower than the tempering temperature previously applied	

Electrical Discharge Machining (EDM)

Lucchini 2340 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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