LUCCHINI 2316

STAINLESS STEEL FOR PROCESSING CHEMICALLY AGGRESSIVE AND ACID-RELEASING PLASTIC MOULDS

General characteristics

LUCCHINI 2316 is a martensitic stainless steel, resistant to corrosion, manufactured through a 'super clean' technology that guarantees high microcleanness levels.

Corrosion resistance allows the surface characteristics of the mould to be maintained over time and, as consequence, the die can be stocked with no need for special precautions to be taken and with the certainty of being able to use the mould whenever needed.

Delivery conditions

LUCCHINI 2316 is supplied in annealed or quenched and tempered condition in a dimensional range up to 300 mm in thickness.

In annealed condition the surface hardness is lower than 250 HB in quenched and tempered condition the surface hardness in 280 – 330 HB and the mid-thickness hardness value is guaranteed in section up to 350 mm, according to the following correlation: $(HB_{Surface,min\ required} - HB_{Core}) \leq 20HB$.

Main features

- excellent machinability;
- excellent suitability for photo-engraving;
- excellent suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance;
- excellent wear resistance;
- Good resistance to corrosion.

Main application

- moulds for corrosive plastic materials (PVC, recycled polymers, etc.);
- moulds for the automotive industry and optical parts (head lamp components);
- moulds for medical instruments;
- moulds for food industry products;
- moulds for the cosmetics industry;
- moulds for rubber pressing;
- dies and gauges for PVC extrusion;
- mechanical parts for extrusion presses (ex. extrusion heads).

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Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]
LUCCHINI 2316 Alloying [% in weight]	min	0,33	-	-	15,00	1,00	/
	max	0,43	1,00	1,00	17,50	1,30	1,00

Comparison with international classifications:
W. Nr. 1.2316
DIN EN ISO 4957: X38CrMo16

Physical and mechanical properties

Main physical properties

LUCCHINI 2316	20°C	250°C	500°C
Young modulus E [MPa]	210	198	177
Coefficient of linear thermal expansion α [10-6/K]	-	11,4	12,2
Thermal conductivity λ [W/mK]	17,5	20,7	23,2

Main mechanical properties

LUCCHINI 2316	20°C	200°C
Ultimate tensile strength UTS [MPa]	1100	980
Yield strength YS [MPa]	900	780
Elongation (A) [%]	15	16
Reduction of area (Z) [%]	45	47

The above mentioned are average values of a sample hardened at 1030°C, quenched and tempered to achieve hardness value of 40 HRC.

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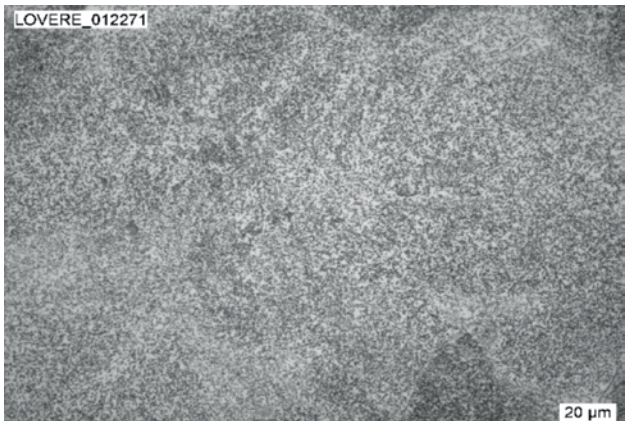
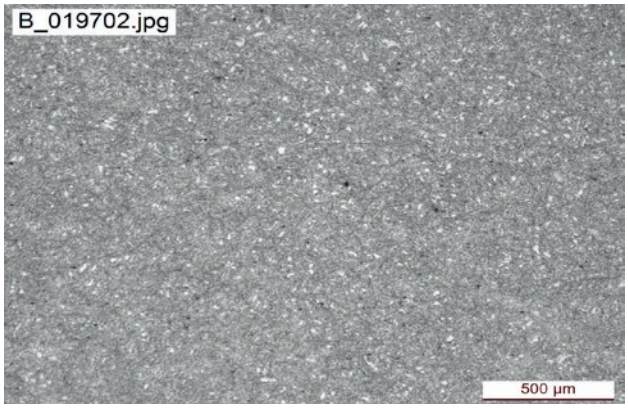
Microstructure

The main microstructure of LUCCHINI 2316 in annealed condition is globular perlite with carbides; in quenched and tempered condition is tempered martensite.

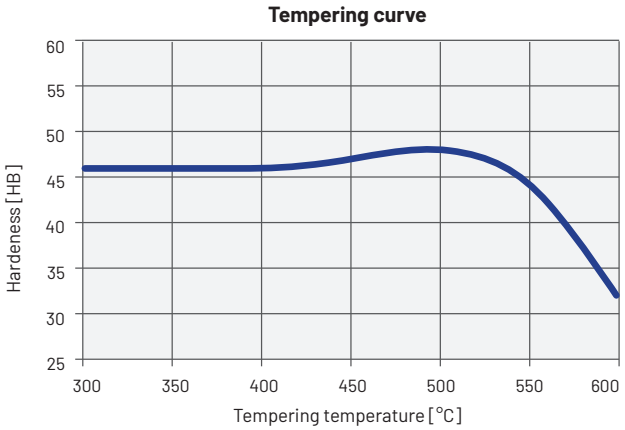


500x – Globular perlite with carbides



500x – Tempered martensite

Surface hardness vs tempering temperature



Remark: the above data are representative of the typical behaviour of a 250 mm thick block made in LUCCHINI 2316 and are reported for information only.

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Heat treatment

LUCCHINI 2316 is supplied in annealed condition with a hardness value below 250 HB or in quenched and tempered conditions with no need for additional heat treatment operations.

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.

Soft annealing

Suggested temperature	750°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	650°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

A pre-heating step at 700°C is recommended to reduce the stress during the heating up to austenitizing temperature.

Suggested temperature	1030°C
Soaking time	60 min every 25 mm thickness
Cooling	Vacuum cooling, oil, polymer

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.

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

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Polishing and photo-engraving

LUCCHINI 2316 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: 3 Very good
Suitability for medium gloss polishing:3 Very good
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

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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

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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

Welding on LUCCHINI 2316 is not recommended but, if it cannot be avoided, please consult Lucchini RS specialists.

The following information about welding procedure on LUCCHINI 2316 is only indicative.

Material condition	Annealed	Hardened and tempered
Welding technique	TIG	
Pre-heating at	250 – 300°C	
Recommended Heat treatment	Heating at 680 °C and cooling at room temperature Tempering at 10-20 °C below the temperature of the last tempering	

Electrical Discharge Machining (EDM)

LUCCHINI 2316 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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Via Giorgio Paglia, 45
24065 LOVERE (BG) - Italy
Phone +39 035 963724

www.lucchinirs.com

GROUP LUCCHINI RS