

KEY[®]LOS 2002

Special and Innovative
pre-hardened steel suited
for the most demanding
plastic moulds also for
extremely large sections

General characteristics

KeyLos® 2002 is a special and innovative pre-hardened alloyed steel, suitable for the manufacture of big size injection moulds.

KeyLos® 2002 is obtained through a special 'super clean' manufacturing process and special heat treatments.

KeyLos® 2002 is normally supplied in the pre-hardened condition with a surface hardness of 360-400 HB.

For the detected hardness values in standard sized products, the following correlation is usually valid and guaranteed:

$$(HB_{\text{Surface, min required}} - HB_{\text{Core}}) \leq 20HB$$

KeyLos® 2002 represents the synthesis and the perfect balance of all the grades normally applied in this field and it is suited for a very wide range of applications in the plastics industry.

Thanks to an accurate design of the chemical alloying elements and thanks to a special heat treatment, KeyLos® 2002 is characterized by a high degree of through hardening and it is suited in the case of very large dimensions, that need its greater toughness balanced with very high hardness through to the core.

Because of the low Carbon Equivalent content, the weldability level is excellent and KeyLos® 2002 becomes safer in case of welding repair.

Being Calcium treated, KeyLos® 2002 has an excellent level of machinability and micro-purity. Due to this, KeyLos® 2002 is very suitable for polishing and photo-engraving.

KeyLos® 2002 is the best option for the production of blocks with thicknesses up to 1200 mm.

KeyLos® 2002 offers the following advantages:

- excellent machinability;
- excellent toughness level;
- excellent suitability for photo-engraving;
- excellent suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance;
- excellent wear resistance;
- internal homogeneous hardness on blocks with thicknesses up to 1200 mm;
- optimized manufacturing cycle: from steel block to mould, with no need for intermediate treatments;
- good weldability, improved with low C content.

Constant development in processing technologies of high quality plastic parts requires the use of KeyLos® 2002, thanks to its high fatigue and wear resistance, combined with its excellent homogeneity, machinability and extremely low thermal conductivity.

KeyLos® 2002 represents one of the most important tough options, for highly resistant and extremely large plastic moulds that need very high pressure strength, excellent resistance to abrasion and a shorter machining time.

The increasing in the use of synthetic and abrasive materials has led manufacturers to use KeyLos® 2002 also when suitability for polishing and graining, combined with abrasion and compression resistance, are required.

EskeyLos® 2002 is 100% ultrasonically inspected, according to the most demanding of NDT standards.

Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]
KEYLOS 2002 Alloying [% in weight]	min	0,20	0,20	1,40	1,20	0,55	1,00
	max	0,30	0,50	1,70	1,60	0,75	1,30

Table for comparison of international classification

W. Nr. /
DIN designation: ≈28MnCrNiMo6-5-4

Main applications

KeyLos[®] 2002 is suitable for the following applications:

Plastic moulding:

- medium and big sized moulds for the automotive industry;
- moulds for the food industry;
- moulds for rubber pressing;
- pressure moulds (SMC, BMC);
- bolsters;
- suited for a wide range of applications.

Extrusion:

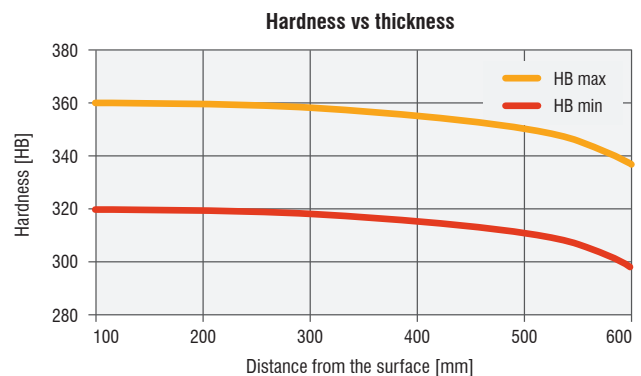
- dies and gauges for PVC extrusion;
- mechanical parts for extrusion presses.

Physical and mechanical properties

Main physical properties

KEY[®]LOS 2002	20°C	250°C	500°C
Modulus of elasticity [GPa] (1GPa=1000 MPa)	210	194	176
Coefficient of thermal expansion [10 ⁻⁶ /K]	-	12,5	14,3
Thermal conductivity [W/mK]	34,5	34,0	33,8

These values are average values obtained from the middle of the section of a 1000 mm thick bar, subjected to hardening at 900 °C, quenching and tempering at 600 °C.



Main mechanical properties

KEY[®]LOS 2002	20°C	200°C
Ultimate tensile strength (UTS) [MPa]	1.080	920
Yield stress (YS) [MPa]	980	780
(A) [%]	17	-
(Z) [%]	53	-

Heat treatments

KeyLos® 2002 is supplied in the pre-hardened condition. If it is necessary to obtain different hardness levels or if a heat treatment cycle is necessary, the parameters in the following table are recommended. The attached data are for information purposes only and must be varied dependent on the heat treatment facility and the thickness of the bar.

Soft annealing

Suggested temperature	700 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow in the furnace at max 20 °C/h to 600 °C , then at room temperature

Soft annealing is useful to improve machinability. The obtained hardness is lower than 250 HB.

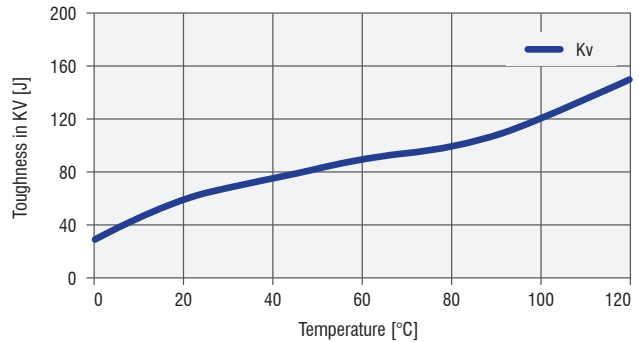
Stress Relieving

Suggested temperature	550 °C
Soaking time	60 min every 25 mm thickness
Cooling	slow in the furnace at max 20 °C/h to 200 °C , then at room temperature

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.

Stress relieving is recommended where it is necessary to eliminate residual stresses induced by mechanical working or by a preceding heat treatment.

Toughness vs temperature



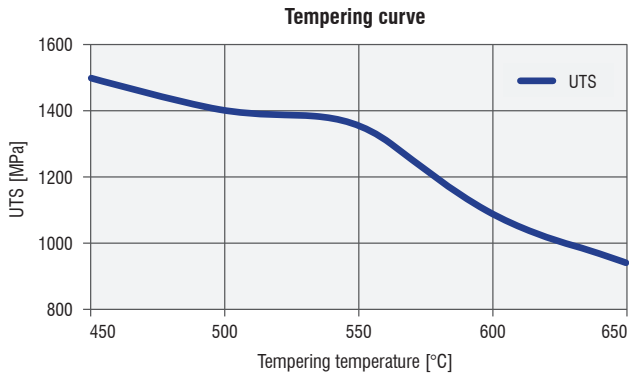
Hardening

Suggested temperature	950 °C
Soaking time	60 min every 25 mm thickness
Cooling	Polymer or water quench

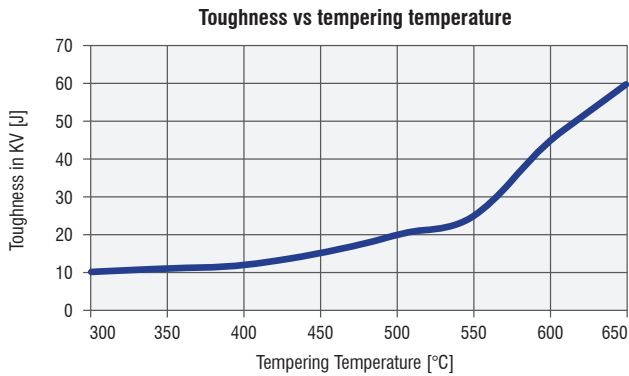
We suggest to carry out hardening on material supplied in the annealed condition and tempering immediately afterwards.

Tempering

Suggested temperature	The tempering temperature to be applied to the material depends on the required mechanical properties. See following graph.
Soaking time	60 min every 25 mm thickness
Cooling	Room temperature



Tempering curve of a sample which has been austenitised at 950 °C.



After tempering we suggest carrying out stress relieving at a temperature lower than 50 °C.

Induction hardening

On this steel it is possible to carry out induction hardening.

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

Nitriding

KeyLos[®] 2002 is suitable for ionic and gas nitriding. This treatment is very useful for moulds or dies subjected to extremely stressful applications.

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

Modern nitriding processes allow the original dimensions of the component to be maintained.

We recommend heat treating the component in the finish machined condition.

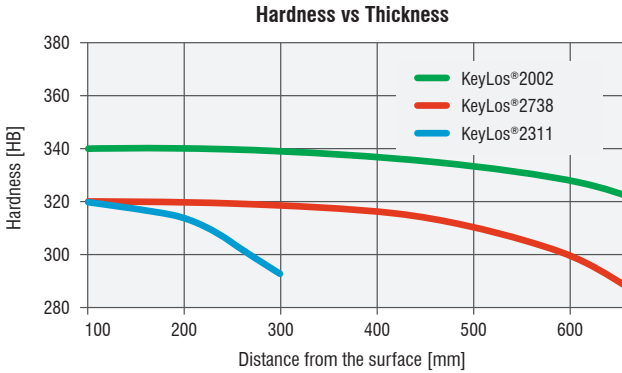
We recommend the following manufacturing cycle, in order to obtain the best results:

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

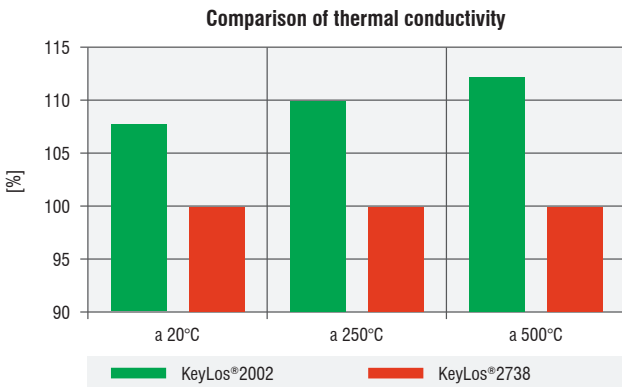
In any case, other properties can be analyzed and studied deeper by Lucchini RS on specific Customer request: please consult Lucchini RS specialists of MET Department.

KeyLos® 2002 compared to other grades

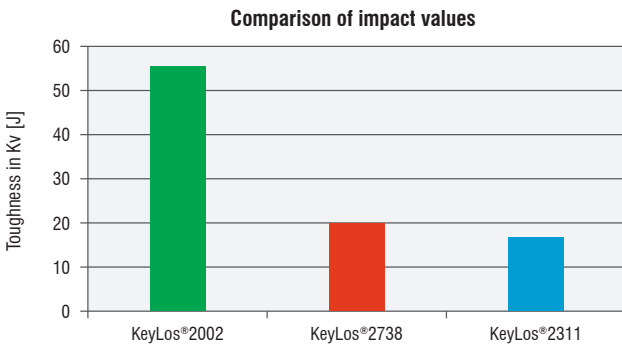
Average values of hardness variation related to thickness of blocks made of KeyLos® 2002, KeyLos® 2738 and KeyLos® 2311.



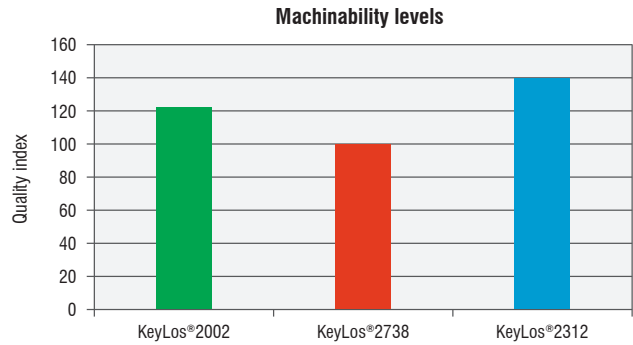
Comparison of thermal conductivity between KeyLos® 2002 and KeyLos® 2738.



Comparison of impact values among KeyLos® 2002, KeyLos® 2738 and KeyLos® 2311. The comparison has been made on blocks with the same hardness, at a temperature of 20 °C.

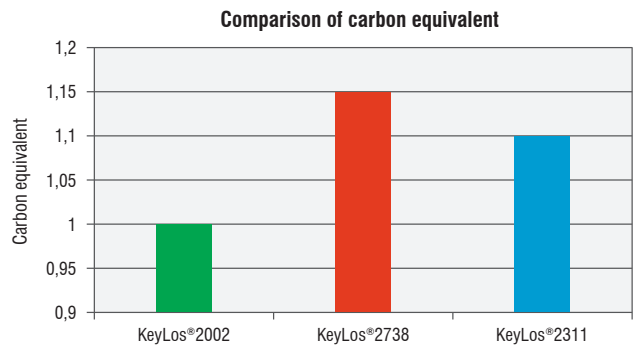


Machinability levels of KeyLos® 2002, KeyLos® 2738 and KeyLos® 2312.

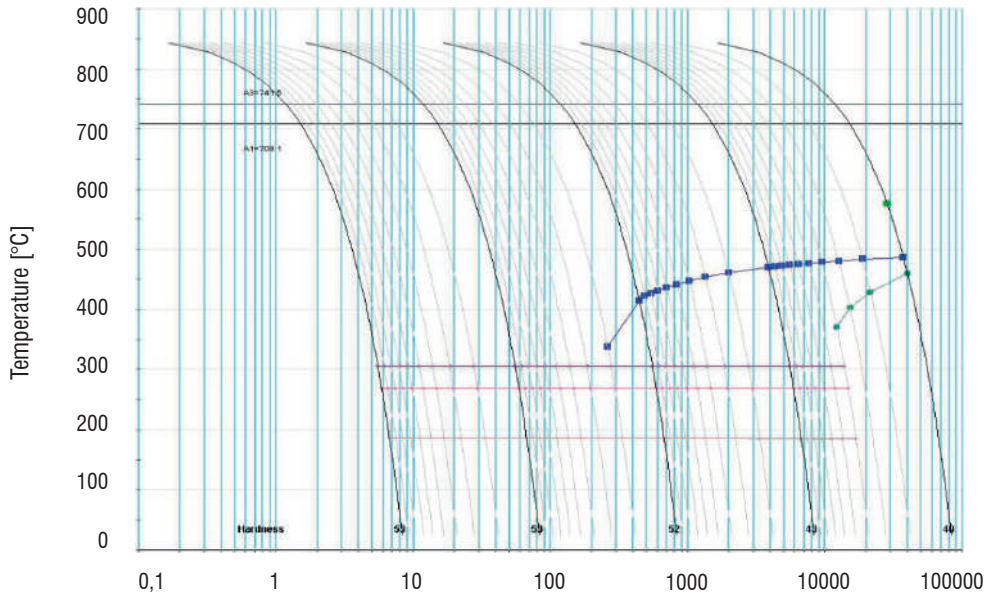


Comparison of Carbon Equivalent content between KeyLos® 2002, KeyLos® 2738 and KeyLos® 2311.

KeyLos® 2002 has a lower Carbon Equivalent content than other grades normally used in this field. This implies better weldability and low risk of cracking, making welds of a finished mould easier to carry out.



CCT Curve



Microstructure of KEYLOS[®] 2002



The microstructure of KeyLos[®] 2002 detected about 20 mm under surface is tempered martensite.

Guidance for machining

The following parameters are indicative only and must be adapted to the particular application and to the machinery employed.

Turning

Type of insert	Rough machining		Finish machining	
	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

Type of insert	Rough machining		
	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	(*)

Type of insert	Pre-finishing		
	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	(*)

Type of insert	Finishing		
	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

Approximate equivalent values between hardness and ultimate tensile strength.

HB	530	520	512	495	480	471	458	445	430	415	405	390	375
HRc	54	53	52	51,1	50,2	49,1	48,2	47	45,9	44,5	43,6	41,8	40,5
MPa	1.900	1.850	1.800	1.750	1.700	1.650	1.600	1.550	1.500	1.450	1.400	1.350	1.300

HB	360	350	330	320	305	294	284	265	252	238	225	209	195
HRc	38,8	37,6	35,5	34,2	32,4	31	29	27	--	--	--	--	--
MPa	1.250	1.200	1.150	1.100	1.050	1.000	950	900	850	800	750	700	650

Welding

Welding of KeyLos[®] 2002 can give good results if the following procedure is observed:

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

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 of its tool steel grades, putting eco-effectiveness into practice.

The main adopted steps are:

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

Electrical Discharge Machining (EDM)

KeyLos[®] 2002 can be machined by EDM to obtain complex shape.

Afterwards it is advisable to stress relieving the material.

Chrome Plating

KeyLos[®] 2002 can be Chrome plated in order to enhance the mechanical characteristics on the surface.

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

Photo-engraving

Thanks to modern production processes and to the low Sulphur content, KeyLos[®] 2002 is suitable for photo-engraving to obtain various patterns.

Polishing

KeyLos[®] 2002 is particularly suitable for polishing.