

KEY[®] LOS 2738MHH

Innovative steel designed for
the most demanding plastic injection
and compression moulds

General characteristics

KeyLos[®] 2738MHH represents the latest improvement of Lucchini RS steel grades traditionally dedicated to the plastic injection and compression moulds, developed with specific focus on the big sized blocks.

Thanks to the accurate design of its chemical composition and to the special heat treatment procedure, KeyLos[®] 2738MHH is characterized by excellent hardenability across the block, minimizing the decrease of the hardness from surface to core, excellent ratio of hardness to toughness, very high thermal conductivity and excellent finishing properties.

According to the low Carbon Equivalent content, the weldability is excellent and KeyLos[®] 2738MHH is easier and safer in case of welding repair.

KeyLos[®] 2738MHH, usually supplied in quenched and tempered condition with 320-360 HB surface hardness, is the best option for the large dimension blocks with thickness up to 1200 mm.

For the hardness, besides, is also guaranteed for the detected hardness values:

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

In sections up to 1200mm.

Main features

- Homogeneous hardness across the blocks;
- excellent toughness;
- excellent thermal conductivity;
- excellent wear resistance;
- good machinability;
- very good polishability;
- excellent for photo-engraving;
- excellent for nitriding and hard chromium plating;
- improved weldability.

Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]	V [%]
KEY[®]LOS 2738MHH	min	0,22	0,15	1,20	1,20	0,45	0,80	0,10
Alloying [% in weight]	max	0,32	0,55	1,60	1,60	0,70	1,50	0,20

Comparison with international classifications.

W. Nr. /
DIN designation: $\approx 26MnCrNiMo7$

Lucchini RS tool steels are designed in order to optimize the material's performances.

The brand name KeyLos[®] identifies Lucchini RS product, the number 2738 refers to Werkstoff classification; M stands for modified in comparison with KeyLos[®] 2738 chemical composition; HH stands higher hardness in comparison with KeyLos[®] 2738.

Main applications

- Big sized injection and compression moulds for exterior and interior plastic components for automotive sector: in particular cavities for bumpers and dashboards.
- Home appliances: rear TV housing, copier housing, crates, dustbins, chairs et cetera.

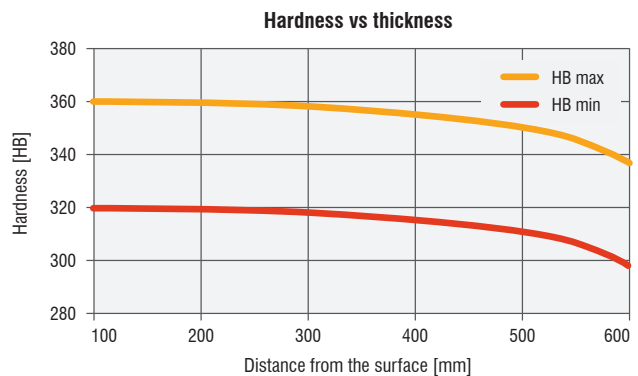
KeyLos[®] 2738MHH as all the other Lucchini RS steel grades is also designed with the aim to guarantee the minimum use of virgin materials, moving toward the use of scrap categories difficult to be recycled.

Physical and mechanical properties

Main physical properties

KEY[®] LOS 2738MHH	20°C	250°C	500°C
Modulus of elasticity [GPa] (1GPa=1000 MPa)	209	193	176
Coefficient of thermal expansion [10 ⁻⁶ /K]	-	12,6	14,4
Thermal conductivity [W/mK]	34,6	34,1	33,9

The herewith values are the average from half section of 1000 mm thickness block, after hardening at 900 °C, quenching and tempering at 600 °C.



Main mechanical properties

KEY[®] LOS 2738MHH	20°C	200°C
Ultimate Tensile strength (UTS) [MPa]	1.085	925
Yield stress (YS) [MPa]	985	785
Elongation (A) [%]	18	-
Reduction of area (Z) [%]	53	-

Heat treatments

KeyLos® 2738MHH is usually supplied in quenched and tempered condition. If different hardness/heat treatment procedure are required, we recommend the following parameters.

The herewith attached data are for information purpose only and must be adjusted to the heat treatment facility and the dimensions of the block.

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

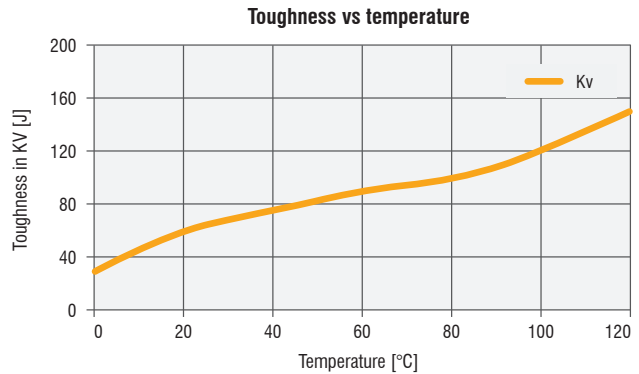
Soft annealing is useful to improve machinability. Actual hardness is ≤ 250 HB.

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

Stress relieving is recommended to remove residual stresses produced by previous heat treatment or by machining operations.

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.

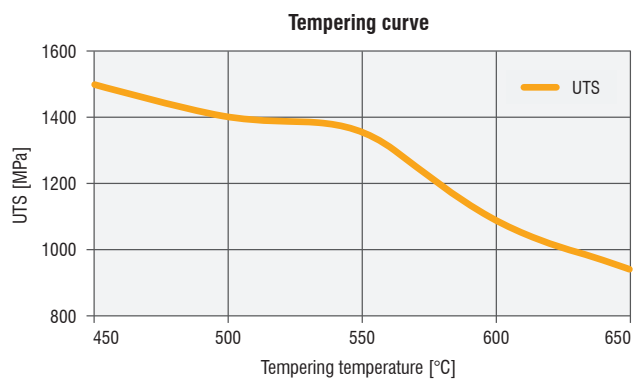


Hardening

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

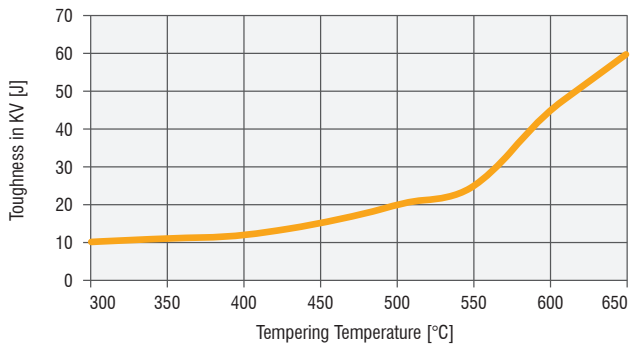
Tempering

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 austenitized at 950 °C.

Toughness vs tempering temperature



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

Induction hardening

KeyLos[®] 2738MHH is suitable for induction hardening. We recommend cooling at room temperature and tempering after induction hardening.

Nitriding

KeyLos[®] 2738MHH 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. We recommend to heat treat the piece in finish machined condition.

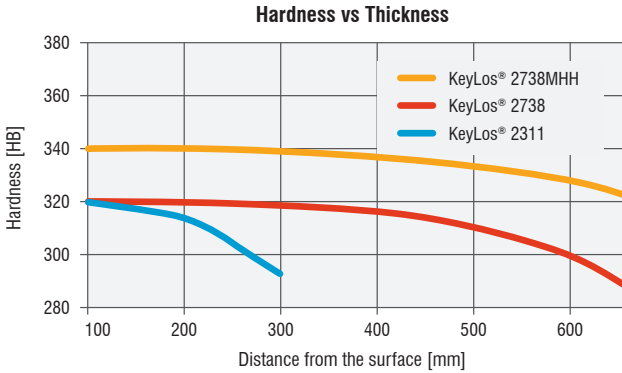
In order to obtain the best results, we recommend the following manufacturing procedure:

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

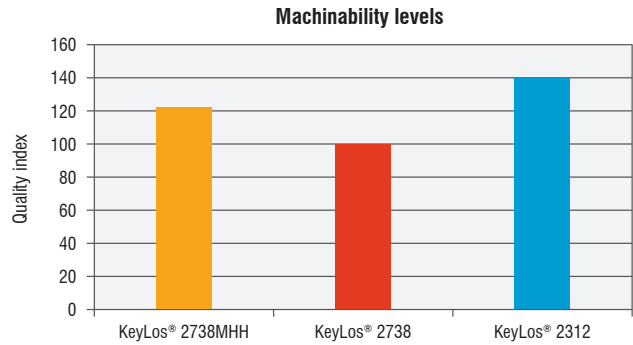
In any case, other properties can be deeper analysed by Lucchini RS against specific Customer request: please contact our Metallurgy Department.

KeyLos® 2738MHH compared to other grades

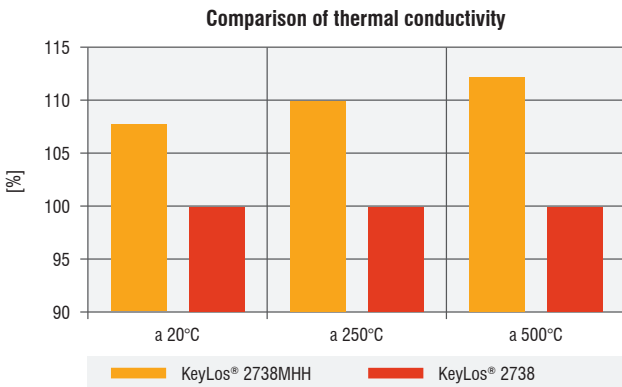
Comparison of average values of hardness variation versus thickness among KeyLos® 2738MHH, KeyLos® 2738 and KeyLos® 2311.



Comparison of machinability among KeyLos® 2738MHH, KeyLos® 2738 and KeyLos® 2312.

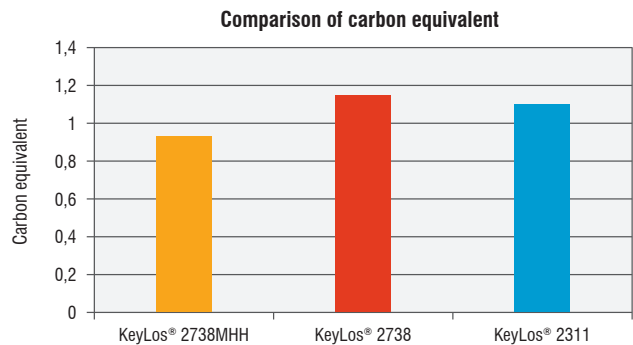


Comparison of thermal conductivity between KeyLos® 2738MHH and KeyLos® 2738.

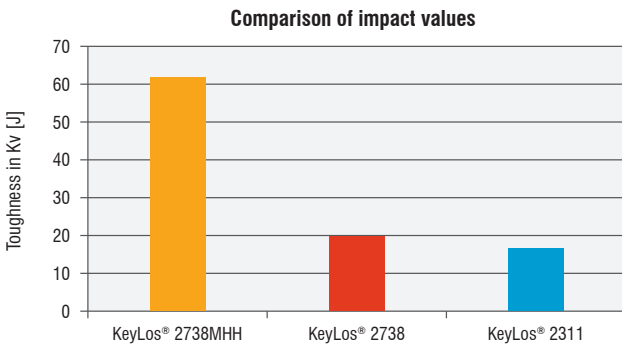


Comparison of Carbon Equivalent content among KeyLos® 2738MHH, KeyLos® 2738 and KeyLos® 2311.

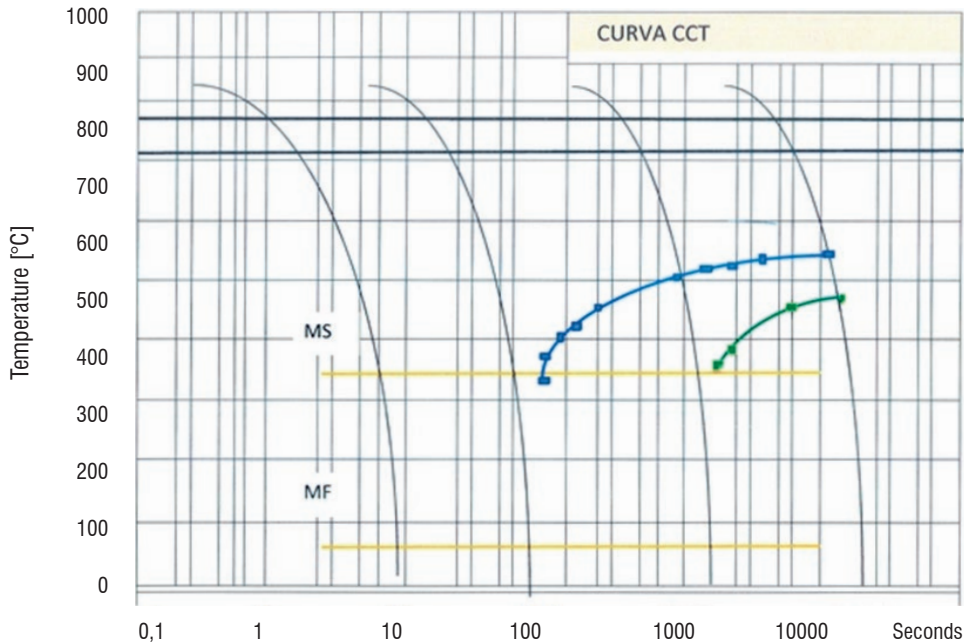
Thanks to the Carbon Equivalent content lower than the other grades traditionally normally used for plastic moulding, KeyLos® 2738MHH get better weldability and lower risk of cracking during welding repair on finish piece.



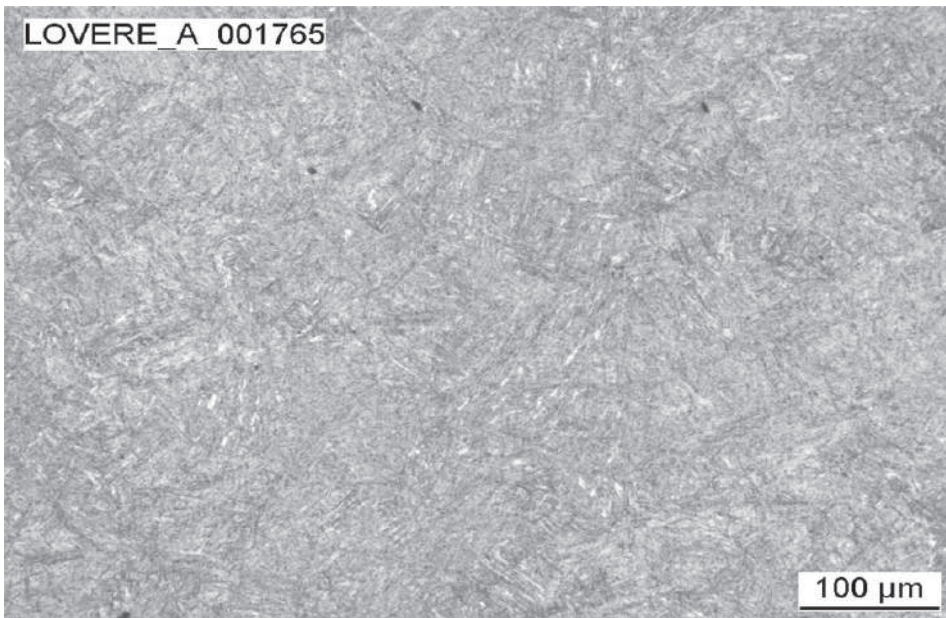
Comparison of impact values among KeyLos® 2738MHH, KeyLos® 2738 and KeyLos® 2311 with same hardness, at 20 °C temperature.



CCT Curve



Annealed microstructure of KeyLos[®] 2738MHH



The microstructure of KeyLos[®] 2738MHH detected about 20 mm under surface is tempered martensite.

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.

Lucchini RS Mould steel Family for plastics Industry																			
Special features and delivered conditions	Pre-hardened Not Corrosion Resistant Mould Steel Grades																		
	KEYLOS												ESKYLOS				BEYLOS		
	1730	1730 M	7225	ON	2312	2311	UP	2738 MSH	2738	PLUS	2738 MHH	2002	6959	2002	6959	2340	2365 M	2711	2714
HB in surface in Annealed condition	/	/	/	/	/	/	/	/	/	/	/	< 220	/	< 220	< 220	< 220	< 250	< 250	
HB in surface Pre-hardened	≤ 200	≤ 210	220-270	280-330	280-330	280-330	280-330	290-340	300-350	320-360	360-400	370-410	360-400	370-410	400-450	400-450	370-410	370-410	
Maximum thickness [mm]	300	300	500	500	600	600	800	800	1.000	800	1.200	1.200	500	500	500	500	500	700	
Hardness and Wear Resistance	1	1	1	2	2	2	2	3	2	3	3	3	3	3	4	4	3	3	
Degree of Through Hardening in the section	1	1	1	1	2	2	3	3	3	3	4	4	4	4	4	3	3	3	
Toughness	1	1	2	2	1	3	3	3	2	3	3	3	4	3	4	3	2	4	4
Machinability after Annealing	/	/	/	/	/	/	/	/	/	/	/	/	3	/	3	3	3	3	3
Machinability after Hardening	3	3	2	1	4	2	2	2	2	2	2	2	1	2	1	1	1	1	1
Etch-Grainability	1	1	1	2	0	3	3	3	3	3	3	3	2	4	4	4	4	2	2
Polishability	2	2	2	2	0	3	3	3	3	3	3	3	2	4	4	4	4	3	3
Repair by Welding	1	1	1	0	0	1	1	2	1	2	2	2	1	2	1	1	1	1	1
Thermal Conductivity	3	3	2	2	2	2	2	3	2	3	3	3	2	3	2	1	1	2	2
Corrosion Resistance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4 Excellent 3 Very Good 2 Good 1 Normal 0 Unsuitable

The herewith attached data are average values.

The advised applications and the quick comparison guide among the different grades are for information only and have got just the purpose to offer to the reader an evaluation tool.

They have not to be considered as warranty, either express or implied.

Guidance for machining

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

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 comparison between hardness and ultimate tensile strength values.

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

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

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 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.

Electrical Discharge Machining (EDM)

KeyLos[®] 2738MHH can be machined by EDM to obtain complex shape.

Afterwards we advise to carry out the stress relieving procedure.

Chrome Plating

KeyLos[®] 2738MHH 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, we advise to carry out heat treatment at 200°C for about 4 hours.

Photo-engraving

Thanks to the current production processes and to the low Sulphur content, KeyLos[®] 2738MHH is suitable for photo-engraving to obtain various patterns.

Polishing

KeyLos[®] 2738MHH is particularly suitable for polishing.