

KEYLOS[®] 1730

Basic Carbon
steel for small
plastic moulds
and prototypes for
dies industry



General characteristics

KeyLos®1730 is a Carbon steel basically designed for the manufacture of small sized dies, bolsters or press component prototypes for dies industry.

KeyLos®1730 represents a good balance of:

- mechanical characteristics;
- high machinability and polishability;
- high micro-purity.

KeyLos®1730 has been designed for prototype tooling cost reduction; in fact, shorter mould making and cycling times can be obtained, thanks to its very good machinability and its high thermal conductivity.

This steel grade is obtained through a special 'super clean' manufacturing process, which allows a high level of microcleanness to be achieved.

KeyLos®1730 is supplied in the normalised condition with surface hardness up to 200 HB.

High levels of machinability and microstructural homogeneity are obtained thanks to a Calcium treatment process on the liquid steel and a careful heat treatment process.

KeyLos®1730 is the basic solution for the production of small plastic moulds and prototypes for die industry in Carbon steel with thickness up to 300 mm.

KeyLos®1730 offers the following advantages:

- excellent machinability;
- excellent suitability for photo-engraving;
- excellent suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance in surface;
- good wear resistance, due to the pearlitic structure, if we consider that the hardness values are around 200 HB;
- optimised manufacturing cycle: from steel block to mould, with no need for intermediate treatments;
- quite good weldability, in case of extreme repairing.

KeyLos®1730 is 100% ultrasonically inspected, according to the most demanding of NDT standards.

KeyLos®1730 is also designed with the aim to guarantee the minimum use of virgin materials, moving toward the use of scrap categories difficult to recycle for standard grades, that can become food for the steel making production of KeyLos®1730.

Chemical analysis

| KEYLOS® 1730 | Alloying [% in weight] |
|---------------------|-----------------------------------|
| C [%] | 0,40 ÷ 0,50 |
| Si [%] | 0,15 ÷ 0,40 |
| Mn [%] | 0,60 ÷ 1,00 |

Table for comparison of international classification

W. Nr. **1.1730**

DIN **C45W**

AISI **1.045**

Lucchini RS's tool steels have been researched and formulated in order to optimize the material performances.

The brand name identifies the Lucchini RS product and the number evokes the Werkstoff classification or other means of reflecting the characteristics of use.

Main applications

KeyLos®1730 in the pre-hardened condition is suitable for the following applications.

Plastic moulding:

- small sized moulds for the automotive industry;
- moulds for food industry products;
- moulds for rubber pressing;
- pressure moulds (SMC, BMC);
- bolsters for plastic moulds.

Physical and mechanical properties

Main physical properties

| KEYLOS[®] 1730 | 20°C | 250°C | 500°C |
|---|------|-------|-------|
| Modulus of elasticity [GPa] (1GPa=1000 MPa) | 210 | 196 | 177 |
| Coefficient of thermal expansion [10⁻⁶/K] | - | 12,6 | 14,4 |

Main mechanical properties

| KEYLOS[®] 1730 | 20°C |
|--|------|
| Ultimate tensile strength (UTS) [MPa] | 650 |
| Yield stress (YS) [MPa] | 560 |

These values are average values obtained from the middle of the section of a 300 mm thick bar, subjected to Lucchini RS heat treatment.

Heat treatment

KeyLos[®]1730 is supplied in the normalised-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.

Stress Relieving

| | |
|------------------------------|--|
| Suggested temperature | 400 °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.

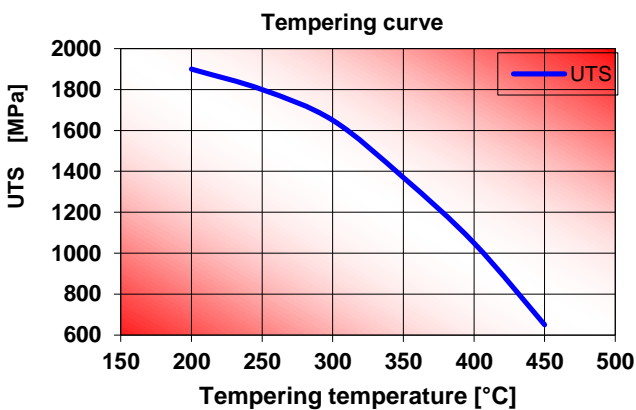
Hardening

| | |
|------------------------------|------------------------------|
| Suggested temperature | 830 °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 830 °C.

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

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.

Induction hardening

On this steel it is possible to carry out induction hardening. We recommend cooling at room temperature and tempering after heat treatment.

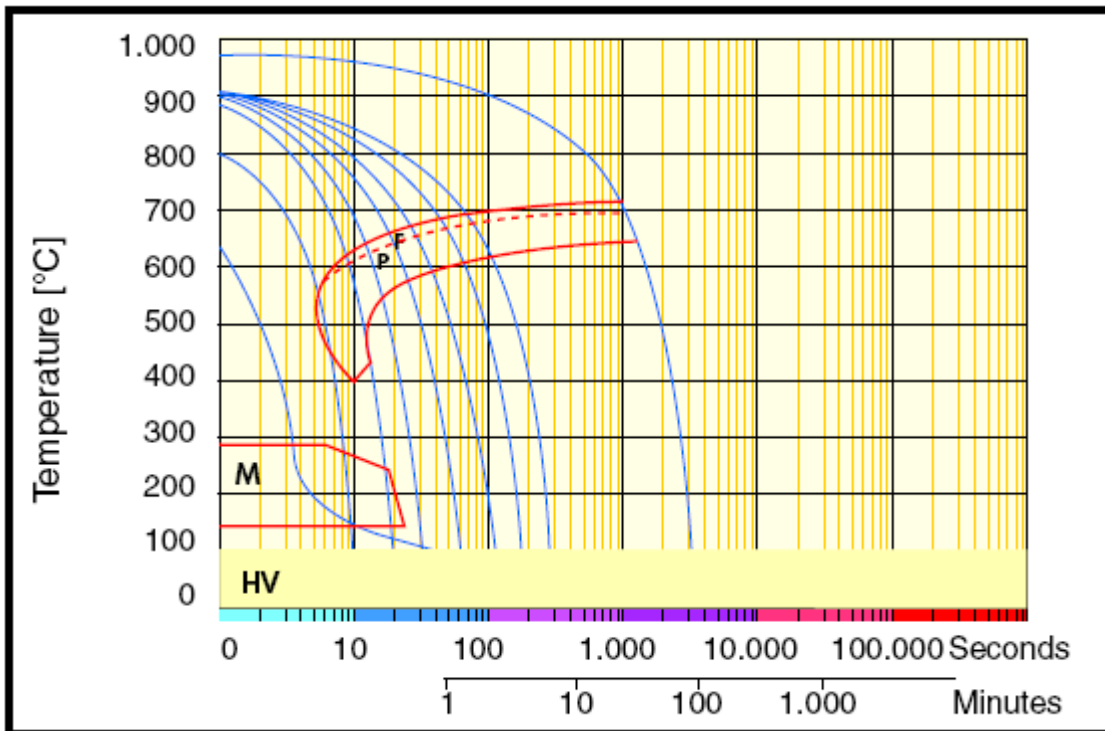
Nitriding

KeyLos® 1730 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.

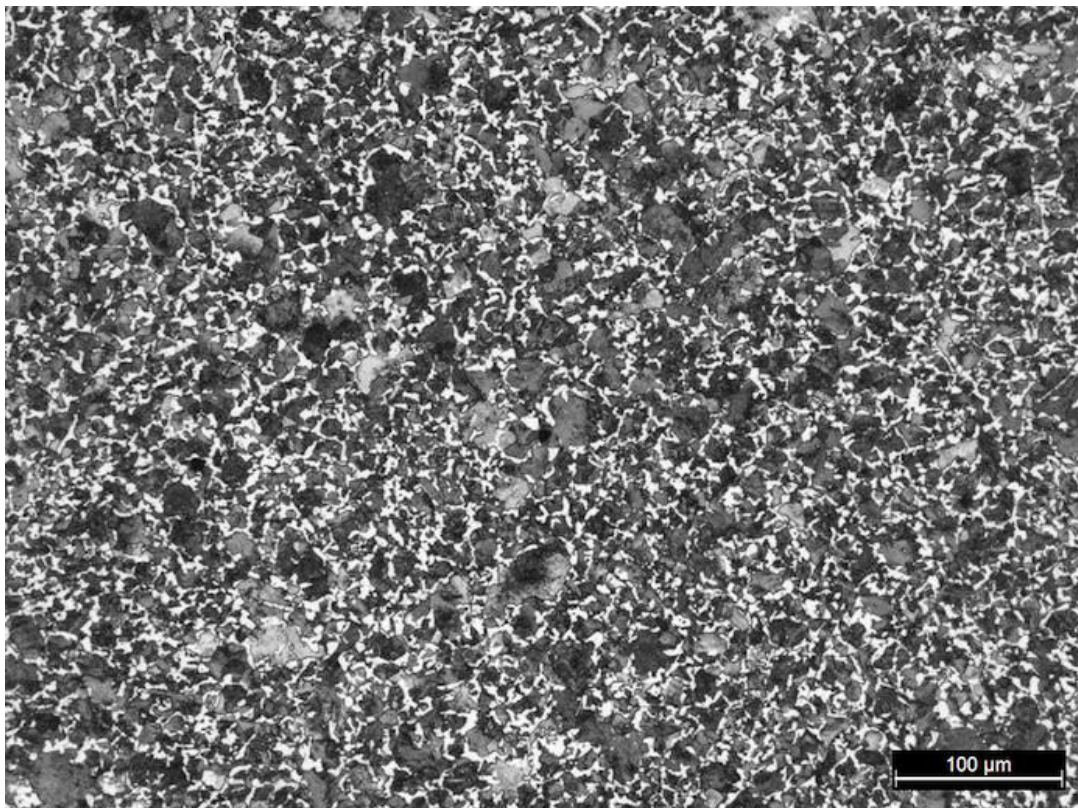
We recommend the following manufacturing cycle, in order to obtain the best results:

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

CCT Curve



Microstructure of KEYLOS® 1730



The microstructure of KeyLos®1730 as delivered by Lucchini RS, detected about 20 mm under surface, consists of a fine lamellar pearlite and ferrite.

Quick comparison guide among the different grades

The following table shows a quick comparison among the most important characteristics of the pre-hardened grades normally applied in plastic moulding.

| | |
|-----------|---|
| Excellent | 4 |
|-----------|---|

| | |
|------------|---|
| Very Good | 3 |
| Good | 2 |
| Normal | 1 |
| Unsuitable | 0 |

| 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 | 1730M | 7225 | ON | 2312 | 2311 | UP | 2738MSH | 2738 | PLUS | 2738MH | 2002 | 6959 | 2002 | 6959 | 2340 | 2365M | 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 | 1.000 | 800 | 1.200 | 1.200 | 500 | 500 | 500 | 500 | 500 | 500 | 700 | |
| Hardness and Wear Resistance | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 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 | 3 | 3 | 3 | 3 | |
| Toughness | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 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 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | |
| Etch-Grainability | 1 | 1 | 1 | 2 | 0 | 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 | 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 | |
| Thermal Conductivity | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 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 | |
| 4 Excellent 3 Very Good 2 Good 1 Normal 0 Unsuitable | | | | | | | | | | | | | | | | | | | |

The information and the data presented here are typical or average values and are not a guarantee of maximum or minimum values.

Applications specifically suggested for materials described herein and in the quick comparison guide among the different grades are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

Guidance for machining

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

Turning

| KEYLOS 1730 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

| KEYLOS 1730 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 | (*) |

| KEYLOS 1730 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 | (*) |

| KEYLOS 1730 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 |

Drilling

| KEYLOS 1730 | | | |
|-------------------------------|----------------------------------|-----|-------------|
| Type of insert | tip with interchangeable inserts | HSS | brazed tip |
| V_c cutting speed [m/min] | 130 ÷ 160 | (*) | 90 ÷ 120 |
| f_n feed per turn [mm/turn] | 0,05 ÷ 0,15 | (*) | 0,15 ÷ 0,25 |

(*) not advisable

General formulae

| KEYLOS 1730 | | |
|----------------------------------|---|--|
| Type of machining | Drilling | Milling |
| n : number of turns of mandrel | $\frac{V_c * 1000}{\pi * D_c}$ | $\frac{V_c * 1000}{\pi * D_c}$ |
| V_f : feed speed [m/min] | $V_f = f_z * n$ | $V_f = f_z * n * z_n$ |
| f_n : feed per turn [mm/turn] | - | $f_n = \frac{V_f}{n}$ |
| 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®1730 can give good results if this 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®1730 can be machined by EDM to obtain complex shape.

Afterwards it is advisable to stress relieving the material.

Photo-engraving

Thanks to modern production processes and to the low Sulphur content, KeyLos®1730 is suitable for photo-engraving to obtain various patterns.

Polishing

KeyLos®1730 is particularly suitable for polishing.



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