# POLMAX

## UDDEHOLM POLMAX

ASSAB

| ASSAB | UDDEHOLM a voestalpine company | REFERENCE STANDARD | | |
|---|---|---|---|---|
| | | AISI | WNr. | JIS |
| ASSAB XW-42 | SVERKER 21 | D2 | 1.2379 | (SKD 11) |
| CALMAX / CARMO | CALMAX / CARMO | | 1.2358 | |
| VIKING | VIKING / CHIPPER | | (1.2631) | |
| CALDIE | CALDIE | | | |
| ASSAB 88 | SLEIPNER | | | |
| ASSAB PM 23 SUPERCLEAN | VANADIS 23 SUPERCLEAN | (M3:2) | 1.3395 | (SKH 53) |
| ASSAB PM 30 SUPERCLEAN | VANADIS 30 SUPERCLEAN | (M3:2 + Co) | 1.3294 | SKH 40 |
| ASSAB PM 60 SUPERCLEAN | VANADIS 60 SUPERCLEAN | | (1.3292) | |
| VANADIS 4 EXTRA SUPERCLEAN | VANADIS 4 EXTRA SUPERCLEAN | | | |
| VANADIS 8 SUPERCLEAN | VANADIS 8 SUPERCLEAN | | | |
| VANCRON SUPERCLEAN | VANCRON SUPERCLEAN | | | |
| ELMAX SUPERCLEAN | ELMAX SUPERCLEAN | | | |
| VANAX SUPERCLEAN | VANAX SUPERCLEAN | | | |
| ASSAB 618 / 618 HH | | (P20) | 1.2738 | |
| ASSAB 718 SUPREME / 718 HH | IMPAX SUPREME / IMPAX HH | (P20) | 1.2738 | |
| NIMAX / NIMAX ESR | NIMAX / NIMAX ESR | | | |
| VIDAR 1 ESR | VIDAR 1 ESR | H11 | 1.2343 | SKD 6 |
| UNIMAX | UNIMAX | | | |
| CORRAX | CORRAX | | | |
| ASSAB 2083 | | 420 | 1.2083 | SUS 420J2 |
| STAVAX ESR | STAVAX ESR | (420) | (1.2083) | (SUS 420J2) |
| MIRRAX ESR | MIRRAX ESR | (420) | | |
| MIRRAX 40 | MIRRAX 40 | (420) | | |
| TYRAX ESR | TYRAX ESR | | | |
| POLMAX | POLMAX | (420) | (1.2083) | (SUS 420J2) |
| ROYALLOY | ROYALLOY | (420 F) | | |
| COOLMOULD | COOLMOULD | | | |
| ASSAB 2714 | | | 1.2714 | SKT 4 |
| ASSAB 2344 | | H13 | 1.2344 | SKD 61 |
| ASSAB 8407 2M | ORVAR 2M | H13 | 1.2344 | SKD 61 |
| ASSAB 8407 SUPREME | ORVAR SUPREME | H13 Premium | 1.2344 | SKD 61 |
| DIEVAR | DIEVAR | | | |
| QRO 90 SUPREME | QRO 90 SUPREME | | | |
| FORMVAR | FORMVAR | | | |

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( ) - modified grade

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Edition 20230725

# GENERAL

The rapid development in the high tech area is putting higher and higher demands on the tool steel. Surface finishes, which have not been possible to achieve with ordinary tool steel, are required. For these extreme requirement Polmax is the right choice. For Polmax, methods like ESR (Electro Slag Remelting) and VAR (Vacuum Arc Remelting) are used in order to reduce inclusion levels to minimum amounts.
Characteristics found in Polmax:

- Excellent polishability
- Good corrosion resistance
- Good wear resistance
- Good machinability
- Good stability in hardening

| | | | | | |
|---|---|---|---|---|---|
| Typical analysis % | C<br>0.38 | Si<br>0.9 | Mn<br>0.5 | Cr<br>13.6 | V<br>0.3 |
| Delivery condition | Soft annealed to approx. 200 HB | | | | |

# APPLICATIONS

Examples on applications where extreme surface finishes are required:

- Lens moulds
- Moulds for medical applications
- Moulds for optical applications
- Moulds for analysis phials

# PROPERTIES

## PHYSICAL PROPERTIES

Hardened and tempered to 52 HRC. Data at room and elevated temperatures.

| Temperature | 20 °C | 200 °C | 400 °C |
|---|---|---|---|
| Density kg/m$^3$ | 7 800 | 7 750 | 7 700 |
| Modulus of elasticity MPa | 200 000 | 190 000 | 180 000 |
| Coefficient of thermal expansion /°C from 20 °C | - | 11.0 x 10$^{-6}$ | 11.4 x 10$^{-6}$ |
| Thermal conductivity W/m°C | 16 | 20 | 24 |
| Specific heat J/kg°C | 460 | - | - |

## STRENGTH OF MATERIAL

The strength vlaues are to be considered as approximate. The test samples have been hardened in oil from 1025°C and tempered twice to 52 HRC.

| | |
|---|---|
| Tensile strength, Rm, N/mm$^2$ | 2 050 |
| Yield point, Rp0.2, N/mm$^2$ | 1 610 |

## CORROSION RESISTANCE

Polmax is resistant to corrosive attack by water, water vapour, weak organic acids, dilute solutions of nitrates, carbonates and other salts.
A tool made from Polmax will have good resistance to rusting and staining due to humid working and storage conditions and when moulding corrosive plastics under normal production conditions.
Polmax shows the best corrosion resistance when tempered at 250°C and polished to a mirror finish.

# HEAT TREATMENT

## SOFT ANNEALING

Protect the steel and heat through to 890 °C. Then cool in furnace at 20°C per hour to 850 °C, then at 10°C per hour to 700°C, then freely in air.

## STRESS RELIEVING

After rough machining the tool should be heated through to 650 °C, holding time 2 hours. Cool slowly to 500 °C, then freely in air.

## HARDENING

Preheating temperature: 600 – 850°C.

Austenitising temperature : 1000 – 1500°C but usually 1020 - 1030°C

| Temperature, °C | Soaking time * minutes | Hardness before tempering, HRC |
|---|---|---|
| 1 020 | 30 | 56 ± 2 |
| 1 050 | 30 | 57 ± 2 |

* Soaking time = time at hardening temperature after the tool is fully heated through

Protect the part against decarburisation and oxidation during hardening.

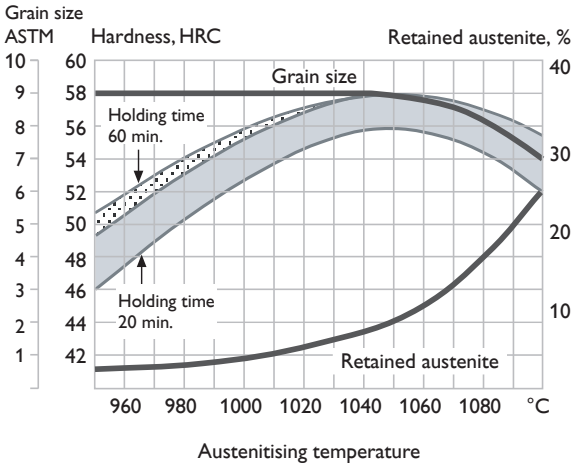
## QUENCHING

### QUENCHING MEDIA

- Fluidised bed or salt bath at 250-550 °C then cool in air blast
- Vacuum with sufficient positive pressure
- High speed gas/circulating atmosphere

In order to obtain optimum properties, the cooling rate should be as fast as is concomitant with acceptable distortion. When heat treating in a vacuum furnace, a 4-5 bar overpressure is recommended. Temper immediately when the tool reaches 50-70 °C.

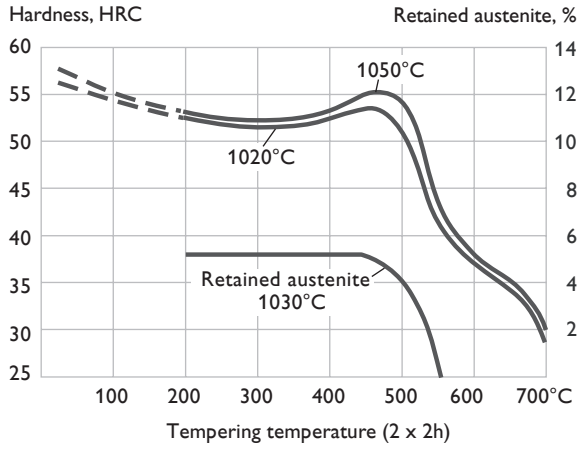
### HARDNESS, GRAIN SIZE AND RETAINED AUSTENITE AS FUNCTIONS OF AUSTENITISING TEMPERATURE




## TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph.

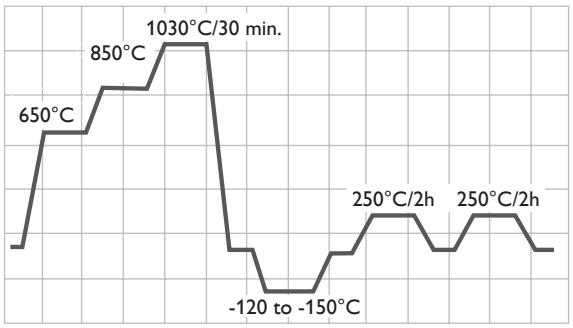
Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 180°C. Holding time at temperature minimum 2 hours.




Note that:

- Tempering at 250°C is recommended for the best combination of toughness, hardness and corrosion resistance.
- Above curves are valid for small samples, achieved hardness depends on mould size
- A combination of high austenitising temperature and low tempering temperature <250°C gives a high stress level in the mould and should be avoided.

For maximum hardness and best combination of toughess, corrosion resistance and dimension stability during use, following heat treatment cycle is recommended.

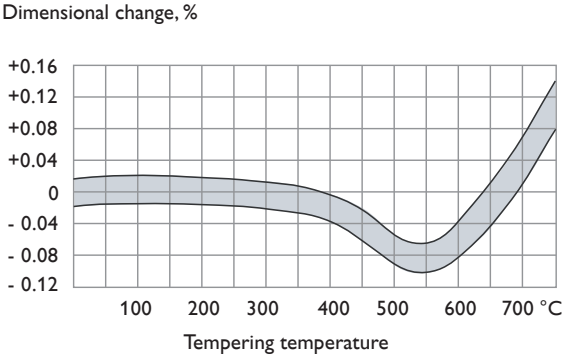



Subzero cooling is only required when demands on dimension stability during use are very high. Received hardness: 52-54 HRC.

## DIMENSIONAL CHANGES

The dimensional changes during hardening and tempering vary depending on temperatures, type of equipment and cooling media used during heat treatment.

The size and geometric share of the tool is also of essential importance. Thus, the tool shall always be manufactured with enough working allowance to compensate for dimensional changes. Use 0.15% as a guideline for Polmax provided that a stress relief is performed between rough and semi-finished machining as recommended.



### DURING HARDENING

An example of dimensional changes on a plate, hardened under ideal conditions 100 x 100 x 25 mm is shown below.

| Hardening from 1020°C | | Width % | Length % | Thickness % |
|---|---|---|---|---|
| Martempered | Min.<br>Max. | +0.02<br>-0.03 | ±0<br>+0.03 | -0.04<br>- |
| Air hardened | Min.<br>Max. | -0.02<br>+0.02 | ±0<br>-0.03 | ±0<br>- |
| Vacuum hardened | Min.<br>Max. | +0.01<br>-0.02 | ±0<br>+0.01 | -0.04<br>- |

Note: Dimensional changes during hardening and tempering should be added together.

# MACHINING RECOMMENDATIONS

## TURNING

| Cutting data parameters | Turning with carbide | | Turning with High speed steel Fine turning |
|---|---|---|---|
| | Rough turning | Fine turning | |
| Cutting speed ($v_C$), m/min | 160 – 210 | 210 – 260 | 18 - 23 |
| Feed (f) mm/rev | 0.2 – 0.4 | 0.05 – 0.2 | 0.05 -0.3 |
| Depth of cut ($a_p$) mm | 2 – 4 | 0.5 – 2 | 0.5 - 3 |
| Carbide designation ISO | P20 - P30 Coated carbide | P10 Coated carbide or cermet | - |

## DRILLING

### HIGH SPEED STEEL TWIST DRILL

| Drill diameter mm | Cutting speed ($v_C$) m/min | Feed (f) mm/r |
|---|---|---|
| ≤ 5 | 12 – 14 * | 0.05 – 0.10 |
| 5 – 10 | 12 – 14 * | 0.10 – 0.20 |
| 10 – 15 | 12 – 14 * | 0.20 – 0.30 |
| 15 – 20 | 12 – 14 * | 0.30 – 0.35 |

* For coated HSS drill $v_c$ = 20 - 22 m/min.

### CARBIDE DRILL

| Cutting data parameters | Type of drill | | |
|---|---|---|---|
| | Indexable insert | Solid carbide | Carbide tip [1] |
| Cutting speed ($v_C$), m/min | 210 – 230 | 80 – 100 | 70 – 80 |
| Feed (f) mm/r | 0.05 – 0.15 [2] | 0.08 – 0.20 [3] | 0.15 – 0.25 [4] |

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20 – 40 mm
[3] Feed rate for drill diameter 5 – 20 mm
[4] Feed rate for drill diameter 10 – 20 mm

## MILLING

### FACE AND SQUARE SHOULDER MILLING

| Cutting data parameters | Milling with carbide | |
|---|---|---|
| | Rough milling | Fine milling |
| Cutting speed ($v_C$) m/min | 180 – 260 | 260 – 300 |
| Feed ($f_z$) mm/tooth | 0.2 – 0.4 | 0.1 – 0.2 |
| Depth of cut ($a_p$) mm | 2 – 4 | 0.5 - 2 |
| Carbide designation ISO | P20 – P40 Coated carbide | P10 - P20 Coated carbide or cermet |

### END MILLING

| Cutting data parameters | Type of milling | | |
|---|---|---|---|
| | Solid carbide | Carbide indexable insert | High speed steel |
| Cutting speed ($v_C$), m/min | 120 – 150 | 170 – 230 | 25 – 30 [1] |
| Feed ($f_z$) mm/tooth | 0.01 – 0.20 [2] | 0.06 – 0.20 [2] | 0.01 – 0.30 [2] |
| Carbide designation ISO | – | P20 – P30 | – |

[1] For coated HSS end mill, vc ~ 45 – 50 m/min
[2] Depending on radial depth of cut and cutter diameter

## GRINDING

### WHEEL RECOMMENDATION

| Type of grinding | Soft annealed | Hardened |
|---|---|---|
| Face grinding straight wheel | A 46 HV | A 46 HV |
| Face grinding segments | A 24 GV | A 36 GV |
| Cylindrical grinding | A 46 LV | A 60 KV |
| Internal grinding | A 46 JV | A 60 IV |
| Profile grinding | A 100 LV | A 120KV |

# POLISHING

Polmax has extremely good polishability in the hardened and tempered condition.

A slightly different technique is needed when polishing corrosion resistant tool steel compared with conventional tool steel. The main principle is to use smaller steps at the fine grinding/polishing stages and try to grind to as fine surface as possible before starting the polishing operation. It is also important to stop the polishing operation immediately the last scratch from the former grain size has been removed.

### PRACTICAL HINTS

- Polishing should be carried out in dust and draught free places. Hard dust particles can easily contaminate the abrasive and ruin an almost finished surface.
- Each polishing tool should be used for only one paste grade and kept in dust-proof container.
- The polishing tools gradually become "impregnated" and improve with use.
- Hands and work piece should be cleaned carefully between each change of paste grade, the work-piece with a grease solvent and the hands with soap.
- Paste should be applied to the polishing tool in manual polishing, while in machine polishing, the paste should be applied to the work-piece.
- The finer the grain size, the less thinning liquid
- Polishing pressure should be adjusted to the hardness of the polishing tool and the grade of the paste. For the finest grain sizes, the pressure should only be the weight of the polishing tool.
- Heavy material removal requires hard polishing tools and coarse paste.
- Finish polishing of plastic moulds should be carried out in the release direction.
- Polishing should start in the corners, edges and fillets or the difficult parts of the mould.
- Be careful with sharp corners and edges, so they are not rounded off. Preferably use hard polishing tools.

Cleanliness in every step of the polishing operation is of such great importance that it can not be over emphasized.

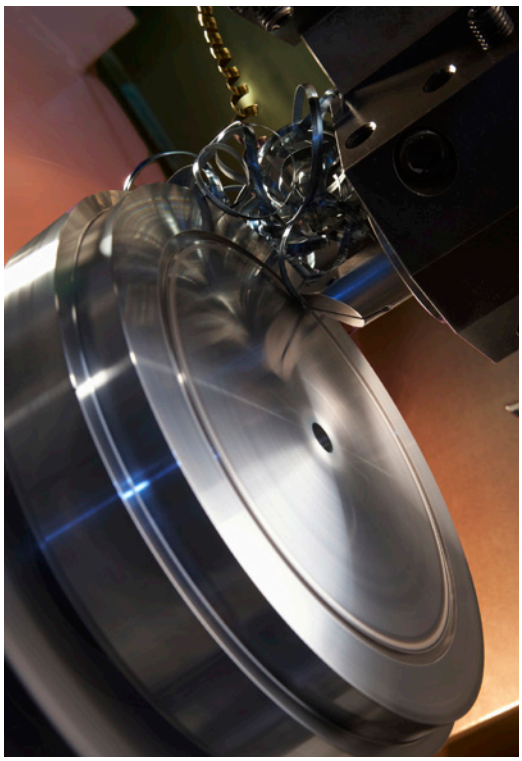
# PHOTO-ETCHING

Polmax has a very low content of slag inclusions, making it suitable for photo-etching.
The special photo-etching process that might be necessary because of Polmax's good corrosion resistance is familiar to all the leading photo-etching companies.

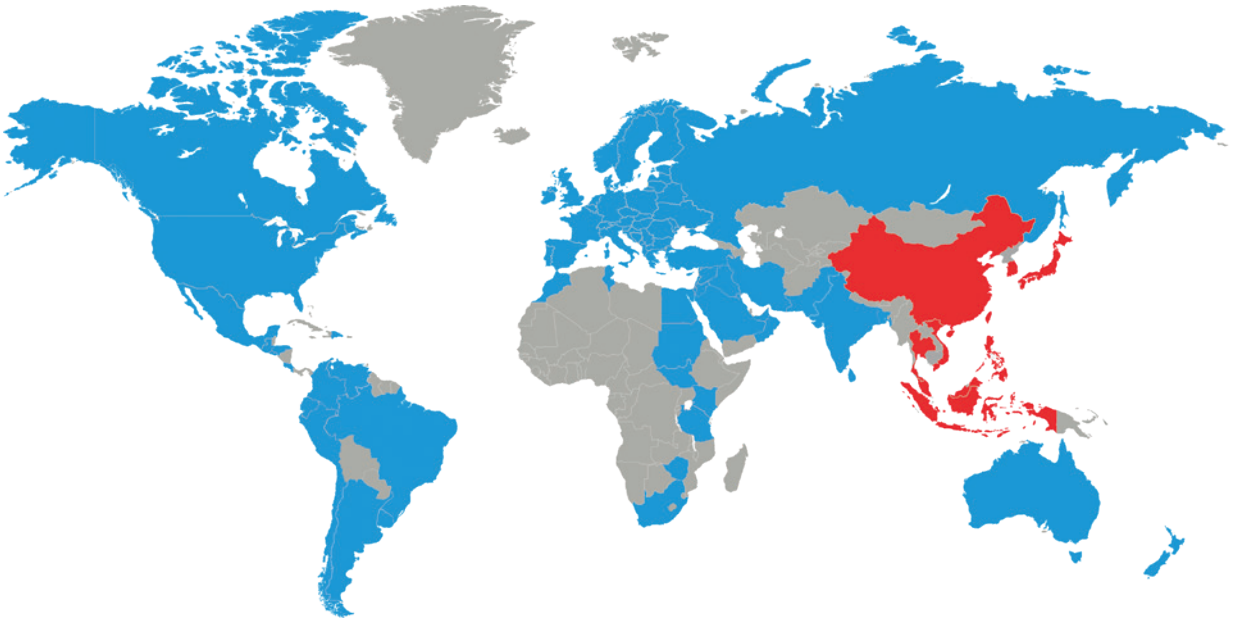
# FURTHER INFORMATION

Please contact your local ASSAB office for further information on the selection, heat treatment, application and availability of ASSAB tool steel.

# ASSAB
## SUPERIOR TOOLING SOLUTIONS
# A ONE-STOP SHOP




ASSAB is a one-stop product and service provider that offers superior tooling solutions. In addition to the supply of tool steel and other special steel, our range of comprehensive value-added services, such as machining, heat treatment and coating services, span the entire supply chain to ensure convenience, accountability and optimal usage of steel for customers. We are committed to achieving solutions for our customers, with a constant eye on time-to-market and total tooling economy.



Choosing the right steel is of vital importance. ASSAB engineers and metallurgists are always ready to assist you in your choice of the optimum steel grade and the most suitable treatment for each application. ASSAB not only supplies steel products with superior quality, but we also offer state-of-the-art machining, heat treatment, surface treatment services and additive manufacturing (3D printing) to enhance your tooling performance while meeting your requirements in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

In Asia Pacific, ASSAB anchors the distribution network for Uddeholm, a Swedish tool steel manufacturer with more than 350 years of experience in the tool steel industry. The two companies together service leading multinational companies (MNCs) in more than 90 countries.

For more information, please visit
www.assab.com

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