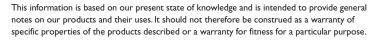
PRELIMINARY BROCHURE

UDDEHOLM CORRAX®

MS AUTOMOTIVE A NEW WAY OF THINKING HIGH PERFORMANCE DUCTILITY CUSTOMER BENEFITS TOUGHNESS STRENGT DAY NETWORK OF EXELLENCE LONG LASTING TOOLS TOTAL ECONOMY THE WORLD'S LEADING SUPPLIER OF TOOLING MAT A NEW WAY OF THINKING HIGH PERFORMANCE DUCTILITY TOUGHNESS STRENGTH INNOVATION KNOWLEDGE UNDERST DING SUPPLIER OF TOOLING MATERIALS PARTNERSHIP HARDNESS WORLDWIDE NETWORK OF EXELLENCE PRESENCE LONG ESS_STRENGTH_INNOVATION_KNOWLEDGE_UNDERSTANDING_MACHINABILITY TRUST IS SOMETHING YOU EARN, EVERY DAY HIP HARDNESS WORLDWIDE PRESENCE GLOBAL COMMITMENT LONG DURABILITY RELIABILITY RESULTS SOLVING F RSTANDING MACHINABILITY TRUST IS SOMETHING YOU EARN, EVERY DAY LONG LASTING TOOLS TOTAL ECONOMY K OF EXELLENCE LONG LASTING TOOLS TOTAL ECONOMY THE WORLD'S LEADING SUPPLIER OF TOOLING MATERIAL ENGTH INNOVATION GLOBAL COMMITMENT KNOWLEDGE UNDERSTANDING MACHINABILITY TRUST IS SOMETHING CHINABILITY **TRUST IS SOMETHING YOU EARN, EVERY DAY** LONG LASTING TOOLS TOTAL ECONOMY CUSTOMER BENEFIT







General

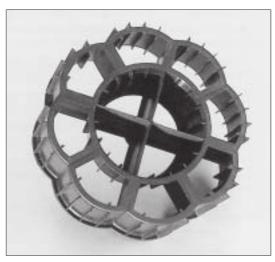
Compared with conventional corrosion resistant tool steel, Uddeholm Corrax has the following advantages:

- Flexible hardness, 34–50 HRC, achieved by an ageing treatment in the temperature range 425–600°C (790–1110°F)
- Extremely good dimensional stability during the ageing
- High uniformity of properties also for large dimensions
- Very good weldability, no preheating necessary
- No hard "white" layer after EDM
- Corrosion resistance superior to that of AISI 420 and W.-Nr. 1.2083

| Typical analysis % | C 0,03 | Si 0,3 | Mn 0,3 | Cr 12,0 | Ni 9,2 | Mo 1,4 | AI 1,6 |
|--------------------|-----------------------------|-----------|-----------|------------|-----------|-----------|-----------|
| Delivery condition | Solution treated to ~34 HRC | | | | | | |
| Colour code | Blac | :k/grey | | | | | |

Applications

- Injection moulds for
 - corrosive plastics
 - rubber
 - medical and food industry
- Extrusion dies
- Plastic processing
 - screws
- Engineering parts



Uddeholm Corrax is a very suitable mould steel for plastic parts with complicated design.

Properties

Physical data

Aged to approx. 46 HRC.

| Temperature | 20°C (68°F) | 200°C (390°F) | 400°C (750°F) |
|---|---------------------------------|---|---|
| Density kg/m³ lbs/in³ | 7 700 0,28 | _ _ | <u>-</u> |
| Modulus of elasticity N/mm² psi | 200 000 29 x 10 ⁶ | 190 000 28 x 10 ⁶ | 170 000 25 x 10 ⁶ |
| Coefficient of thermal expansion per°C from 20°C per°F from 68°F | _ _ | 11,7 x 10 ⁻⁶ 6,5 x 10 ⁻⁶ | 12,3 × 10 ⁻⁶ 6,8 × 10 ⁻⁶ |
| Thermal conductivity W/m °C Btu in/ft² h °F | _ _ | 18 125 | 21 146 |

Mechanical data

Tensile strength at room temperature.

| | Solution treated ~34 HRC | Aged to ~40 HRC | Aged to ~46 HRC | Aged to ~50 HRC |
|---|--------------------------------|------------------|--------------------|--------------------|
| Yield strength Rp0,2 N/mm ² psi | 700 100 000 | 1 000 150 000 | 1 400 200 000 | 1 600 230 000 |
| Tensile strength R _m N/mm ² psi | 1 100 160 000 | 1 200 170 000 | 1 500 220 000 | 1 700 250 000 |

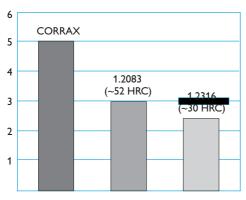
Compressive strength at room temperature.

| | Solution treated ~34 HRC | Aged to ~40 HRC | Aged to ~46 HRC | Aged to ~50 HRC |
|------------------------------------|--------------------------------|--------------------|------------------|--------------------|
| R _c 0,2 N/mm² psi | 900 130 000 | 1 300 190 000 | 1 600 230 000 | 1800 260 000 |

Corrosion resistance

Uddeholm Corrax has a very good corrosion resistance, better than the corrosion resistant standard grades used for plastic moulding. The corrosion resistance is the same in all heat treated conditions (except after nitriding).

Corrosion resistance



Uddeholm Corrax will withstand attacks from most corrosive plastics and diluted acids.

A mould made of Uddeholm Corrax will also have good resistance to humid working and storage conditions. Uddeholm Corrax also shows better resistance to stress corrosion cracking than standard hardenable corrosion resistant steel grades.

Heat treatment

Uddeholm Corrax is delivered in solution treated condition and can be used in the asdelivered condition. When, however, the steel is to be heat treated to a higher hardness, the following instructions may be helpful.

Stress relieving

Stress relieving can not be performed as for other steel grades since an increase in temperature results in a higher hardness because of ageing effect.

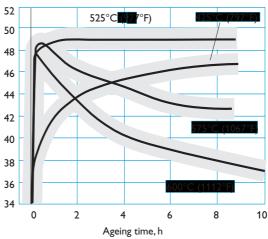
Ageing

Uddeholm Corrax can be used in as-delivered condition.

Higher hardness is obtained by ageing. Suitable ageing parameters can be obtained from

the figure below. Ageing time means the time at the ageing temperature after the tool is fully heated through.

Hardness, HRC



When the ageing time is reached, cool the tool in air to room temperature. Ageing at high temperature gives a better toughness compared with ageing to the same hardness at a lower temperature.

AGEING RECOMMENDATION

| Ageing temperature/time | Hardness |
|--|--------------------|
| 525°C/2 h (977°F/2 h)* 575°C/2 h (1067°F/2 h) | ~50 HRC ~46 HRC |
| 600°C/4 h (1112°F/4 h) | ~40 HRC |

^{*} Ageing to 50 HRC is only recommended when toughness is not important

If Uddeholm Corrax is used at temperatures higher than 200°C (390°F) the solution treated condition (delivery condition) is not recommended because ageing can occur during use.



Solution treatment

It is possible to solution treat Uddeholm Corrax, if aged, in order to get back to the delivery condition.

Solution treatment should be done at 850°C (1560°F), holding time 30 minutes. Cool in air.

Dimensional change

Ageing results in a small and uniform decrease in volume. The following shrinkage can be expected during ageing.

| Ageing | Dime Longi- tudinal direction | Trans- versal direction | nge % Short trans- versal direction |
|-----------------------------------|--|-------------------------------|---|
| 525°C/2 h (977°F/2 h) ~50 HRC | -0,07 | -0,07 | -0,07 |
| 575°C/2 h (1067°F/3 h) ~46 HRC | -0,09 | -0,09 | -0,09 |
| 600°C/4h (1112°F/4h) ~40 HRC | -0,14 | -0,14 | -0,14 |

Cutting data recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendations".

The recommendations, in the following tables, are valid for Uddeholm Corrax in solution treated condition approx. 34 HRC.

Turning

| Cutting data | Turning carb | • | Turning with high speed steel |
|---|---------------------------|---------------------------------------|-------------------------------------|
| parameters | Rough turning | Fine turning | Fine turning |
| Cutting speed (v _c) m/min f.p.m. | 110–160 360–525 | 160–210 525–690 | 13–18 43–59 |
| Feed (f) mm/r i.p.r. | 0,2–0,4 0,008–0,016 | 0,05–0,2 0,002–0,008 | 0,05–0,2 0,002–0,008 |
| Depth of cut (a _p) mm inch | 2–4 0,08–0,16 | 0,5–2 0,02–0,08 | 0,5–3 0,02–0,12 |
| Carbide designation ISO | P20-P40 Coated carbide | P10 Coated carbide or cermet | - |

Milling

FACE- AND SQUARE SHOULDER MILLING

| C. W. L. | Milling with carbide | | | |
|---|------------------------------|---|--|--|
| Cutting data parameters | Rough milling | Fine milling | | |
| Cutting speed (v _c) m/min f.p.m | 70–90 230–295 | 90–110 295–360 | | |
| Feed (f _z) mm/tooth inch/tooth | 0,2–0,4 0,008–0,016 | 0,1-0,2 0,004-0,008 | | |
| Depth of cut (a _p) mm inch | 2–5 0,08–0,20 | -2 -0,08 | | |
| Carbide designation ISO | P20–P40 Coated carbide | P10–P20 Coated carbide or cermet | | |

END MILLING

| | Type of milling | | | | |
|---|--|--|---|--|--|
| Cutting data parameters | Solid carbide | Carbide indexable insert | High speed steel | | |
| Cutting speed (v _c) m/min f.p.m. | 60–100 200–328 | 70–110 230–360 | 20–25¹) 66–82¹) | | |
| Feed (f _z) mm/tooth inch/tooth | 0,006-0,20 ²⁾ 0,0002-0,008 ²⁾ | 0,06-0,20 ²⁾ 0,002-0,008 ²⁾ | 0,01–0,35 ²⁾ 00004,–0,014 ²⁾ | | |
| Carbide designation ISO | K10, P40 | P20-P30 | - | | |

 $^{^{1)}}$ For coated HSS end mill $v_c = 35-45$ m/min. (115-148 f.p.m.)

Drilling

HIGH SPEED STEEL TWIST DRILL

| Drill diameter | | Cutting speed (v _c) | | Feed (f) | |
|-------------------------------|---|--------------------------------------|------------------|--|--|
| mm | inch | m/min | f.p.m. | mm/r | i.p.r. |
| - 5 5-10 10-15 15-20 | -3/16 3/16-3/8 3/8-5/8 5/8-3/4 | 13–15* 13–15* 13–15* 13–15* | 43–49* 43–49* | 0,05-0,10 0,10-0,20 0,20-0,25 0,25-0,30 | 0,002-0,004 0,004-0,008 0,008-0,010 0,010-0,012 |

^{*} The same cutting speed when using coated HSS drill $v_c = 13-15$ m/min. (43-49 f.p.m.)

CARBIDE DRILL

| | Type of drill | | | |
|--|--|---|---|--|
| Cutting data parameters | Indexable | Solid | Brazed | |
| | insert | carbide | carbide ¹⁾ | |
| Cutting speed (v _c) m/min f.p.m. | 180–200 | 100–130 | 50–70 | |
| | 590–656 | 328–427 | 164–230 | |
| Feed (f) mm/r i.p.r. | 0,05-0,15 ²⁾ 0,002-0,006 ²⁾ | 0,10-0,25 ²⁾ 0,004-0,01 ²⁾ | 0,15-0,25 ²⁾ 0,006-0,01 ²⁾ | |

¹⁾ Drill with internal cooling channels and brazed carbide tip

Grinding

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm publication "Grinding of Tool Steel".

WHEEL RECOMMENDATION

| Type of grinding | Delivery condition and aged condition |
|------------------------------|---------------------------------------|
| Face grinding straight wheel | A 46 GV |
| Face grinding segments | A 36 FV |
| Cylindrical grinding | A 60 JV |
| Internal grinding | A 60 IV |
| Profile grinding | A 120 JV |

When good surface finish is required a SiC-wheel could be an alternative.

EDM

Uddeholm Corrax can be EDM'd in the same way as ordinary tool steels. The "white layer" will, however, not be as hard and is therefore more easily removed.

Photo-etching

Uddeholm Corrax has a very good corrosion resistance and a special process is thus required for chemical photo-etching. Fine patterns with shallow depths <0,04 mm (0,002") are readily achievable.

Welding

Preheating is not necessary. When welding on Uddeholm Corrax in delivery condition, intermittant welding is recommended.

In order to obtain an even hardness, it is necessary to carry out a heat treatment after welding. The temperature and time are determined by the required hardness and the filler material. Corrax TIG-Weld is recommended to be used as filler material.

For further information, please contact your local Uddeholm office.

²⁾ Depending on radial depth of cut and cutter diameter

²⁾ Depending on drill diameter

Property comparison chart

| Uddeholm steel grade | Hardness HRC | Wear resistance | Corrosion resistance |
|-------------------------|-----------------|--------------------|----------------------|
| CORRAX | 34 | | |
| CORRAX | 50 | | |
| STAVAX SUPREME | 52 | | |
| STAVAX ESR | 52 | | |
| ELMAX | 58 | | |
| RAMAX 2 | 37 | | |
| IMPAX SUPREME | 32 | - | |

Further information

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

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