# CPM®Rex 20 Data Sheet
# Tooling Alloys

Zapp is Certified to ISO 9001

### Chemical Composition

| | |
|---|---|
| Carbon | 1.3 % |
| Chromium | 3.8 % |
| Vanadium | 2.0 % |
| Tungsten | 6.3 % |
| Molybdenum | 10.5 % |

### CPM® Rex 20

CPM® Rex 20 is a colbalt-free super high-speed steel produced by a powder metallurgical process. It has heat treat response and red hardness comparable to that of M42 but offers better wear resistance and greater toughness.

It was originally designed to replace M42 in any application where cobalt is undesirable.

Due to its unique combination of properties, CPM® Rex 20 is used in non-cutting applications such as bearings and in plasticizing components such as screw segments, barrels and non-return valves.

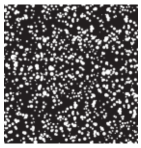
### Typical Applications

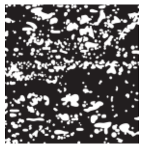
- Form tools
- Bearings
- Broaching tools
- Gear hobs
- Plastic tooling
- Spade Drills

### Physical Properties

| | |
|---|---|
| Modulus of elasticity E [GPa ] | 235 |
| Density [kg/dm³] | 8.17 |
| Coefficient of thermal expansion [mm/mm/K] over temperature range of | |
| 20 - 100 °C | 10,7 x 10 $^{-6}$ |
| 20 - 200 °C | 11,2 x 10 $^{-6}$ |
| 20 - 300 °C | 11,7 x 10 $^{-6}$ |
| 20 - 425 °C | 11,9 x 10 $^{-6}$ |
| 20 - 540 °C | 12,2 x 10 $^{-6}$ |
| 20 - 600 °C | 12,6 x 10 $^{-6}$ |

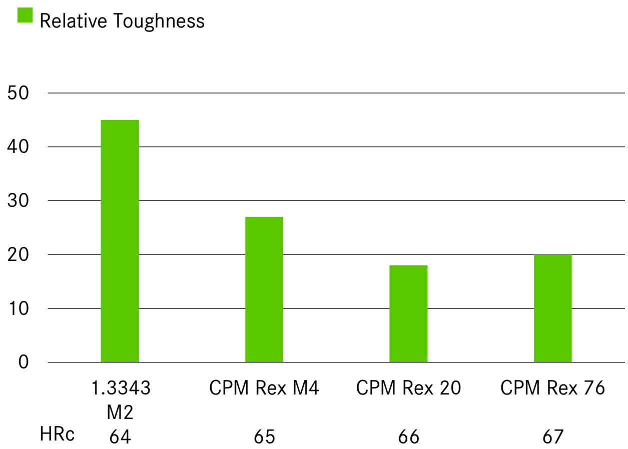
### Powder Metallurgical and Conventional Microstructure





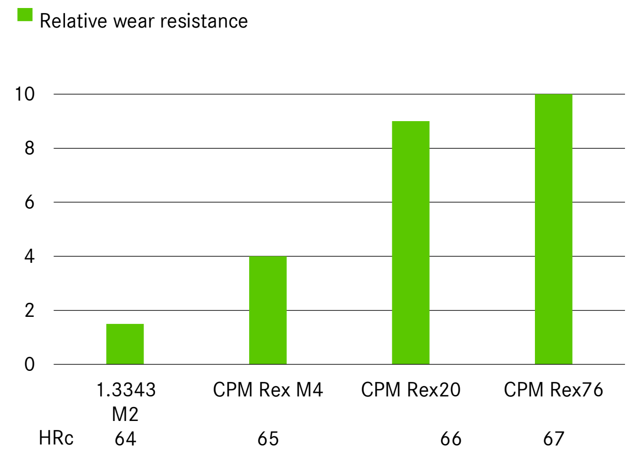
The uniform distribution of carbides in the powder- metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

### Toughness




Standard size of the Charpy-test-piece with a 12.7 mm notch radius.

### Wear Resistance



## Thermal Treatments

### Soft Annealing
CPM® Rex 20 is heated uniformly to a temperature of 870 °C and then maintained at this temperature for 2 hours. Then, the material is cooled to 540 °C in a furnace at a cooling rate of maximum 15 °C per hour.

It is then further cooled in still air down to room temperature. The typical hardness achieved by soft annealing is approximately 260 – 300 HB.

### Stress Relieving
Rough machined material is stress relieved by heating to 600 – 700 °C. Once complete heat penetration has been reached (minimum 2 hours), the material is allowed to cool in the furnace to approximately 500 °C followed by cooling in air.

Hardened material is stress relieved at 15 – 30°C for 2 hours below last tempering temperature followed by cooling in air.

### Straightening
Straightening should be done in the temperature range of 200 – 430 °C.

### Hardening
Hardening of usually involves the use of two preheating steps according to the table on the right. Depending on furnace and charging, additional preheating steps can be implemented.

Best combination of toughness and wear resistance is attained by tempering at 550 to 560 °C. In order to achieve a corresponding degree of dissolution of the alloying elements, as well as an appropriate hardening, minimum heat penetration times as given in the table are recommended.

These holding times should be correspondingly adapted for thick or thin-walled material cross sections.

### Quenching
Quenching can take place in hot bath at 540°C, oil or pressurized gas. Quenching in salt bath or oil leads to maximum hardness, whereas cooling in vacuum can lead to lower values of 1 – 2 HRc.

By use of vacuum quenching a minimum pressure of 6 bar is recommended. The appropriate pressure needs to be adjusted for complex tool shapes in order to minimize risk of cracking and tool distortion.

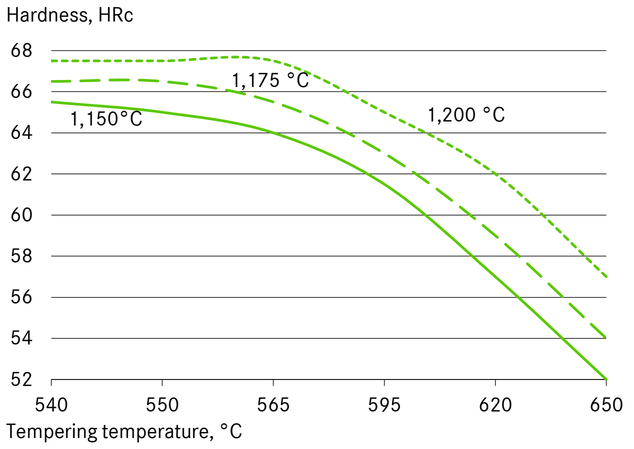
For attaining ideal toughness properties, it is recommended to apply the hot bath quenching method.

### Tempering
Tempering should be carried out immediately after the material has cooled down to below 40 °C or when the tool can be held with hands.

Triple tempering with a holding time of 2 hours in each stage at the tempering temperature is necessary. It is important to ensure that the tools are cooled down to room temperature between the individual tempering stages.

### Surface Treatments
CPM® Rex 20 is very suitable for PVD and CVD coatings. It is also possible to apply a nitriding layer.

**Tempering Diagram**




**Heat Treatment Instructions**

| | |
|---|---|
| 1st preheating | 450–500 °C |
| 2nd preheating | 850–900 °C |
| (3rd preheating) | 1,000-1,050 °C |
| Hardening | As specified in table |
| Tempering | 3 x each 2 hours as specified in table |

Quenching after hardening in hot bath at approx. 550°C or in vacuum at least at 5 bar overpressure.

| **Required hardness HRc ± 1** | **Austenitizing temperature °C** | **Holding time at austenitizing temperature min.*** | **Tempering temperature °C** |
|---|---|---|---|
| 62 | 1,150 | 10 | 590 |
| 64 | 1,150 | 10 | 560 |
| 66 | 1,175 | 5 | 550 |
| 67 | 1,200 | 3 | 550 |

* In case of previous preheating at 870 °C. The data referred to 13 mm round bar samples. The holding times at austenitizing temperature should be correspondingly adapted for large and very thin profile dimensions. The maximum permissible austenitizing temperature of 1,205 °C must not be exceeded.
Holding time in sec./mm thickness.

## Machining Data

### Turning

| Cutting parameter | Turning with cemented carbide medium turning | finish turning | HSS |
|---|---|---|---|
| Cutting speed ($V_C$) m/min. | 70–90 | 90–130 | 15 |
| Feed (f) mm/U | 0,2–0,4 | 0,05–0,2 | 0,05–0,3 |
| Cutting depth ($a_p$) mm | 2–4 | 0,05–2 | 0,5–3 |
| Tools according ISO | P 10–P 20* | P 10* | – |

* Use wear resistant coated cemented carbide, e. g. Coromant 4015 or Seco TP 100.

### Milling
Face- and Edge Milling

| Cutting parameter | Milling with cemented carbide medium turning | finish turning | HSS |
|---|---|---|---|
| Cutting speed ($V_C$) m/min. | 70–90 | 90–130 | 15 |
| Feed (f) mm/U | 0,2–0,3 | 0,1–0,2 | 0,1 |
| Cutting depth ($a_p$) mm | 2–4 | 1–2 | 1–2 |
| Tools according ISO | K 15* | K 15* | – |

* Use wear resistant coated cemented carbide, e.g. Coromant 4015 or Seco TP 100.

End Milling

| Cutting parameter | Solid carbide | Milling cutter w. indexable tips | Coated HSS |
|---|---|---|---|
| Cutting speed ($V_C$) m/min. | 20–35 | 50–80 | 12* |
| Feed (f) mm/U | 0,01–0,20** | 0,06–0,20** | 0,01–0,30** |
| Tools according ISO | K 20 | P 25*** | – |

* for TiCN-coated end mills made of HSS $V_C$ ~ 25-30 m/min.
** depends on radial depth of cut and on milling cutter - diameter
*** Use wear resistant coated cemented carbide, e.g. Coromant 3015 or SECO T15M.
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### Drilling
Spiral Drill Made of HSS

| Driller-⌀ mm | Cutting speed ($V_C$) m/min. | Feed (f) mm/U |
|---|---|---|
| 0– 5 | 8–14* | 0,05–0,15 |
| 5 – 10 | 8–14* | 0,15–0,25 |
| 10 – 15 | 8–14* | 0,25–0,35 |
| 15 –20 | 8–14* | 0,35–0,40 |

* for TiCN-coated end mills made of HSS $V_C$ ~ 25-30 m/min.

Carbide Metal Driller

| Cutting parameter | Drill type insert drill | Solid carbide tip | Coolant bore driller with carbide tip* |
|---|---|---|---|
| Cutting speed ($V_C$) m/min. | 110–130 | 40 | 35 |
| Feed (f) mm/U | 0,08–0,14** | 0,10–0,15** | 0,10–0,20** |

* driller with coolant bores and a soldered on carbide tip
** depends on driller-diameter

### Grinding

| Grinding method | Soft annealed | Hardened |
|---|---|---|
| Surface grinding, straight grinding wheels | A 13 HV | B 107 R75 B3*<br>3SG 46 GVS**<br>A 46 GV |
| Surface grinding | A 24 GV | 3SG 36 HVS** |
| Cylindrical grinding | A 60JV | B126 R75 B3*<br>3SG 60 KVS**<br>A 60 IV |
| Internal grinding | A 46 JV | B126 R75 B3*<br>3SG 80 KVS**<br>A 60 HV |
| Profile grinding | A 100 LV | B126 R100 B6*<br>5SG 80 KVS**<br>A 120 JV |

* for these applications we recommend CBN-wheels
** grinding wheel from the company Norton Co.

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Last revision: January 2022