Application For Heavy-Duty Turning and High Hardness Component

Zhengzhou Halnn Superhard Materials Co., Ltd

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1. Machining Characteristics of Large scale high hardness component
2. Turning Heavy-duty Large scale rolls Application
3. Machining High Manganese Steel Wear-resistant castings Application
4. Machining High Chromium Cast iron Wear-resistant castings Application
5. Energy and power industry applications (wind power bearings, hydraulic props)
6. Other machining high hardness materials application
Machining Characteristics of Large scale high hardness component
Characteristics of Heavy turning

Characteristics of Heavy-duty Turning: (1) Large size (2) Heavy Weight

Compare with common cutting, heavy-duty cutting tool has the characteristics of large cutting depth, relatively low cutting speed and relatively slow feeds, so its processing technology is very different from ordinary mechanical cutting process. These processes Characteristics exist in the rigidity of the machine, reducing the stability of the performance, the choice of tools, tool installation, the choice of cutting condition, workpiece clamping and others; especially processing high hardness heavy parts is most difficult.
Common Questions:
(1) It needs long time machining each component, and need change the insert in the process which will affect the process efficiency.
(2) High hardness castings exist sand, stomach, white hard pot, etc. defects, which lead to the insert chipping or damage.
(3) After adding materials (Spraying, Surfacing or laser cladding), the component surface hardness is high, which make it more difficult to machine, such as laser cladding mold, spraying tolls, etc.
(4) Large scale component itself has high hardness, such as wind power bearings, heavy Gears, high hardness metallurgy rolls, large scale wear resistant component
Large scale castings: high Ni-Cr cast iron, high chromium cast iron itself hardness will achieve HRC60, and the surface will have sand, which will lead to difficult to machine.
Heavy-duty component, the hardness will be higher after surfacing, spraying, laser cladding, will be more difficult to machine.
Wind Power bearings or wind turbine bearings usually have large size, the hardness after heat treatment will be HRC58~62. Turning the raceway must use hard turning process.
Heavy-duty large scale machine parts
Large scale gears
High hardness cold rolls
PART 02

Turning Heavy-duty Large scale rolls Application
Halnn CBN Grade for Heavy-duty Turning

Halnn Superhard, as the predecessor of China superhard cutting tools, has our own research center, make the National Key Laboratory of superhard materials and Henan University of Science and Technology for technical support, focus on research cbn cutting tools and high grade diamond tools for brittle hard materials and difficult to machine materials, has our advantages in turning instead of grinding, high hardness heavy-duty turning, high speed cutting and machining difficult to machine materials,ect field. **Halnn CBN Grade for heavy-duty turning:**

<table>
<thead>
<tr>
<th>Select Insert</th>
<th>Suited Materials</th>
<th>Machining Type</th>
<th>Application Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN-K1</td>
<td>Chilled Cast Iron</td>
<td>Roughing</td>
<td>High Ni-hard alloy cast iron rolls, Slurry pump, Wear resistant castings, Chilled cast iron rolls</td>
</tr>
<tr>
<td></td>
<td>High Ni-Cr alloy cast iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High hardness cast iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN-S10</td>
<td>High Speed Steel(HSS)</td>
<td>Roughing</td>
<td>HSS Rolls, Semi-steel rolls</td>
</tr>
<tr>
<td>BN-S20</td>
<td>Hardened Steel</td>
<td>Roughing, Semi-finishing</td>
<td>HSS Rolls,Ball Screw,Screwing Bearings,High manganese steel crushing cone</td>
</tr>
<tr>
<td></td>
<td>Heat resistant and abrasive resistant steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High manganese steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN-S200</td>
<td>Hardened Steel, Superalloy</td>
<td>Finishing</td>
<td>Wind power bearings, Slewing Bearings</td>
</tr>
<tr>
<td>BDN80</td>
<td>Ni-based alloy, Stellite alloy, Superalloy</td>
<td>Roughing, Finishing</td>
<td>Ni-based alloy component, Aircraft turbine disk</td>
</tr>
</tbody>
</table>
Rolls Common Cutting Types

- Roughing Cylindrical
- Hole Turning
- Milling
- Heavy Turning
- Turning Groove
- Roll Repairing
Roll classification and common processing difficulties

According to the level of hardness classification

1. Low hardness rolls processing characteristics and tool selection
   Such as ductile iron roll, high alloy cast iron roll, they commonly used in hot roll, Supporting roller, middle roller. Compare with working rolls, their characteristics are low hardness.

   Turning this type rolls, you can choose carbide insert.

2. Processing characteristics of high hardness rolls and tool selection
   Such as machining chilled cast iron (ICDP), High nickel chromium cast iron rolls, high boron steel rolls, HSS Rolls, Semi-steel rolls (casting semi-steel rolls and high carbon semi-steel rolls), Ni-Cr-Mo centrifugal composite rolls.

   Because of its high hardness, these rolls blank usually has stomatal, sand, ect defects. And it requires high on the cutting tools performance, such as impact resistance, heat-resistance, wear resistance, ect.
Rolls Materials-Hardness-CBN Grade

Specific above casting defects and other problems, Halnn researched some CBN grades for machining these high hardness rolls.
How to confirm the tool solutions

How can you get the tool solutions for machining rolls from us?
Please offer the information details as the following tablet:

<table>
<thead>
<tr>
<th>Component Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolls Materials</td>
</tr>
<tr>
<td>Rolls Hardness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous Cutting Tools Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insert Brand</td>
</tr>
<tr>
<td>Insert Materials</td>
</tr>
<tr>
<td>Failure Mode</td>
</tr>
</tbody>
</table>
Rough machining High Ni-Cr Alloy Cast Iron Rolls

**Material:** High Ni-Cr Cast Iron, Hardness HSD80

**Selected Insert:** BN-K1

**Cutting Condition:**
- $ap=9\text{mm}$,
- $Fr=0.5\text{mm/r}$,
- $Vc=25\text{m/min}$

**Processing Difficulties:**
1. High Hardness
2. Large working allowance
3. Casting Defects

<table>
<thead>
<tr>
<th>Selected Insert</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-K1</td>
<td>Improved 3 times</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td></td>
</tr>
</tbody>
</table>
BN-K1: Normal Wear, it can use all cutting edges.

Other CBN: Insert fragmented, it lead to serious loss.
Semi-finishing chilled cast iron rolls

Material: Chilled cast iron rolls, Hardness HSD67
Selected Insert: BN-K1
Cutting Condition: ap=2mm, Fr=0.5mm/r, Vc=66m/min

<table>
<thead>
<tr>
<th>Selected Insert</th>
<th>Efficiency</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-K1</td>
<td>Improved 2times</td>
<td>3 times</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
Finish turning forged steel cold rolls

Material: Forged steel cold rolls, Hardness HRC60
Selected Insert: BN-20

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-S20</td>
<td>Improved 5 times</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td>/</td>
</tr>
</tbody>
</table>
Turning the high boron steel rolls Groove

Material: High Boron Steel, Hardness HSD68
Selected Insert: HLCBN

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Machining Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn HLCBN</td>
<td>24 holes/insert</td>
</tr>
</tbody>
</table>
Turning the repairing rolls screw

Material: High Speed Steel rolls, Hardness HSD67
Selected Insert: BN-S20/BN-S10
Machining Condition: Vc=68m/min, ap=0.5mm, f=0.5mm/r

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-S20</td>
<td>5 times</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td>/</td>
</tr>
</tbody>
</table>
Milling the grooves of high speed steel rolls
Turning the tungsten carbide rings

Materials: WC (Tungsten Carbide);
Hardness: HRA 88
Insert: CDW20;

(For some shaped or large carbide rings, hard turning is more efficient than grinding)
## Cutting Conditions of Different Rolls

<table>
<thead>
<tr>
<th>No.</th>
<th>Rolls Materials</th>
<th>Hardness</th>
<th>Select CBN Insert</th>
<th>Recommend Cutting Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vc(m/min)</td>
</tr>
<tr>
<td>1</td>
<td>High Ni-Cr Cast Iron Rolls/Hi-Cr Cast Iron Rolls</td>
<td>HSD60~80</td>
<td>BN-K1</td>
<td>40~60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60~90</td>
</tr>
<tr>
<td>2</td>
<td>Cast Semi-SteeRolls</td>
<td></td>
<td></td>
<td>30~60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50~80</td>
</tr>
<tr>
<td>3</td>
<td>High Carbon Semi-Steel Rolls</td>
<td></td>
<td></td>
<td>35~50</td>
</tr>
<tr>
<td>4</td>
<td>Chilled Cast Iron Rolls</td>
<td></td>
<td></td>
<td>25~50</td>
</tr>
<tr>
<td>5</td>
<td>High Speed Steel/HSS Rolls</td>
<td>HSD85~92</td>
<td>BN-S20</td>
<td>20~45</td>
</tr>
<tr>
<td>8</td>
<td>Tungsten Carbide Ring</td>
<td>HRA88</td>
<td>BN-S30</td>
<td>10~15</td>
</tr>
<tr>
<td>9</td>
<td>Forged Steel Cold Rolls</td>
<td>HRC65</td>
<td>BN-S20</td>
<td>10~25</td>
</tr>
</tbody>
</table>
Corresponding tool holder for machining rolls
Typical Customs of Halnn in rolls industry

- Final Customers: WISCO, ANSTELL, HBIS STEEL GROUP, VALIN STEEL, BLHI, and BAOSTEEL ROLL.
- Customers for Carbide Rings: XIAMEN GOLDEN EGRET SPECIAL ALLOY, ect.
- Cooperation company: Qiqihar Heavy CNC equipment Limited, Qinghai huading heavy-duty machine tools, ect.
Machining High Manganese Steel Wear-resistant castings Application
Application of high manganese steel wear resistant castings
Common processing difficulties of machining high manganese steel wear resistant casting

High manganese steel is a commonly used wear-resistant steel in machinery industry, these wear parts usually have excellent performance: high strength, high toughness, high machinability of high manganese steel is poor, it mainly has the following difficulties:

(1) Plastic deformation, severe processing hardening;
(2) Large plasticity, easily to form BUE;
(3) Large cutting force, high toughness, not easy to break.
(4) Due to the large cutting force, the unit cutting power increases, the heat generated per unit time and high manganese steel itself poor thermal conductivity, the cutting zone temperature up to 1000 °C, severe tool wear, tool life is low.
Tool Solutions for high manganese steel crushing cone

- Machine Tool: CNC vertical Lathe
- Tool Holder: 83° CSXNR/L or 75° CSRNR/L
- Selected Insert: BN-S20
- Typical Customers: Zhejiang Mining Machinery Factory; Metso Minerals;
Characteristics of BN-S20 for machining high manganese steel

1. The CBN Content and Cutting edges of BN-S20 are both researched specific for processing high manganese steel castings, it can not be used to process ordinary mild steel such as 45 # steel.

2. The cutting depth of BN-S20 Solid CBN Insert can be above 7mm, BN-S20 has better impact resistance than ceramic insert and common cbn inserts. Especially for the castings in the bad processing environment, BN-S20 can be used for rough machining, no need grinding first, which can help save the time.

3. With BN-S20 solid cbn insert machinig high manganese steel, the feeds can range depending on the main angle of the tool holder, can't be same cutting condition.

4. BN-S20 belong to indexable insert(including turning and milling insert), not only can be used for machining high manganese steel castings, but also can be used for machining high speed steel rolls, forged steel rolls, large scale bearing steels GCr15, and other high alloy cast steel, ect.
Turning high manganese steel Crushing Cone

Materials: High Manganese steel
Selected Insert: BN-S20 SNMN150716
Cutting Condition: ap=7.5mm, Fr=0.5mm/r, Vc=65m/min

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Cutting speed</th>
<th>Cutting Depth</th>
<th>Tool Life/Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-S20</td>
<td>65m/min</td>
<td>7.5mm</td>
<td>2pcs</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td>19m/min</td>
<td>3.5mm</td>
<td>0.5pcs</td>
</tr>
</tbody>
</table>
Milling high manganese steel liner

Material: High manganese steel Plate
Selected Insert: BN-S20 SNFN120716
Cutting parameters:
ap=2.5mm, Fr=0.2mm/r, Vc=75m/min

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Cutting speed</th>
<th>Feed rate</th>
<th>Tool Life/blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-S20</td>
<td>75m/min</td>
<td>0.2mm/r</td>
<td>270min</td>
</tr>
<tr>
<td>Carbide insert</td>
<td>25m/min</td>
<td>0.15mm/r</td>
<td>25min</td>
</tr>
</tbody>
</table>
Machining high chromium cast iron wear resistant castings
Machining High Chromium Cast Iron

- High Chromium Cast Iron Liner
- High chromium cast iron hammer
- High Chromium Cast Iron Impeller
- High Chromium Cast Iron Pump Housing
- High Chromium cast iron rolls
Characteristics of Cutting High Chromium cast iron

High Chromium cast iron is the third Generation white cast iron after common white cast iron and ni-hard cast iron. In Current times, high chromium cast iron has been the most suitable materials for abrasive resistant materials, and is widely used in mining industry, power industry, and other refractories. Typical component include mill rolls, industry pump(slurry pump, Mud pump) ect. Because high chromium cast iron workpiece belong to large scale castings, the blank will have some defects: Uneven margins, stomach, sand. So choose the right cutting tools will be very important.
Characteristics of BN-K1 machining high chromium cast iron

1. BN-K1 is researched specific for high chromium cast iron in cutting edge and cbn content aspect.

2. The cutting depth of BN-K1 can be above 7mm, has better impact resistance than common ceramic insert and cbn inserts. Especially for heavy interrupt condition, BN-K1 can perform well, no need grinding first, which help the customers improve their efficiency.

3. When using BN-K1 machining high chromium cast iron pumps, we need to choose different cbn grade and the feeds depending on the machining sites.

4. BN-K1 not only can be used for machining high chromium cast iron component, also can be used for other high hardness castings, such as chilled cast iron rolls.
Tool Solutions for Impurities pump

- Slurry Pump (Impurities pumps, mud pumps, pumps) pump body, impeller, liner, cylinder liner, (Materials: Cr15Mo3, Cr15Mo2Cu, KmTBCr12, Cr20 Cr26 high chromium alloy cast iron, white cast iron)
- Common cbn grade: BN-K1 and HLCBN
- Advantages: High hardness, high strength and abrasive resistance, excellent impact resistance
- Common Insert Model: SNMN120712, SNMN120708, CNMN120412, RNMN120400, SNMN120412.
- Can replace: Ceramic insert, carbide Insert, tungsten carbide insert, other pcbn insert.
BN-K1 turning slurry pump body

Component: Slurry pump body
Material: High-chromium white cast iron Cr26, Hardness HRC60
Selected Insert: BN-K1 CNMN120712
Cutting parameters: ap=2.5mm, Fr=0.12mm/r, Vc=75m/min

Process Difficulties:
(1) Large allowance
(2) High hardness
(3) Rough surface porosity, trachoma and other casting defects

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Life per blade</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-K1</td>
<td>85pcs/blade</td>
<td>Normal wear</td>
</tr>
<tr>
<td>Some brand CBN</td>
<td>35pcs/blade</td>
<td>Damage rupture</td>
</tr>
</tbody>
</table>
BN-K1 Turning Impeller

Materials: Slurry Pump impeller, High chromium cast iron Cr26, Hardness HRC60, Heavy Interrupt Turning
Selected Insert: BN-K1 SNMN120712
Cutting parameter: \( ap=2.5\text{mm}, Fr=0.25\text{mm/r}, Vc=45\text{m/min} \)

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Tool Life</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-K1</td>
<td>11pcs</td>
<td>Normal wear</td>
</tr>
<tr>
<td>Some Brand CBN</td>
<td>3pcs</td>
<td>★Damage rupture</td>
</tr>
</tbody>
</table>

**Process Difficulties:**
1. Impeller belong to castings, it will have some casting defects.
2. Each impeller has 5~12 blade, will be heavy interrupt turning condition when machining the cylinder and endsurface.
3. Bad working environment.
**BN-K1 machining high chromium cast steel**

Material: High Chromium alloy cast iron, Hardness HRC60, Heavy Interrupt Turning
Selected Insert: BN-K1 RNMN120400
Cutting Condition: \( ap=1.5\text{mm}, \ F=1.2\text{mm/min}, \ Vc=50\text{m/min} \)

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Cutting Width</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-K1</td>
<td>500mm</td>
<td>Normal wear</td>
</tr>
<tr>
<td>Some Brand CBN</td>
<td>150mm</td>
<td>Damage rupture ⭐️</td>
</tr>
</tbody>
</table>

Processing difficulties:
1. Cast Steel component include Mn,Cr,Ni, which will lead to the cutting tools chipping easily, especially for some large scale cast steel workpiece.
2. It has sand, white, etc casting defects, and it also will has interrupt turning condition, will be easily chipping, and lead to the high tool costs.
Energy and power industry applications

PART 05
Energy and power industry applications

Wind Power Bearings

Hydraulic props
Wind Power bearings and large scale hydraulic has large size, and high hardness (HRC 58~62) after heat treatment, and the hardened layer will reach about 3~5mm, it has large allowance, doesn't have suitable grinding machine, only use hard turning process.
## Characteristics of BN-S200 and BN-S20 turning hardened steel component

<table>
<thead>
<tr>
<th>Halnn CBN</th>
<th>Suited Materials</th>
<th>Machining Type</th>
<th>Suitable machining condition</th>
<th>Depth of Cut</th>
<th>Typical application industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN-S20</td>
<td>Hardened steel, heat resistant steel, high manganese steel</td>
<td>Roughing, Semi-finishing</td>
<td>Continuous- Interrupt</td>
<td>1~10mm</td>
<td>High speed steel rolls, ball screw, wind power bearings, high manganese steel crushing cone</td>
</tr>
<tr>
<td>BN-S200</td>
<td>Hardened steel, superalloy</td>
<td>Finishing</td>
<td>Continuous</td>
<td>≤1mm</td>
<td>Wind Power Bearings</td>
</tr>
</tbody>
</table>
BN-H10 hard turning wind power bearings

Component: Wind power bearings, 42CrMo4, HRC58-62, Semi-Interrupt Turning
Selected Insert: BN-H10 RNGN090300
Cutting Condition
ap=1mm (roughing), ap=0.15mm (finishing), Fr=0.45mm/r, Vc=145m/min, dry cutting

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Cutting Speeds</th>
<th>Lifetime</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-H10</td>
<td>145m/min</td>
<td>3pcs/blade</td>
<td>20%Improved</td>
</tr>
<tr>
<td>Some Brand CBN</td>
<td>120m/min</td>
<td>2pcs/blade</td>
<td>----</td>
</tr>
</tbody>
</table>

Process Difficulties:
1. The materials of wind power bearings belong to 50Mn, 42CrMo, the hardness will be above HRC50, will exist interrupt turning condition
2. It will have large allowance, about 2~6mm
A wind power bearing production workshop
BN-S20 hard turning Hydraulic phop

Component: Hydraulic phop, 27SiMn, HRC55
Selected Insert: BN-S20 CNMN120712
Cutting Condition: ap=1mm, Fr=0.15mm/r, Vc=145m/min, dry cutting

<table>
<thead>
<tr>
<th>Insert material</th>
<th>Cutting Speeds</th>
<th>Roughness</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halnn BN-S20</td>
<td>145m/min</td>
<td>Ra0.4</td>
<td>Improved 11times</td>
</tr>
<tr>
<td>Carbide Insert</td>
<td>30m/min</td>
<td>Ra3.2</td>
<td>----</td>
</tr>
</tbody>
</table>

Laser cladding workpiece processing difficulties:
1. High hardness, about above HRC50
2. Complex component, it doesn't have suitable grinding machine
3. Large allowance, it belongs to interrupt turning condition.
Hardening parts processing case

PART 06
BN-H10 Processing spray ball valve
BN-H10 Processing spray ball valve

**Lathe:** CNC Lathe  
**Component:** Surface Spray Ni55,Ni60 alloy  
**Hardness:** HRC55; HRC60  
Spraying layer thickness: 1.6mm,

**Process Difficulties:**  
1. Surface hardness HRC55~60, irregular surface, it required the insert high hardness, good impact resistance.

2. When cutting, we can not use conventional negative chamfered CBN blade, otherwise it will peel off the surface spray layer.

Halnn special solution: BN-H10 chipbreaker PCBN Insert  
**Effect:** It has good roughness
Halnn Superhard, as the pioneer of superhard cutting tools in China, make national Superhard Materials Key Laboratory and Henan University of Science and technology as technical support, have our own research center, focus on **cbn cutting tools and high grade diamond tools for machining brittle and hard materials**, have obvious advantages on most industries, such as **turning instead of grinding, high hardness materials machining, heavy turning, high speed machining**. At the same time, we have launched a series of new cbn/pcd cutting tools and other material tools in 3C, aerospace and Nuclear energy military field, depending on the research center of Henan Superhard Materials Institute. Our customers have covered many countries and areas, including China Mainland, German, Italy, USA, Korea and other areas.
Thanks!

Zhengzhou Halnn Superhard Materials Co., Ltd

Jan, 2018