Processing and Application of High Speed Steel Roll

Keyword: high speed steel roll

Description: In view of the difficulty of processing high-speed steel rolls and low processing efficiency, this paper expounds the characteristics of high-speed steel rolls, tool material, machine tool performance, processing technology and use, and clarifies tool selection, processing technology, machine tool requirements and roll use. The influence of factors on the application of high-speed steel rolls.

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The 260-unit steel rolling production line of the first rolling plant of a large steel mill in China mainly produces Φ12 mm ~ Φ50 mm rebar and mining bolt steel bars, as well as functional steel bars for nuclear power, finishing threads for high-speed rail, etc. The rolling mill layout Adopt 6-4-7 process form, 1-10 stand alternately, all continuous tension-free rolling. The material of the roll is mainly made of ductile infinite chilled cast iron and high nickel-chromium infinite chilled composite cast iron. With the popularization and application of high-speed steel rolls on in-line bar rolling mills, the 260 units all use high-speed steel rolls in the finishing mill train, which greatly improves the rolling mill operation rate, negative difference control rate and steel surface quality. However, due to its characteristics of high hardness and difficult cutting, it restricts the further expansion and application of high-speed steel rolls. The author briefly expounds the advantages of high-speed steel rolls, tool material selection, processing technology, machine tool performance and roll use, and discusses with you.

● High speed steel roll

High-carbon high-speed steel composite roll (referred to as high-speed steel roll) is the fastest-growing and most widely used hot-rolling roll material in recent years. Its composition is relatively complex alloy steel. Can harden. The material of the working layer is made of high carbon steel, the core material of the roll is made of ductile iron, graphite steel or forged steel, etc. The two different materials are compounded by centrifugal casting or CPC process, and the matrix structure is generally tempered martensite. +Bainite+Carbide, the carbide is distributed in the matrix in a highly dispersed form, so it has high wear resistance and toughness, which makes turning difficult. The mechanical properties of high-speed steel rolls and other rolls of different materials are shown in Table

1.

ROLL MATERIAL	ROLL SURFACE HARDNESS / HSD	CARBIDE		TENSILE STRENGTH / MPa	COMPRESSIVE STRENGTH / MPa	FRACTURE TOUGHNESS ($MPa \cdot m^{1/2}$)	ABRASION RESISTANCE
		PROPORTION / %	SIZE / μm				
HIGH SPEED STEEL	78~90	10~20	<100	700~900	2 700~3 000	25~28	4~5
HIGH CHROMIUM CAST IRON	70~80	20~30	100~150	600~800	1 800~2 200	[illegible]	[illegible]
HIGH NICKEL CHROMIUM MOLYBDENUM CAST IRON	75~85	30~40	200~500	400~600	2 000~2 500	18~25	1

Table 1 Comparison of mechanical properties between high-speed steel rolls and other roll materials

High-speed steel rolls are characterized by good thermal stability, good hardenability, high carbide hardness, easy to form oxide films, good thermal crack resistance and wear resistance, and the requirements for cooling water are far lower than those of cemented carbide. It is required that its single groove rolling capacity can reach 4 to 5 times that of cast iron rolls. It is beneficial to the negative tolerance control of the rolled material and to improve the surface quality of the rolled material. It is mainly a new material roll developed by applying in-line bar products and pre-finished products, as well as slit rolling, pre-cutting, and slitting pass types. Good impact resistance, good thermal fatigue resistance. With the popularization of online bar rolling mills for high-speed steel rolls, R&D and manufacturers spread rapidly. However, the alloying elements added by each manufacturer in the casting process of high-speed steel rolls are different. Therefore, in terms of processing and use, cutting is difficult and easy. The degree and the effect of online use are not completely consistent, and the overall mainly contains carbide-forming elements such as tungsten, molybdenum, chromium, vanadium, and niobium.

● Tool material selection

The cutting part of the tool is directly in contact with the roll for cutting, and bears great cutting pressure and impact, and under high temperature and high pressure, violent friction occurs with the roll, and the working conditions are very bad. The machining tools of high-speed steel rolls are usually made of superhard materials such as diamond and cubic boron nitride (CBN). little. Compared with diamond, CBN tool has higher hardness, thermal stability and chemical inertness, as well as good infrared transmittance and wider forbidden band width.

2.1 High hardness.

Cubic boron nitride (CBN) is second only to diamond, with high hardness and wear resistance, and is the first choice for high-speed steel roll processing tool materials in current steel rolling enterprises. At present, there are two types of CBN tool synthesis types: poly wafer (synthesized by CBN and bonding agent) and composite wafer (synthesized by CBN and bonding agent on the cemented carbide wafer). In the processing of high-speed steel rolls, cermet bonds and ultra-fine grain CBN materials are often used, and the commonly used grades are MBN3 500 and MBN5 000. Practice has also proved that these two grades of CBN cutting tools are the best choice for machining high-speed steel rolls.

2.2 Adequate strength and toughness.

The material of the cutting part of the tool bears a lot of cutting force and impact force during the cutting process. Therefore, it must have sufficient strength and toughness. Polycrystalline diamond (PCD) has two types, natural and artificial, and artificial diamond is mostly used as tool material in industry. However, artificial diamond is brittle and has poor impact resistance, which requires high precision and stability of machine tools. At the same time, diamond tools have poor heat resistance and have a strong affinity with iron elements. Therefore, diamond tools are mainly used for processing non-ferrous metals and their alloys. , It is not suitable for processing iron-based metals, so it is generally not used for roll processing. The thermal stability of CBN tools is twice as high as that of diamond, and it has excellent chemical stability. Its flexural strength and fracture toughness are between those of cemented carbide and ceramic tools.

2.3 High wear resistance and heat resistance.

Generally speaking, the higher the hardness of the tool material, the better the wear resistance. Wear resistance is closely related to heat resistance. The higher the hardness at high temperature, the better the heat resistance. CBN material tools can maintain high hardness at high temperature, that is, good red hardness. At the same time, it has strong plastic deformation resistance at high temperature, so the wear resistance is also high.

2.4 Good thermal conductivity.

Tool materials with good thermal conductivity also have good thermal shock resistance and thermal crack resistance. The thermal stability of CBN composite inserts maintains good red hardness around 1 000 ℃, so it is not greatly affected by cutting heat.

2.5 Good craftsmanship and economy.

CBN tool is a CBN material tool synthesized by artificial methods under high temperature and high pressure conditions with CBN powder and a small amount of binder. It is suitable for manufacturing blades of various shapes and different angles, and is an ideal tool for CNC machining. The mechanical properties of cemented carbide, synthetic diamond and CBN are shown in Table 2.

MATERIAL TYPE	DENSITY / ($g \cdot cm^{-3}$)	HARDNESS HRA / HV	FLEXURAL STRENGTH / GPa	THERMAL CONDUCTIVITY / ($W \cdot m^{-1} \cdot K^{-1}$)	HEAT RESISTANCE / ℃
TUNGSTEN COBALT CEMENTED CARBIDE	14.3~15.3	89~92	1.08~2.35	75.4~87.9	800
TITANIUM CARBIDE CARBIDE	5.56~6.3	92~93.3	0.78~1.08	-	1 100
CUBIC BORON NITRIDE CBN	3.44~3.49	(8 000~9 000)	~0.294	75.55	
SYNTHETIC DIAMOND	3.47~3.56	(10 000)	0.21~0.48	146.54	700~800

Table 2 Mechanical properties of ordinary cemented carbide, synthetic diamond and CBN materials

- ## High speed steel roll processing

The working layer of the high-speed steel roll body is a fine carbide with high hardness dispersed in the martensite matrix. During the cutting process, a severe high-frequency impact is generated on the cutting edge of the tool, and the temperature during the processing of the roll body has little effect on the hardness. , which accelerates tool wear, which makes high-speed steel roll processing difficult and cutting efficiency low. Therefore, the processing of high-speed steel rolls should adopt the methods of high speed, low cutting amount, and frequent tool change to overcome the difficulties in the processing process.

3.1 Processing of roll pass

Due to the large amount of rough machining, fast tool wear and short life of new roll processing of high-speed steel roll pass, generally a blade slightly smaller than the diameter of the base circle of the pass is used to cut the groove shape on the roll body. Then use the CBN tool to cycle according to the CNC machining program. The cutting amount adopts different parameters according to the different parts of the machining hole. Generally, the cutting depth is selected as 0. 3 mm to 0. 4 mm, the cutting speed is 60 m/min ~ 80 m/min, the feed rate is set according to the needs in the preparation of the machining program, the roller ring part is about 0.8 mm/r, and the hole type notch arc part is 0.3 mm /r ~ 0.5 mm/r, hole groove bottom (large arc of base circle) is 0.3 mm/r ~ 0.4 mm/r, and finish machining. The schematic diagram of different parts of the roll groove is shown in Figure 1.

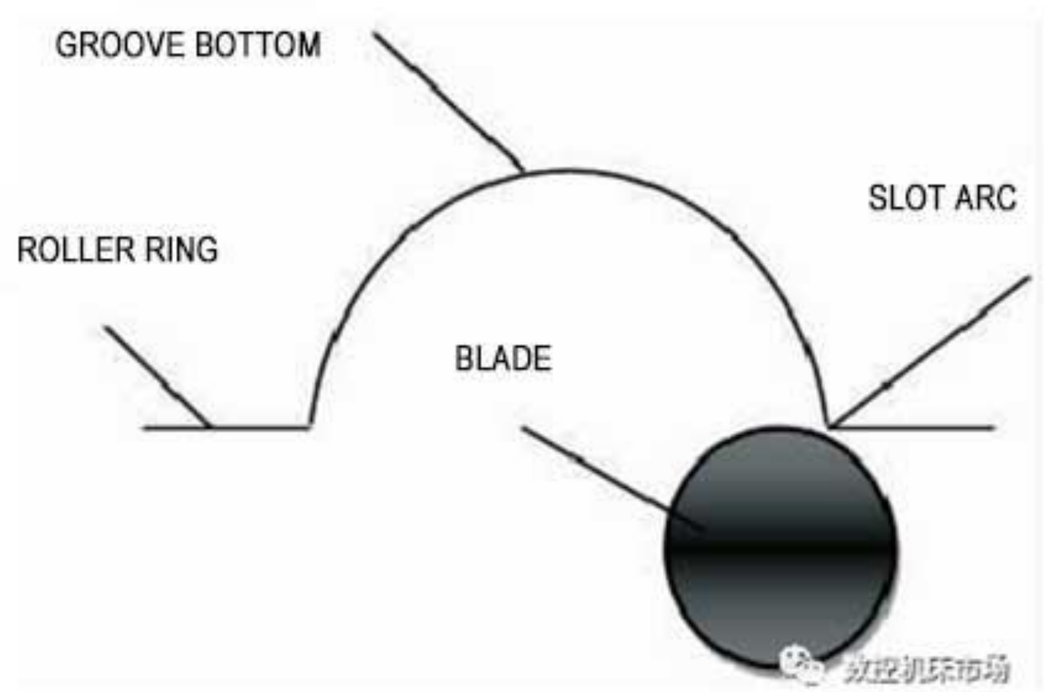

Figure 1 Different parts of the roll groove

3.2 Common problems of hole processing

3.2.1 The hole pattern does not conform to the template or dimensional accuracy

(1) There is a gap at the bottom of the groove.
The feed rate for hole finishing can be appropriately reduced, or the tool compensation can be reduced in the CNC machining program.

(2) The groove shape is asymmetrical, and the gap on one side is large.
A new blade needs to be replaced. If the problem still exists, consider increasing the screw compensation value in the program.

(3) The groove depth is not enough.
If the tool wear is excluded, reduce the feed rate for the arc machining at the bottom of the groove or increase the tool compensation value appropriately.

3.2.2 Tool damage form

(1) Chipping.
A few small nicks or chipping on the cutting edge is a common form of damage. For example, the micro-chipping tool can continue to cut within the allowable wear limit. If it exceeds the tolerance, it needs to be replaced, and the cutting amount should be appropriately reduced.

(2) Broken.
Generally, the material fatigue is not replaced in time after the tool is worn or the impact load is too large, and the feed rate needs to be reduced.

(3) Peeling.
The blade produces a conchoidal flaking on the rake face. It is caused by the mismatch between the cutting speed and the feed amount. Increase the cutting speed and reduce the feed amount appropriately.

3.3 Transverse rib milling (take XK500C multifunctional CNC thread milling machine as an example)

When machining transverse ribs of high-speed steel rolls, it is recommended to use flying cutter milling machines (such as XK9350 or XK500 series) to mill transverse ribs at the flying cutter station and process trademark characters at the swing head station. After clamping the tool holder, adjust the position of the cutter head, and use the special hole pattern alignment template for alignment adjustment (as shown in Figure 2). After aligning the center of the base round hole pattern, remove the centering template and withdraw the knife. Start the machining program, and use manual (hand pulser) to slowly feed the tool until the cutter head touches the bottom of the groove and produces milling scratches. Check the accuracy of the tool setting by checking the scratches. If the cutter head is still misaligned, use manual wheel for fine-tuning.

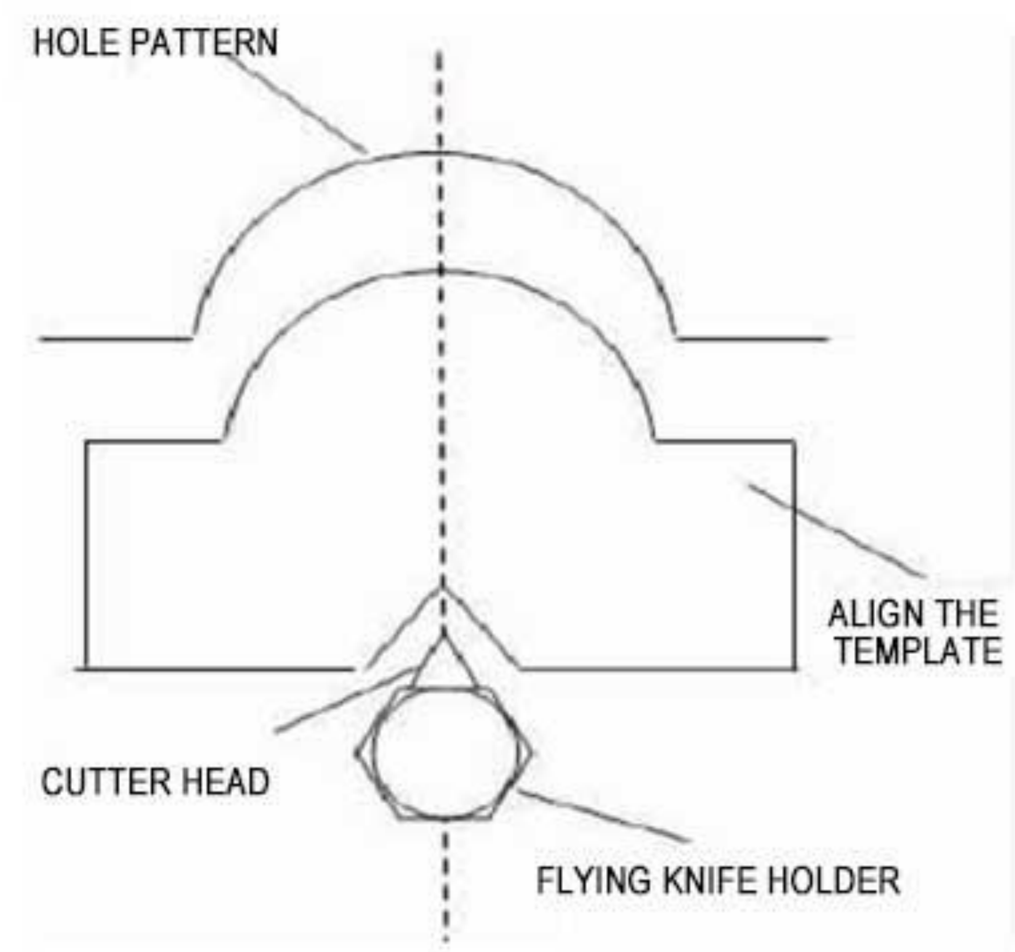

Figure 2 Schematic diagram of the centering of the hole processing tool head

The material of the milling cutter head is H06 or 6EF grade. According to the hardness of the high-speed steel roll material, the general milling feed rate is 0.03 mm / r ~ 0.05 mm / r. Check the wear of the cutter head frequently and replace it in advance in time. , to avoid tool wear and increase the machining resistance, damage the tool, and increase the processing cost.

When processing trademark characters, firstly adjust the machining mode of the machine tool to the swing head mode. The tool setting method is the same as the milling transverse rib. A rod cutter of Φ8 mm ~ Φ10 mm is used to process enough standard depth at one time. The font size and spacing are set in the processing program. or modified.

Roll clamping method and machine tool requirements

High-speed steel roll clamping adopts four-jaw heavy-duty chuck or transition sleeve, plus tailstock rotary sleeve type large top, using the clamping method of two tops and one clamp. At present, the bar wire is mostly fixed by the large bolt at the round head end of the roll in the rolling mill, so the center hole of the round head of the roll is often a screw hole of M48 mm or larger, which requires the tailstock tip to be customized into an umbrella-shaped rotary structure, which increases the number of installations. Clip rigid. In order to facilitate the assembly and disassembly of the universal joint sleeve at the transmission end, the processing chamfer is large, and the standard jaws cannot be caught on the plane of the transmission end, which requires the use of an excessive sleeve. The inner hole of the sleeve should be larger than the size of the roller head, and 4 ~ 6 bolts for fine adjustment of ovality. CNC roll processing requires the machine tool to have good rigidity and firm installation to reduce the vibration effect of surrounding equipment on the machine tool. After the rolls are firmly clamped, the tool holder of the machine tool also needs sufficient rigidity to fix the tool. On the premise of meeting the minimum arc of the hole shape, try to use a large-sized tool holder. When the tool bar extends for a long time, an auxiliary tool top needs to be installed to support the elastic deformation of the tool.

When the transverse rib is processed on the flying cutter milling machine, the gap between the supporting copper blocks should not be too large to ensure the rigidity of the flying cutter bar. In the process of processing, adjust the gap between the support copper block and the cutter bar in time to prevent the cutter bar from breaking.

The use of high-speed steel rolls

During the use of high-speed steel rolls, the cooling of the roll body requires the use of clean, low-temperature water to ensure both water pressure and water volume. In this way, thermal cracks in the roll body caused by overheating are avoided, and the expansion of the thermal cracks causes the roll body to peel off, and at the same time, the phase change of the roll body structure caused by the excessive temperature of the roll body is reduced. The ideal cooling system is a ring-shaped distribution of multiple nozzles in the rolling groove, as shown in Figure 3. Ensure a continuous and sufficient flow of water to the rolling groove. Generally, the water temperature should not exceed 40 °C, the water pressure should be controlled at 0.4 MPa ~ 0.6 MPa, and the water volume in a single tank should not be less than 300 L/min ~ 500 L/min, to ensure that 70% ~ 80% of the water volume is on the outlet side. The water flow should be aimed at the rolling groove to avoid scattering. In addition, the high-speed steel roll has a high sensitivity to thermal cracking. Before the roll is in contact with the red steel, it is necessary to turn on the cooling water in advance to cool the rolling groove.

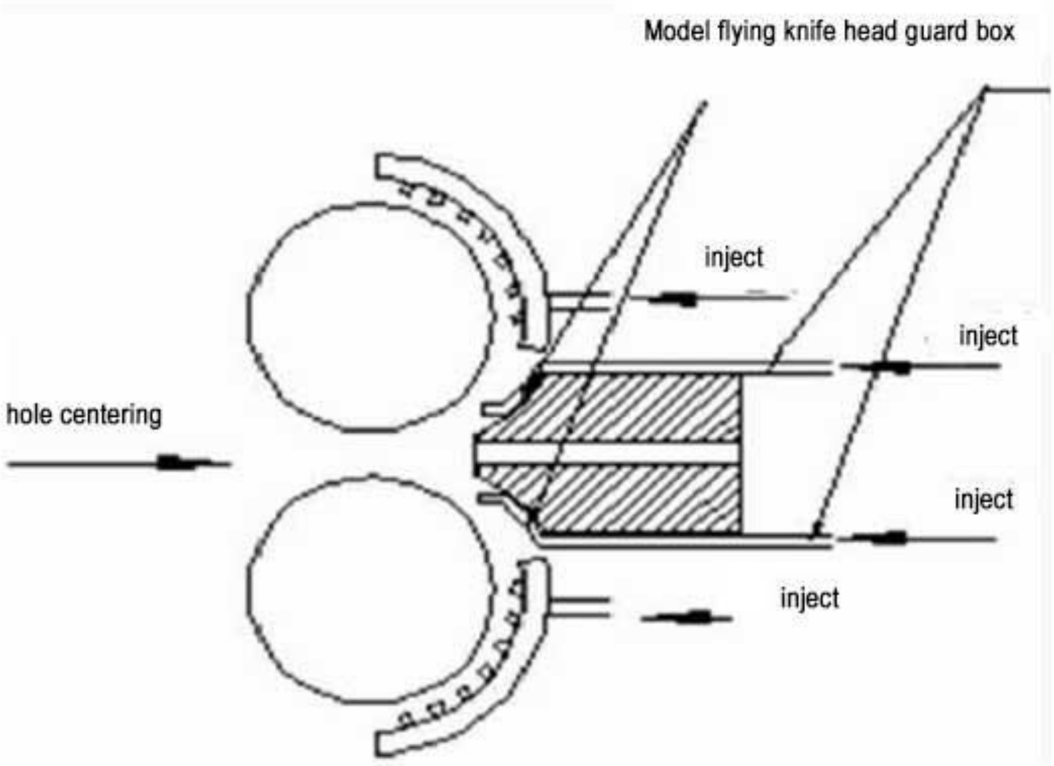

Figure 3 Cooling water pipes

When steel jamming or stacking occurs, water should be continued to cool down to cool down the temperature of the rolled material and the rolling groove, and then stop the water, and remove the rolled pieces accumulated in the rolling groove. When the production is resumed after the accident is dealt with, if the temperature of the rolling groove is higher than 60 °C, it is recommended to replace the grooves, and the grooves should be separated by 2.

● Conclusion

The high hardness and wear resistance of high-speed steel rolls, under the same rolling conditions, compared with chilled cast iron rolls and high-nickel-chromium composite cast iron rolls, the wear amount is smaller, the single-groove rolling amount is doubled, and it can greatly improve the steel. Surface quality, effective control of negative difference dimensional accuracy, the superiority of the online bar machine is becoming more and more prominent. However, the processing tool material of high-speed steel rolls is a major bottleneck restricting its development. With the continuous upgrading of CBN tool materials, through reasonable processing technology, when the rigidity of the machine tool meets the processing conditions, the processing difficulty will gradually decrease, and the processing efficiency will be improved. Further improvement, and the cooling method of high-speed steel rolls will also be improved accordingly. To this end, the promotion and application of high-speed steel rolls has broad prospects, which will definitely bring the advantages of high-speed steel rolls into full play and promote another leap in rolling production equipment.