

The Advantages and Disadvantages of Hot Press in Diamond Tools' Making

by Hanjiang Wang, Diamond Blade Select
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✓ In diamond tools' manufacture, the hot press method has below advantages:

- ✓ 1) The pressure in hot press method is low, so the requirement to the press machine is also low, and graphite or cast-iron molds can be used instead of the ones made of high-strength alloy steel.
- ✓ 2) The bonding strength is high, so this method can be applied to produce complex-shape products and the reject rate can be lowered.
- ✓ 3) The products can be sintered with molds, so their expansion and contraction can be controlled and their sizes can be kept well. After stripping, there will be no elastic aftereffect on the pressed blanks.
- ✓ 4) The heating time is short and the production period is also short. This is convenient for small batch production.
- ✓ 5) The low pressure of this method reduces the possibility of diamonds' crush.
- ✓ 6) The blank materials are sealed in molds, and will not contact with air. The heating time is short. Protective gas may not be used. These simplify the sintering process.
- ✓ 7) The sintering process can be better controlled.

The hot press method also has some disadvantages:

- ✓ 1) There are many production links in this method, and its production efficiency is not high.
- ✓ 2) This method needs many graphite molds, and needs many times of mold loading and stripping.
- ✓ 3) The graphite molds are apt to be damaged, for example, be burned to be defective or be cracked by expansion.

✓ Diamond Tools: How to Choose the Bond

by Hanjiang Wang, Diamond Blade Select
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The bond of a diamond tool is mainly determined by the tool's use. There are mainly three types of bond: resin, ceramic and metal.

1) **Resin Bond:** This bond itself has good elasticity and polishing function, but is subject to being burnt under high temperatures. The resin bond diamond tools have good self-sharpening capacity, and are not easy to be blocked. They seldom need several times' repair. Their grinding/cutting efficiency is high, roughness is low, and the temperature generated in the processing is also low. As their these advantages, the resin bond diamond tools are widely used in half-fine or fine grinding for carbide cutting-tools or workpieces. Resin bond CBN tools are mainly used for the cutting edge's grinding of high-vanadium HSS cutting tools, and half-fine or fine grinding for workpieces of tool steel, mold steel, stainless steel and heat-resisting steel.

2) **Ceramic Bond:** Ceramic bond has higher toughness and good heat-resisting performance. The ceramic bond diamond tools can cut/grind sharply and their efficiency is high. Over-heating and blocks seldom happen in the cutting/grinding process. Their thermal expansion is small, so the processing precision can be easily controlled. They can be repaired easily. They are normally used in coarse or half-fine grinding, profile grinding with broad contact area and grinding for superabrasive sinter.

3) **Metal Bond:** There are two kinds of metal bonds: bronze and electroplate. Bronze bond has good rigidity, high toughness, good wear resistance and long service life. It also has good shape-keeping performance and can withstand larger workload. However, its self-sharpening performance is bad. It is subject to block and is difficult to be repaired. The bronze bond diamond tools are mainly used in cutting and coarse or fine grinding for non-metal materials, such as glass, ceramic, stone, concrete, semiconductor materials and super-hard materials, and a few of them are used in the coarse grinding for carbide alloy, profile grinding and honing. Bronze bond CBN tools can be used in profile grinding for metal materials and honing for various alloy steel.

Electroplate bond has an even higher toughness. The electroplate bond diamond tools have a thin abrasive layer in which the density of the abrasive grains is high. The tool is sharp and its cutting/grinding efficiency is high. It is economical and does not need repair, but its service life is short. Electroplate bond is suitable to be used to manufacture profile grinding tools with complicated forms, small grinding heads, trepanning tools, saw blades and electroplated reamers, and can be applied in high speed grinding manners.

✓ Diamond Tools: How to Choose Diamond Concentration

by Hanjiang Wang, Diamond Blade Select
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Diamond concentration of a diamond tool means the weight of the diamonds in each cubic centimeter of the diamond tool's working layer. The international standard has prescribed that if each cubic centimeter contains 0.88g super-abrasives, its concentration is 100%. The each increase or decrease of 0.22g will cause the concentration to change by 25% correspondently.

Diamond concentration is an important feature of diamond tools, greatly influencing their cutting or grinding efficiency and their processing costs. If the concentration is too high, many diamonds will fall off the tool

prematurely. This leads to the waste of the diamonds. If the concentration is too low, the processing efficiency will be decreased, and the processing requirements may not be satisfied.

When choosing the diamond concentration, we should consider bond type, diamond size, processing procedure, the tool's shape, etc.

Different types of bond have different holding capacities to the diamonds. If the holding strength of a bond is strong, the diamond concentration can be higher.

When the size of diamonds is smaller, the concentration can also be lower to perform precise cutting/grinding and then gain fine finishes. For example, in polishing or high-precision grinding procedure, low concentration resin bond diamond tools are frequently used, and some concentration can be as low as 25%. However, in the coarse grinding procedure which has a high requirement on processing efficiency, big size and high concentration diamond tools can work better.

Normally, the concentration of CBN tools is a little bit higher than the diamond tools'. The reason is that CBN is mainly used to process steel which is normally tougher and softer than the materials which diamonds are used to process.

In choosing diamond concentration, the shape of the diamond tool and its processing manner should also be considered. For the jobs having broad working area, especially for profile grinding which requires retaining the precision of the diamond tool's shape, face grinding and groove grinding, diamond tools with higher diamond concentration should be chosen.

How to Select Suitable Diamond Blades

by Hanjiang Wang, Diamond Blade Select

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If you can manage to select diamond saw blades which are suitable to your work, you will improve your work efficiency and lower your costs, so it's worthy for you to know some methods.

There are many factors which influence the performance of diamond blades. Here we suggest some ideas from 3 aspects:

1. The Features of the Diamond Segments of a Diamond Blade

The features of the diamond segments of a diamond blade mainly include its diamonds' grit (size), toughness and concentration, and its bond's hardness and abrasability (Normally, the harder is the bond, the higher is its abrasability.). These features should be suitable to the nature of the stone to be sawed. In addition, different uses of diamond blades need different features.

The following table lists some suggestions considering these factors:

		Suggestion for Diamonds' Size, toughness and Concentration	Suggestion for the Bond
Nature of Stone	High Hardness and Density	The diamonds' size should be small, toughness should be high, and concentration can be a little bit lower (25% – 30%). This combination can guarantee the cutting efficiency.	The bond should be softer, and then the new diamonds can be more easily exposed.
	Low Hardness	The diamonds' size can be big, toughness can be medium, and concentration can be a little bit higher. This combination can get good cutting efficiency, and at the same time prolong the blade's life.	Bonds with better abrasability should be chosen to prolong the blade's life.
	High abrasability	The high toughness, bigger size and high concentration diamonds should be chosen.	The bond should be harder, and of good abrasability.
Use of Diamond Blade	Big Diameter Blades for Cutting Surfaces	The diamonds' toughness should be high; size should be big (36#-60# grit); concentration can be low. This combination can guarantee the high cutting efficiency.	Bonds with good abrasability should be chosen to prolong the blade's life.
	Small Diameter Blades for Cutting borders	Diamonds of medium toughness and 46#-70# grit can be chosen. This combination can not only guarantee the cutting efficiency, but also improve the cutting quality.	Bonds for easily exposure of diamonds should be chosen to guarantee the cutting quality (smooth and without the loss of edges and corners).

2. The Diameters and Shapes of Diamond Blades

The diameter and shape of a diamond blade should be chosen according to the dimension of the stone to be sawed and the requirements of processing quality.

For example, the diameter of a diamond blade normally should be bigger than 3 times of the maximum thickness of the stone. Diamond concrete saw blades' diameter is often bigger than or equal to 300mm.

The shape and structure of a diamond blade should be chosen according to the requirements of processing precision. When the requirement is producing a smooth surface or the products are thin and of easily border-broken, narrow-gullet diamond blades should be chosen. When the requirement to products' surface is not high or the stone is thick, wide-gullet diamond blades can be used.

3. The Equipment Conditions of Cutting Machines

- For the cutting machines which are not precise, it is better to choose the diamond blades with good-abradability bond.
- For those new and precise cutting machines, diamond blades with softer bond (more easily expose new diamonds) can be chosen.
- For the cutting machines whose line speeds are low, it is better to use the diamond blades with good-abradability bond.

The tips in above 3 aspects apply to not only stone, but also concrete, asphalt, bricks, and many other building materials.

How to Prolong Diamond Blades' Service Lives – Select Suitable Type of Blades

by Hanjiang Wang, Diamond Blade Select

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Selecting suitable type of diamond blades for the materials to be processed is also very important for the blades' service life. The user can consider this issue from below 3 aspects of the diamond blades:

- **The Grit of Diamonds:** The commonly used diamond grit is between 60/80# to 30/35#. The harder the material to be processed is, the smaller diamond grit should be chosen, because smaller diamonds are more easily to cut into hard materials.

In addition, large-diameter diamond blades normally require high cutting efficiency, so big diamond grits should be used for them, for example 30/40# and 40/50; small-diameter diamond blades normally have no such high cutting efficiency requirement, but require a smooth cutting-section of the material, so small diamond grits should be selected, for example 50/60# and 60/80#.

- **The Concentration of the Segment:** The concentration is the percentage of the diamonds in the whole segment materials. Increasing the concentration can prolong the blades' life, because this will reduce the average pressure on each diamond when cutting. However, the increasing in concentration will inevitably increase the blade's cost. Therefore there is a most economical concentration for a certain cutting efficiency.

The diamond particles are normally distributed in the segment unevenly, and are usually made into a wave-shape. This will help to improve the service life and precision of diamond blades.

- **The Hardness of the Bond Materials in the Segment:** In general, the higher hardness of bond materials, the stronger its abrasability. As a result, when sawing the highly abrasive rocks, the user should choose a high hardness of the bond materials; when sawing rocks of soft texture, the user should choose the low hardness; when the rock to be sawed is highly abrasive and at the same time very hard, a medium hardness of the bond materials should be selected.

How to Prolong Diamond Blades' Service Lives – Cutting Parameters

by Hanjiang Wang, Diamond Blade Select
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Prolonging the service life of diamond blades can not only reduce the user's costs, but also let the resources be used fully. There are 3 cutting parameters which impact the blades' life to a fairly big extent:

- **Line Speed of Saw Blades:** In practice, the line speed of diamond blades is limited by equipment conditions and the quality of blades. However, to get the best service life and cutting efficiency, the user should also consider the different natures of the different stones to be sawed when choosing the line speed. In granite sawing, the line speed can normally be set within the range of 25m-35m/s. For the granite of high-content of quartz and therefore difficult for sawing, the lower limit of the line speed range is appropriate. In the production of granite tiles, as the smaller diameter of diamond blades are used, the line speed can reach 35m/s.
- **Cutting Depth:** Cutting depth is an important parameter related to the wear of diamond, effectively cutting, the pressure situation of blades, and the nature of the stone to be sawed. In general, when a high line speed is selected, the user should choose a small cutting depth. By current technologies, cutting depth can normally be chosen between 1mm-10mm. When large-diameter blades are usually adopted to saw the raw materials of granite, cutting depth can be controlled within 1mm-2mm, and at the same time the feed speed should be reduced.

When the line speed is low, generally a big cutting depth should be chosen to improve the cutting efficiency, but the cutting depth must be permitted by the performance of the machine and the strength of blades. Moreover, when there are requirements for the granite surface, a small cutting depth should be employed.

- **Feed Speed:** Feed speed here means the speed of feed of the stone to be sawed. It impacts cutting efficiency, the pressure on blade, as well as the cooling of the cutting area. Its value should be chosen according to the nature of the stone to be sawed. In general, when sawing soft stone such as marble, the user can increase the cutting depth and decrease the feed speed. This will improve the cutting efficiency. When cutting a kind of granite which is of fine structure and is relatively homogeneous, the user can appropriately increase the feed speed. If the feed speed is too low, the cutting edge of diamonds will be easily removed. However, when cutting another kind of granite which is of coarse-grained structure and uneven hardness, the user should decrease the feed speed, otherwise there will be the blade's vibrations which will lead to the fragmentation of diamonds, and the cutting efficiency will then be decreased. The feed speed for cutting granite is normally selected in the range of 9m-12m/min.
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The Advantages and Disadvantages of Cold Press in Diamond Tools' Making

by Hanjiang Wang, Diamond Blade Select
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Cold-pressed diamond tools are much cheaper than hot-pressed diamond tools. They are still widely used in many applications. The cold press production method has some advantages:

- 1) The forming of the tools does not need heating equipment, and the operation is easy.
- 2) The mold need not to be heat-resistant, and has a longer service life.
- 3) The forming production efficiency is high. The tools can be sintered in bulk.
- 4) The density of the formed blanks is lower than the one got via the hot press method, and their porosity is higher. This can help the cooling when these tools are used in grinding or cutting.
- 5) The formed waste products can be recycled timely.

The cold press method also has some disadvantages:

- 1) After sintering, the size of the pressed blanks changes considerably, especially for those complex-shape tools.
- 2) The bonding strength between the pressed blank and the tool's body is low, and issues may arise from these bonding positions.
- 3) The pressure in the cold press is high. This may lead to the crush of the diamonds, and then influence the performance of the tools. There is a raw blanks' movement procedure in the cold press method, and the raw blanks may be bumped and broken.
- 4) The requirement to the forming performance of the raw materials is high. The molds need to be made of high-strength alloy steel.
- 5) The requirement to the workers' blank-pressing skills is rather high.

The Differences between Cold Press and Hot Press in the Manufacture of Diamond Tools

by Hanjiang Wang, Diamond Blade Select
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In the production of diamond segments, diamond grinding blocks, small diamond blades and diamond grinding wheels, one method is to first cold press them into their required profiles and then put them into a kiln for sintering. Another method is to directly sinter them under a certain pressure.

The first method is usually called cold press. It first uses a press machine to cold press the mixture of diamonds and bond powder to their profiles, and then put them in a kiln with reduction atmosphere to sinter them. Though its yield is big, its production procedure and equipment are complex; the blanks after the cold pressing are subject to damage in movements; and the sintering period can be several hours. Also, as the blanks are not pressed during the sintering, the end products' density is low, so they are subject to deformation, and their quality can not be guaranteed.

The second method is usually called hot press. It puts the diamond mixture into a mold, and then uses a dedicated sintering press machine to press it to its profile and sinter it to an end product at one time. Its production procedure is simple; its sintering density is high; and the end products' quality is good. Its production period is normally within 15 minutes. This method is widely used by the industry.

7 Effective Ways to Improve Diamond Tools' Quality

by Hanjiang Wang, Diamond Blade Select
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For improving the quality of diamond tools, we now know 7 effective ways:

1. Adopt high-toughness diamonds in the diamond tools manufacture.

Diamond's quality, grit and concentration play decisive roles in the diamond tools' quality. There are already many famous diamond brands in the world. In August 2007, 20/30 big grit high-toughness diamonds which was produced with China's hinged cubic press machine successfully passed technical identification. This kind diamonds have advantages in both quality and price in the world market. So manufacturers have a more good option.

2. Plate some metal elements for the highly formation of carbide on diamonds to improve the tools' hold to the diamonds.

Good hold to diamonds will cause the diamonds not to fall off from the diamond tools early. In addition, this will also make the diamonds have the good protrusion height, and therefore the diamond tools will be sharper and more durable.

Plating the diamonds with some metal elements, for example Cr, Ni, Ti, W, etc., which will cause the formation of carbide, is a good way to improve the diamond tools' hold to diamonds. This is mainly for three reasons. First, the plated metals can prevent the diamonds' oxidation, graphitization and the hot corrosion of Fe element under a certain temperature, pressure and the time of sintering. Second, the plated metals can form carbide alloy

on the interface between the diamonds and the tool's bond in the sintering. This will do much help to the chemical bonding and metallurgical combining of the diamonds and the metals in tool's bond. Third, after plated with these metals, the diamonds' friction is improved.

3. Use ultrafine powder and pre-alloyed powder in the tools' bond.

Ultrafine powder helps to decrease the temperature of sintering, and increase the hardness. Pre-alloyed powder can prevent metals of low melting point from losing and segregating, benefit the elastic limit and yield strength of sintered products, increase the tools' hold to diamonds, decrease the temperature of sintering, and reduce the time of heat preservation.

4. Use good granulation technique in the production of segments.

Good granulation technologies will reduce the segregation of diamonds, distribute the diamonds more evenly, improve the cutting performance of segments, increase the mobility of the powder, benefit the cold pressing technique, and reduce the dust hazards to workers.

5. Use the vacuum protection atmosphere hot pressing technique and equipments in the sintering process.

Sintering is a key technique in the diamond saw blades' manufacture. It will have an impact on the saw blades' segment density, hardness, cutting performance, technical performance of the sintering equipments, production costs, and product quality.

6. Apply Hot Isostatic Press (HIP) and high temperature brazing technique in the manufacture of diamond wire saws.

Hot Isostatic Press (HIP) can decrease the porosity of the products, and improve the beads' density, hardness, toughness and performance.

High temperature brazing will make the beads have: a reasonable diamonds distribution, chemical bonding and metallurgy combination, a strong hold to diamonds, and good diamonds' protrusion heights. By applying this technique, the use of diamonds will save half, the cutting speed will be 2 to 4 times of the ordinary when the useful life is equal, and the production costs will be lowered.

7. Use laser welding technique.

Laser welding machines can improve the quality of welding. They are characterized by: big power, less gas consumption, low running cost, less maintenance, reliability, quality of the beam, etc. With the laser welding technique, the fixing way of the saw blade's body and its segments is changed from the manual mode to the fully automatic mode, which is precise and reliable.