PCD Piston Tools

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Development Background of Automotive Engine Piston

Global automotive piston market is expected to reach $15,705 million by 2022, growing at a CAGR of 4.8% from 2016 to 2022. Automotive piston is an engine component cylindrical in shape, which slides back and forth in the cylinder bore due to force produced by the expansion of gas during the combustion process. The piston is called the heart of the engine. It is one of the most important parts of the engine.

Pistons, as a very important component in the transmission of energy in automobile engines, have special requirements for their materials: low density, light weight, good thermal conductivity and small thermal expansion coefficient; and have sufficient high temperature strength, wear resistance and corrosion resistance, Good dimensional stability. It should also be easy to make and inexpensive. The piston system consists of a piston, a piston ring and a piston pin; this system transmits the force generated by the connecting rod to the crankshaft.

The piston produces mechanical energy that drives the crankshaft, which in turn drives the wheels of the vehicle. Due to the latter's high compression ratio, petrol engine pistons typically have fewer piston rings than diesel engine pistons. Most pistons are made of aluminum and steel alloys to withstand high temperatures.
Material of Automotive engine piston

Among the various components of the engine, the piston is considered to be the most stress-tolerant and temperature-wide component. Therefore, choose the most suitable material is the key to the successful produce the piston.

From the working environment of the internal combustion engine piston, it can be seen that it has a series of requirements on the material properties of piston aluminum alloy: small specific gravity, small thermal expansion coefficient, good wear resistance, good mechanical properties, good thermal conductivity and good processability. According to the above requirements, three kinds of alloy types are formed during the development of aluminum alloy for piston. According to the content of silicon, eutectic alloy (about 12% of silicon content), hypereutectic alloy (about 18% of silicon content) and High-silicon aluminum (silicon content of about 25%).

With the engine piston material silicon content increased, the processing performance of the material decreased, the hard alloy tools used in the past is not competent. Specific for high silicon aluminum, Manufacturers developed the most ideal tool material - PCD tool.
PCD Tool for automotive engine pistons

Ideal processing tool for Engine piston --- PCD tool
High-silicon aluminum alloy has higher hardness and wear resistance than other aluminum alloys. When cutting, the cutting tool alternately cuts soft aluminum-based and hard silicon particles, the carbide insert are easy to wear and also easily produce BUE, which will affect the roughness and processing accuracy. In order to avoid the BUE and work hardening, the cutting edge must be sharp and the cutting edge must be smooth. PCD tool just meets all these requirements.

Advantages of PCD Tools
(1) The hardness of PCD can reach as high as 8000HV, which is 8 to 12 times of cemented carbide.
(2) The thermal conductivity of PCD is 700W/mk, 1.5 ~ 9 times of cemented carbide, even higher than PCBN and copper alloy;
(3) The friction coefficient and expansion coefficient of PCD are small;
(4) PCD and non-ferrous metals and non-metallic materials, the affinity between small;
(5) Sharp edge and blade surface roughness
Summary

Piston common processing parts, including the Cylindrical, the top surface, the top ball socket, the outer ring groove, pin hole, etc, when the piston material is aluminum alloy, we often use PCD cutting tools for processing pistons with different content silicon aluminum alloy, Selected PCD materials are as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Granularity (μm)</th>
<th>Characteristics</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDW010</td>
<td>10μm</td>
<td>Universal PCD Grade, good toughness and high abrasive resistance</td>
<td>Suit for single tool for rough machining, especially for wood molding, medium and low silicon aluminum alloy parts (such as piston).</td>
</tr>
<tr>
<td>CDW025</td>
<td>25μm</td>
<td>High wear resistance and edge quality</td>
<td>Suit for high Silicion Aluminum alloy, MMC, Tungsten carbide and ceramic, graphite, wear resistant parts, mainly used in wood finishing insert and saws</td>
</tr>
<tr>
<td>CDW302</td>
<td>2~30μm</td>
<td>Mixed 2μm and 25μm, good wear resistance and edge quality and edges strength</td>
<td>It mainly used for machining MMC, high Silicion Aluminum alloy, high strength cast iron and other application.</td>
</tr>
</tbody>
</table>
PCD Tool for automotive engine pistons

When cutting aluminum alloy materials, the tool life of carbide insert is only about 5% of the PCD cutting tools, the cutting speed of the carbide cutting tools is only about 120m/min, and the obtained surface quality is also very poor. However, with PCD Tool, the cutting speed can reach about 360m/min even when roughing high-silicon aluminum alloy, and high processing surface can be obtained. Processing High-silicon aluminum alloy material must use medium particle PCD material CDW010.

For example, when a Russian piston manufacturer processes high silicon products, it can only process 20-30 pistons at one time by using general-purpose cemented carbide welding tools. The wear of the tools is particularly serious and the quality of the piston processing surface is very poor. It can not meet the processing requirements. After using CDW010 grade PCD Tool, it can produce more than 300, processing quantities and processing quality greatly improved than the previous.
1. Machining the top ball socket of the pistons---PCD Grooving Tool

The top of the piston usually is a groove, mainly reserved for the combustion chamber space, so this type pcd grooving tools also called PCD combustion chamber insert. Advantages: When rough and finish machining the top ball socket of the pistons, PCD materials with high wear resistance will meet the requirements of large margin, excellent surface roughness and long tool life!

The head radius of the PCD Grooving Tool can be made according to customer's requirements, so as to meet the needs of different spherical arc piston.
2. Machining cylindrical of the pistons---PCD External Turning Tool

Turning the cylindrical is the easiest process, we can choose ISO PCD Insert, normally pcd modelis VCGX, and the angle can be made as customers' requirements, common angle include 0° and 7°.

Also has some special design PCD Tools for turning process. As the following image, they are commonly used for turning the piston's cylindrical and end surface. They also can be made as customized requirements.
PCD Piston Tools---Grooves

3. Machining Grooves of the pistons---PCD Grooving Tool

When finish machining aluminum piston ring groove, it required high on the performance of the PCD Tools. Most of these PCD Grooving Tools belong to non-standard tools, we need to follow the manufacturer's piston drawings and tool clamping method to determine the structure of the tool, the common tool forms as follows:

PCD Grooving tool process aluminum piston ring groove, compared with the traditional cutting tool, can improve the efficiency and the cutting speed, reduce tool costs.
PCD Piston Tools---Pin hole

4. Machining Pin hole of the pistons---PCD Boring Tool

For machining the piston pin hole part, it often use the following PCD boring blade. The tool is simple in design, and the customer can customize the tip angle, tool nose radius, blade length and blade width according to actual needs.
PCD Piston Tools---Stop End

5. Machining Stop End of the pistons---PCD Turning Tool

Between the bottom of the piston and the inner diameter of the piston connection, there will usually be a small step for the stop. We usually refer to the tool that processes this area as a PCD Stop End Tool.
Some pistons on the market will not be made entirely of aluminum alloy. Sometimes, in order to improve the performance of the piston, cast iron will be used in the first ring groove portion on the top of the piston. At this time, CBN Grooving Tools can be Choosed. For different content of silicon aluminum piston, the first need to determine the structure of the insert, and then you can choose the manufacturer according to the piston material to help you choose the most suitable PCD material.

Halnn superhard, as China's pioneer in the production of super-hard tool, the early brittle and hard materials with cubic boron nitride cutting tools and high-grade diamond for the research, the super-hard tool in the academic community enjoys a high reputation, especially in the "Turning instead of Grinding," ultra-high hardness heavy cutting, high-speed processing of cast iron and other sub-sectors to lead the industry first-class level, both at home and abroad have their own advantages.

At the same time, according to the natural resources of Henan Superhard Materials Institute, Halnn continue to launch new CBN / PCD tools and other new materials tools in the 3C industry, aerospace, nuclear and military fields.
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Thanks!

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