

Types of Cutting Tools & Materials Properties

Cutting tool materials:

The various types of cutting tool materials are used in tools for remove metal from workpiece. Generally, the tool must be harder than the work material. The selection of tool material depends upon the various factor. They are,

- Design of tool
- Production volume
- Rigidity and condition of machine
- Physical and chemical properties of job materials

Properties of cutting tool material:

The various properties of cutting tool materials:

Hot Hardness:

The cutting tool is able to withstand high temperature during the machining without any losses its cutting edge. So the tools or maintained it hardness at high temperature. The hardness of tool must be higher than workpiece. The additional material added to tool for improve hardness. The material of aluminium, tungsten, molybdenum and vanadium.

Wear resistance:

It is the tool ability of resist the wearing. The friction due to contact between tools and work materials during the machining operation. In this reason wear in the tool. If tool not having the sufficient amount of wear resistance, so it will be fail quickly. That give poor surface finish of work material. So the additional of Cobalt material added in the tool combination to increase the wear resistance property.

Toughness:

It is a combination properties of strength and ductility. The tool should be having sufficient toughness withstand the shock and vibration. If the tool having sufficient amount of toughness, the fine edge of cutting tool does not break down or chip formation. When the cutting tool suddenly loaded together, this types of property limit with the hardness in the tool. The high hardness of tool will be brittle and weak in tensile load. For adding additional of molybdenum and Nickel in tool material to improve the toughness.

Low friction:

For generally, the coefficient of friction between workpiece and tool must be a lower. So the lower friction reduce the heating and wearing in the tool material.

Tool cost:

The tool material must be important for economical in mass of production. It should be easily manufacture from the material combination. Above properties addition to the tool material to get the following properties,

- Thermal conductivity will be high
- Easily to grind and sharpening operation
- Resistance to thermal shocking

Types of cutting tools materials:

The following material having suitable for heat treated where ever requirement in the manufacturing of machine tool.

- Carbon tool Steel
- High speed Steel
- Cemented carbide
- Diamonds
- Ceramics

Carbon tool Steels:

The following composition of plain carbon steel used in the cutting tool as follows,

- Silicon – 0.1 to 0.4 %
- Carbon – 0.8 to 1.3 %
- Manganese – 0.1 to 0.4 %

This tool Steel have good hardness, toughness and strength when there are hardened and tempered. This composition of material suitable for lower cutting speed and used in those application. It cutting temperature range is below 200 degree centigrade. It material get including cheap, easy to forging and simply with harden. This material used to made of die, tap, hacksaw blade and reamer.

The medium alloy steel is similarly to carbon tool steel. They are alloyed with sufficient amount of molybdenum, tungsten, chromium and vanadium. It having carbon up to 5%. Molybdenum and chromium are added to combination by increase hardenability of tool Steel, also tungsten added to material composition by improve the wear resistance. The material hardness is lost at 350 degree centigrade. This materials are used to made of punches, die, taps, knives, reamers and etc.

High speed Steel:

Tools or cut the material effectively even at high speed. It steels having high wear resistance and hot hardness in composition. Its cutting speed can be 2 to 3 times more than carbon steel. It tool perform high speed of cut and metal removal rate, improve the cutting performance. This steel maintain its hardness up to 900 degree centigrade. The alloy element such as chromium, tungsten, Cobalt, vanadium and molybdenum are improve the wear resistance and hot hardness. The high speed Steel used for made of drill, tap, die, turning tools end milling cutters.

The different types of high speed Steel used in cutting tools:

- Cobalt high speed Steel
- Molybdenum high speed Steel
- 18 – 4 – 1 high speed Steel

The composition of following material,

18 – 4 – 1 high speed Steel

Tungsten = 18%

Chromium = 4%

Vanadium = 1%

Carbon = 0.75%

It materials give better performance over great range of materials and cutting speed. Its material hardness up to 600 degree centigrade. It is used for all purpose of cutting. So most of cutting tool are made from this steel. Drill bits, milling cutter, single point cutting tool are made from this Steel.

Molybdenum high speed Steel:

The composition of material such as

Molybdenum = 6%

Tungsten = 5%

Chromium = 4%

Vanadium = 2%

This material having ability of high toughness and cutting.

Cobalt high speed Steel:

It having following material composition,

Cobalt= 12%

Tungsten= 20%

Chromium= 4%

Vanadium= 2 %

Also named as super high speed Steel. It types of material used for rope cutting and heavy duty tools like as milling cutter, lathe tools, planner tools and etc.

Cemented Carbide:

It made by mixing of tungsten powder and carbon at high temperature(1500 degree centigrade), the ratio of weight like that 94 and 6 respectively. The tungsten carbide combined with Cobalt, then compacted and sintered in furnace about 1400 degree centigrade. It mainly used at Higher cutting speed. The composition of material like that,

Tungsten= 82%

Titanium carbide= 10%

Cobalt= 8%

That take in form of insert (clamped form or either braced). The clamped insert can be thrown, after that wear out of all cutting edge. The cutting tool have withstand higher temperature at 1000 degree centigrade. It cutting speed is 6 times higher than high speed Steel. But, It is a brittle material and low resistance to shock. It is very strong and preventing the cracking of tool.

That should be having two main types,

Straight tungsten carbide

Alloy tungsten carbide

The straight tungsten carbide have more strongly and higher wear resistance. But, that provide rapid cracking take place in the machining Steel. To improve the resistance of Cratering, alloyed tungsten carbide must be used with adding Titanium and molybdenum carbide.

Titanium carbide material used to reduce the tendency of chip to weld and improved hot hardness to the tools. Titanium carbide addition to improve the resistance to crater wear and made of structure fine grained. For get excellent result, both tantalum and Titanium carbide are inserted. This carbide should be used for machining the very hard steel and machining brittle metal like as bronze and cast iron.

Ceramics

The mixing of Boron nitride powder and Aluminium oxide are sintered 1700 degree centigrade. This type of material having very hard with good compressive strength. The ceramic are used to

made of tips and clamped on metal shank of tool. It perform at high cutting speed as two to three times than tungsten carbide. They cannot used in shock and vibration occur because it is brittle.

The material composition of ceramics tool as follows,

Aluminium oxide= 90%

Chromium oxide= 10%

It have excellence surface finish of work material, high compressive strength, longer life of tool and grater machining flexibility. It withstand the temperature upto 1700 degree centigrade. It materials are used to made of single point cutting tool to machining the work materials such as cast iron and plastic. During the machining process no coolant is needed but tool must be strongly supported.

The different condition for effectively use of ceramics on carbide tools,

High cutting speed

Elimination of any unbalanced force

Use of effective chip removal and chip grads

Highly surface finish on cutting tool

Rigidity of tool and workpiece

Diamond tools:

It is a hardest cutting material as compare to other. For polycrystalline diamond is made by sintering under high temperature and pressure. It material has high compressive strength, low coefficient of friction and it is extremely wear resistance. That is used for machining of very hard material like as plastics, class, ceramic etc. The deformation during the machining process very less due to high compressive and bending strength, high hardness. The Diamond tool provide good surface finish at high speed with good dimensional accuracy. The tool is a very small and best suited for Lightning of cut and finishing operation. Diamond tool can resist temperature up to 1250 degree centigrade.

The properties of diamond tool for generally,

Hardest substance

High heat conductivity

Very low coefficient of friction

Poor electrical conductivity

Low coefficient of thermal expansion

It suitable for high tool life, 50 to 100 time more than cemented carbide. The disadvantages of diamond tool are higher cost and brittleness.