Uses and Applications for Carbide Burs

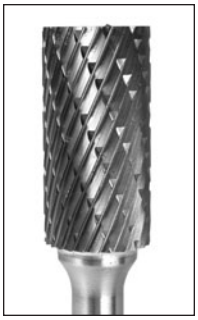
Tungsten carbide burs have been manufactured for decades as a metal cutting tool. Burs are typically used in high RPM die grinders to smooth, remove, or de-bur all types of material anywhere from steel and aluminum to plastic and super hard alloys, such as Inconel, to precious metals. Common industries that use burs extensively are heavy industrial steel fabrication, foundries, aerospace, dental, jewelry making and surgical tooling to name a few.

Burs come in a large variety of sizes and shapes for any application. Perhaps the most important characteristic when choosing a bur is the type of tooth pattern (cut) it has. The most common cuts are shown below. Some applications may require less common tooth patterns not shown here, and end users will ask for very specialized tooth patterns for their specific application and material.

For grinding hard metals such as steel and iron the following tooth patterns are most commonly used:

STANDARD CUT

This tooth pattern is perhaps the second most common fluting pattern because it allows the operator a smooth cutting tool with moderate material removal and a smooth clean finish.



DOUBLE CUT

This tooth pattern has become the most widely used tooth pattern in the industry. The primary teeth are ground identical to the Standard Cut tool, but a secondary flute in the opposite direction of the standard teeth is ground to allow more material to clear the flutes as you use the tool. The material removal is faster than the standard cut but the finish will be slightly less smooth.

BEAR CUT

In the heaviest industrial applications we recommend the Bear Cut bur, also known as the Shipyard Cut. This tool is not really suited for retail sales, but more for the professional end user looking for high material removal. The tool achieves its aggression by having less teeth and a different geometry so that the operator can work very quickly with the tool. It is more difficult to control than either the Standard Cut or Double Cut tools, but is a very important tool for applications that need fast material removal and not necessarily a smooth clean finish.

For grinding soft materials like aluminum, copper, zinc or plastics there is one specific tooth pattern used:

NON-FERROUS CUT OR ALUMNA BUR

This tooth pattern has relatively few teeth with much deeper flutes than any of those mentioned above. The design of the tool allows for very easy chip clearance from the material being ground. These tools will not "clog" as easily as the above patterns would when working with soft material.

The technical aspect of the teeth or "flute geometry" as it is commonly known is more complicated. The flute geometry has several important factors that determine the speed of material removal, the ease of control of the tool in the operator's hands and the finish the operator is looking to achieve. Some of this was discussed above in choosing the correct tooth pattern for the application but here are the specifics as to why one pattern performs in one manner as opposed to another.

- **RAKE ANGLE** – The rake angle is the angle of the cutting surface that comes in contact with the material being ground. Most modern burs are ground on CNC fluting machines that allow far greater manipulation of the rake angle than in the past. With burs the rake angle is found in negative degrees. We grind our burs based on applications typically between -10deg and -20deg. The higher the negative rake, the more aggressive the tool tends to become .
- **FLUTE DEPTH** – Flute depth varies greatly based on the diameter of the bur as well as the tooth pattern but should be consistent all the way around the tool. The most important aspect of flute depth is the ability of the chips to clear the flutes and continually expose a clean sharp cutting surface. Flutes that are too deep trap material in the base of the flute causing them to clog. Flutes that are too shallow don't allow a good chip to form causing the chip to stay in contact with the material creating excessive heat that will breakdown the cutting edge too quickly.
- **TOOTH THICKNESS** – Is a direct correlation with the tooth's ability to accept the impact of hitting the material at very high RPM. The tooth thickness is a function of the rake angle and flute depth and measured across the mid-height of the tooth.
- **HELIX ANGLE** – The helix angle is the rotational angle of the teeth as they travel from the top of the bur towards the shank. This is the barber pole like pattern you see on the tool when you turn it with your fingers. The helix angle has the largest impact on the operator's control of the tool. Typically retail based tools have a 30 degree helix angle which offers a great deal of control by the operator. The higher the angle the more control. Lower helix angles offer faster material removal but less control. Shipyard cut burs and alumna burs have lower helix angles to maximize material removal.

To determine the right flute geometry for their bur lines each manufacturer makes decisions on what characteristics they want their tools to have. For Grobet standard and double cut burs, we have made decisions to maximize control of the tool with material removal and long tool life. To do this we have a fairly high helix angle for control, we maintain a medium rake angle and stress flute thickness to maximize tool life. The double cut bur as identified above is essentially a standard cut bur with a secondary cut in the opposite helix angle. While a standard cut bur will typically remove longer, thinner chips from the material being ground the double cut bur will break the chips into smaller pieces and allow them to exit more quickly from the flute exposing the cutting surface more to the material.

The Bear cut bur was developed over time and with a great deal of interaction with many of our heavy industrial customers. These customers are looking for maximum material removal with the least attention to the surface finish. These tools have a lower helix angle than standard or double cut burs and thus are more difficult to control. Professional operators are used to this situation but prefer the greater material removal. There are fewer flutes in this cut allowing for deeper flutes producing bigger chips. These tools have a higher rake angle as well which makes for a more aggressive cut for the operator. As mentioned above, these burs take time to get used to and could remove too much material too quickly for the retail market.

Non-Ferrous or Alumna cut burs act more like endmills than burs. Cutting soft material produces very large chips that require very big flutes to allow clearance. The cutting tooth has a relief along the length of the tooth so that the back of the tooth does not contact the material being ground with the bur and thus reducing heat build-up.

Heat in any cutting tool is what will reduce its life. Trying to manage the removal of the chips from the flutes is critical to the life of the tool. For applications generating larger chips, the helix angle is typically lower so that they exit the flute as directly as possible.

Once the correct tooth pattern is determined, then you must decide on the best tool to run the bur and what the correct RPM would be. Please refer to the chart below to determine optimal RPM based on the diameter of the bur you are using. Pneumatic die grinders are the most common device to hold and use a bur, but certainly other tools can be used. Please keep in mind, that the higher the RPM, the smoother the tool should run in your hand. If you begin to experience chatter while using the bur you should first check the flutes of the bur (the area in between the teeth) to ensure there is no material stuck in there causing an out of balance condition. Clean out any debris and try using the tool again. If the chattering continues try increasing the RPM of the bur until it smoothes out. The bur requires constant steady pressure to perform correctly, but it should not be forced down with excessive pressure. The bur should only be in contact with one surface at a time. Burs that are forced into corners that come in contact with two surfaces at once can fail and break.

Typically speaking, in the application of Carbide Burs the smaller the tool is the faster the desired RPM. Some of the smallest tools, for example 1/8" or 3mm diameter tools and below will perform best in very high RPM "Pencil Grip Grinders." While they are not necessarily required, attention should be given to the recommended RPM on this chart so that the end user gets the most satisfaction out of the use of these burs.

Recommended RPM for

Head Diameter	Soft Material	Hard Material	Brass, Cast Iron, Copper, Bronze	Unhardened Steel
16	8,000 - 30,000	12,000 - 19,000	9,500 - 23,000	18,000 - 23,000
15	8,000 - 33,000	13,000 - 20,000	10,000 - 25,000	18,500 - 25,000
14	8,500 - 35,000	15,000 - 22,000	10,000 - 28,000	20,000 - 27,000
13	8,500 - 40,000	16,000 - 24,000	11,000 - 30,000	21,000 - 30,000
12	8,700 - 42,000	18,000 - 25,000	12,000 - 33,000	23,000 - 31,000
11	9,000 - 45,000	19,000 - 27,000	13,000 - 36,000	25,000 - 35,000
10	10,000 - 50,000	20,000 - 30,000	15,000 - 40,000	28,000 - 39,000
9	11,000 - 54,000	21,000 - 33,000	16,000 - 43,000	30,000 - 43,000
8	12,000 - 58,000	24,000 - 36,000	19,000 - 47,000	35,000 - 48,000
7	15,000 - 62,000	26,000 - 40,000	20,000 - 53,000	39,000 - 52,000
6	18,000 - 70,000	30,000 - 47,000	24,000 - 60,000	41,000 - 57,000
5	21,000 - 75,000	38,000 - 55,000	29,000 - 69,000	47,000 - 65,000
4	25,000 - 80,000	45,000 - 67,000	35,000 - 78,000	51,000 - 75,000
3	30,000 - 90,000	58,000 - 90,000	45,000 - 90,000	59,000 - 90,000

Notes:
1. Speeds recommended may be adjusted for optimum results
2. Use slower speeds for hard materials
3. Apply light pressure with constant movement
4. Speed's below optimum can cause chipping
5. Do not bury the bur into the work. Use approx 1/3 of the length
6. Too high of a speed will wear the teeth