Main characteristic of carbide drills

The figure N°1 shows the shape of a drill tool with the geometrical characteristic and the name of its parts.
We must observe that some effective angles are changed compared to the nominal angle in accordance with the direction of cutting direction.
Both the cutting direction and the effective angle of the cutting edge are different in each diameter of the cutting cone.
This means that in ever point of the cutting edge change the cutting condition.
The cutting direction , and therefore the effective angles, are connected with the value of the feed per revolution and the diameter considered in accordance of the following formulae.

$$\Delta\alpha = arctan\frac{f}{\pi d}$$

$\alpha_{ex} = \alpha_x$- $\Delta\alpha$ = $\alpha_x - arctan\frac{f}{\pi d}$ and $\gamma_{ex} = \gamma_x + arctan\frac{f}{\pi d}$

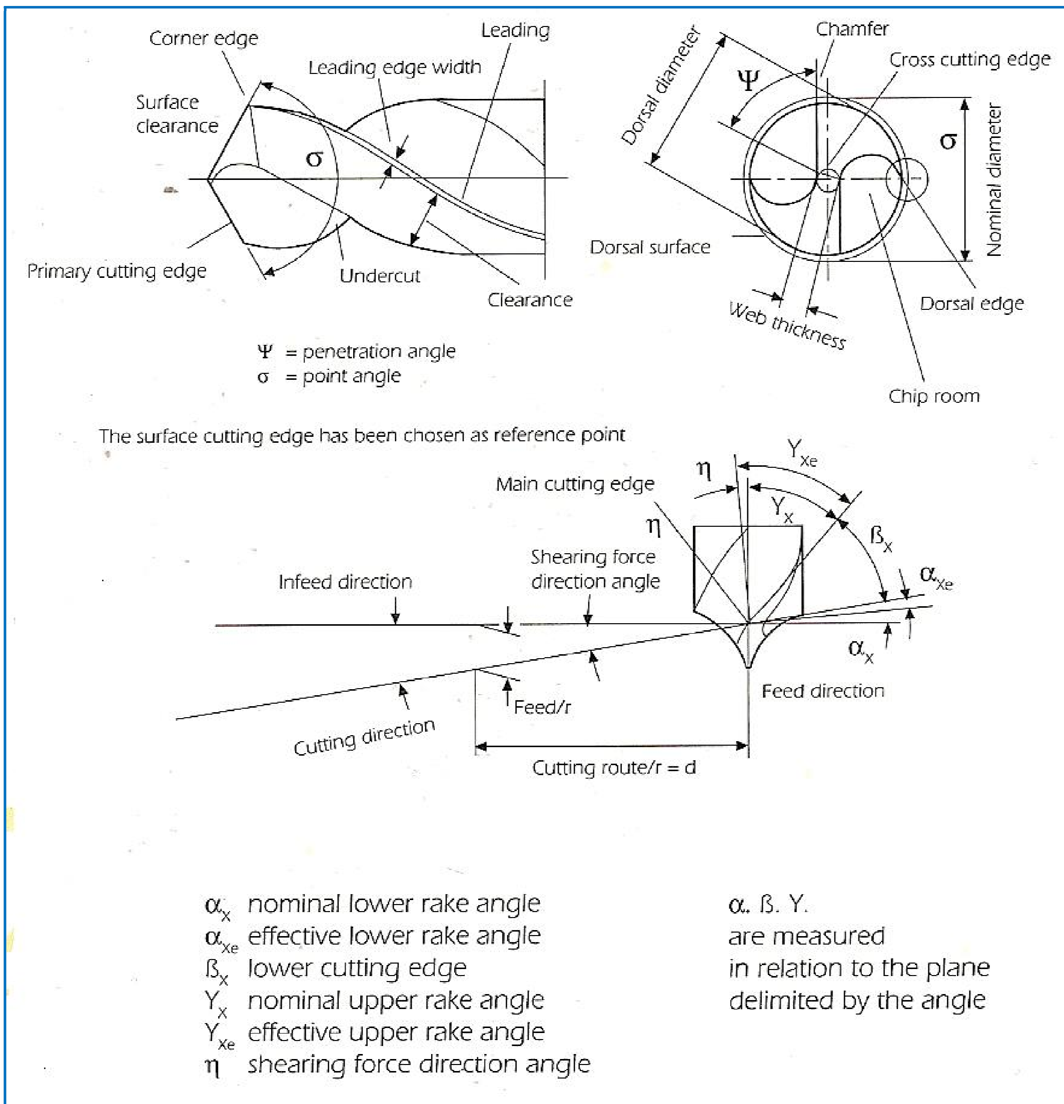

Fig.N°1- *Geometry of the head of a drill cutter*

The angle α_x (and the α_{xe}) are relief angle and if these values become too small there are the danger of interference between the workpiece and the rear part of the cutting edge. For this reason the cutting action in proximity of the center is more difficult.

Carbide drills

For mechanical use normally the carbide drill are “solid” up to 20 mm of diameter, means they are obtained by grinding the flutes from a solid blank cylinder of “Carbide”.
For to obtain the best result the manufactures are using now the micro-grain carbide.
The performances of the drills and the total life depends also if the tools are coated or not.
With an appropriate coating we can obtain a large economical advantage, like it’s shown in the figure N°2.

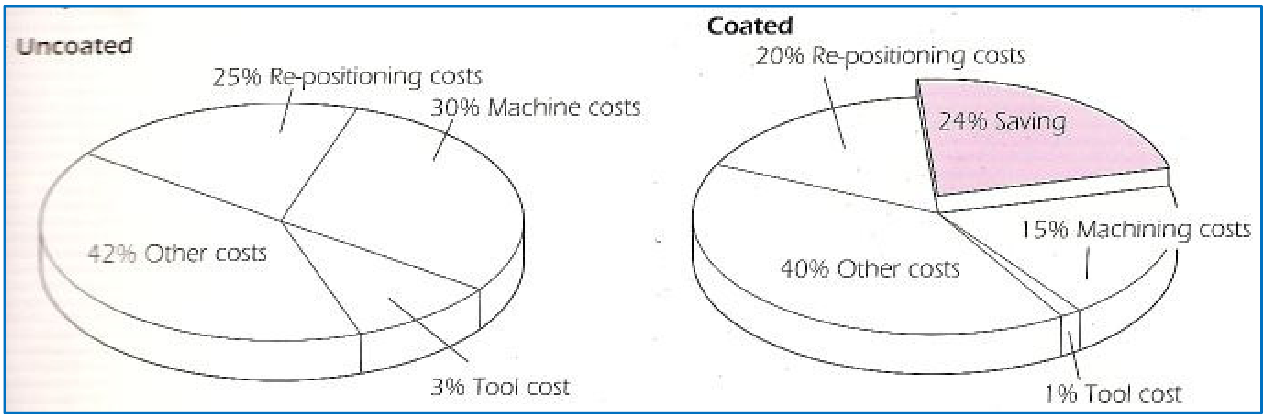

Figure N°2- *Comparison between machining cost using uncoated and coated tools (data from Cerin SpA)*

In accordance with the different working material it’s used a specific coating material. Cerin SpA (Affi – Verona – Italy) uses the following colours for recognize the different type of carbides.

	TiAlN	Titanium & Aluminium Nitride	Very hard material (3300HV) with low heat conductivity and goo friction coefficient. It stands very high machining temperatures and is suitable for dry cutting, high speed cutting and abrasive materials.
	TiN	Titanium Nitride	Tough the strongly adhesive coating with low thermal conductivity. Its hardness is 2500 HV and is suitable for medium cutting speed tools.
	TiCN	Titanium Carbonitride	Tough and strong multi-layer coating. It is very hard material (3250 HV) with a low coefficient of friction. Suitable for steel machining at medium cutting speed with coolant.
	CrN	Chromium Nitride	Very tough coating. Hardness (1800 HV). Low coefficient of friction and good resistance to high machining temperature. Good abrasion resistance.

The following two tables show the working condition suggested by the company Cerin SpA (Affi-Verona -Italy), the first one for non coated tool, the second one for coated drills.

Tab. N°1 – Working condition for non coated carbide drills

Material	Cutting speed Vc - m/min	FEED PER TOOTH ACCORDING TO DIAMETER							Coolants
		Ø 2	Ø 5	Ø 8	Ø 10	Ø 12	Ø 16	Ø 20	
Steel up to 500 N/mm²	80-90	0,02	0,04	0,06	0,08	0,08	0,10	0,10	emulsion
Alloy steel over 500 N/mm²	50-60	0,01	0,02	0,04	0,04	0,05	0,08	0,08	emulsion
Tool steel	40-50	0,01	0,02	0,02	0,03	0,04	0,05	0,05	oil
Hardened steel	40-50	0,01	0,05	0,020	0,025	0,025	0,030	0,05	oil
Spring steel	40-50	0,01	0,02	0,03	0,04	0,05	0,06	0,08	oil
Cr-Ni steel - Stainless steel	30-40	0,01	0,015	0,02	0,03	0,04	0,05	0,06	emulsion
Alloy steel special alloys	20-40	0,01	0,015	0,02	0,025	0,03	0,03	0,04	oil emulsion
Semisteel cast iron	50-70	0,01	0,02	0,03	0,05	0,08	0,10	0,12	emulsion
Cast iron up to 200 HB	60-70	0,02	0,04	0,05	0,06	0,08	0,10	0,15	dry/emulsion
Cast iron over 200 HB	50-70	0,02	0,03	0,04	0,05	0,06	0,8	0,10	dry/emulsion
Cast iron up to 500 HB	40-50	0,02	0,03	0,04	0,05	0,06	0,07	0,08	dry/emulsion
Cast iron over 500 HB	40-50	0,02	0,03	0,04	0,05	0,06	0,07	0,08	dry/emulsion
Copper / bronze / brass	100-120	0,02	0,04	0,05	0,06	0,08	0,10	0,15	emulsion
Aluminium alloys up to 11% Si	80-100	0,03	0,06	0,08	0,10	0,12	0,15	0,15	emulsion
Aluminium alloys over 11% Si	80-100	0,02	0,04	0,06	0,08	0,10	0,12	0,15	emulsion
Titanium and titanium alloys	20-30	0,01	0,02	0,04	0,05	0,06	0,08	0,10	emulsion
Plastic materials Thermosetting	150-200	0,02	0,04	0,06	0,08	0,10	0,12	0,15	dry
Epoxy resin and reinforced fibers	120-150	0,02	0,03	0,04	0,06	0,08	0,10	0,12	dry

Tab. N°2 – Working condition for coated carbide drills

	TiALN		TiN		TiCN		CrN	
Material	Cutting speed m/min.	Feed per tooth Ø 2-4-6	Cutting speed m/min.	Feed per tooth Ø 8-10-12	Cutting speed m/min.	Feed per tooth Ø 16-18-20	Cutting speed m/min.	Coolant
Steel up to 500 N/mm²	120	0,02-0,04	100	0,06-0,08	110	0,10-0,12		emulsion
Alloy steel over 500 N/mm²	100	0,02-0,03	80	0,04-0,05	90	0,06-0,08		cutting oil emulsion
Tool steel	80	0,01-0,03	60	0,04-0,06	70	0,07-0,08		cutting oil
Hardened steel	80	0,01-0,02	60	0,03-0,04	70	0,05-0,06		cutting oil
Spring steel	70	0,01-0,02	50	0,03-0,04	60	0,05-0,06		cutting oil emulsion
Cast iron up to 200 HB	90	0,03-0,05		0,06-0,08		0,10-0,15		emulsion
Cast iron over 200 HB	90	0,02-0,04		0,05-0,07		0,08-0,10		emulsion
Cast Iron up to 500 HB	80	0,02-0,05		0,06-0,08		0,10-0,12		emulsion
Cast iron over 500 HB	80	0,01-0,04		0,05-0,06		0,08-0,10		emulsion
Aluminium alloys up to 11% Si	250	0,03-0,08	200	0,10-0,12		0,15-0,20		dry emulsion
Aluminium alloys over 11% Si	200	0,02-0,07	150	0,08-0,10		0,15-020		dry emulsion
Aluminium castings	200	0,02-0,05	150	0,06-0,08	200	0,10-0,15		emulsion
Copper	230	0,02-0,04		0,06-0,08		0,10-0,15	180	emulsion
Bronze / silver	250	0,02-0,08		0,10-0,12	200	0,15-0,25		dry emulsion
Brass / zinc / nickel	200	0,02-0,04		0,06-0,08		0,10-0,20	150	emulsion
Titanium	40	0,01-0,02		0,03-0,05		0,06-0,08	30	emulsion