ravinaikconsultingspecialist

Selecting the Right Solid Carbide Drill for Drilling Applications

Introduction:

Solid carbide drills (SCD) vs. HSS drills

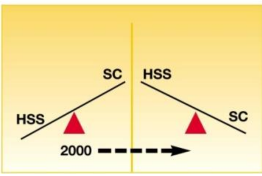
Better machining tolerances – SCDs are stiffer, harder than HSS drills and thus bend much less; SCDs are manufactured to closer tolerances for Diameter runouts and their drill points have a smaller chisel edge, than HSS drills, which enable SCDs to machine holes to much closer tolerances (H9) compared with H13-H14 with HSS drills.

Better productivity – At similar feeds, a cutting speed of about 100 m/min, is possible with SCDs compared to max. 15 m/min. with HSS drills. SCDs will thus offer improved productivity over HSS drills.

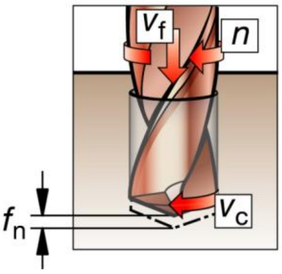
Tool life – The tool life with SCDs is normally 20 times longer than with HSS drills. The cost per hole and the total cost are in general 60 – 80% less as compared to HSS drills. Figures well worth considering!

Therefore the main benefits with SCDs are: Higher productivity, longer tool life, & hence a low cost of production compared with HSS Drills.

There is however, a risk of breakage when using SCDs because of their brittle nature. This is offset by their main usage being on Machining centres and Turning centres with accurate Tool Holding; So with the advent of Machining Centres and Turning Centres in the Metalworking industry at the beginning of this century,the "Sea-Saw" between SCDs and HSS Drills tilted in favour of SCDs @ the beginning of this century.. see fig:



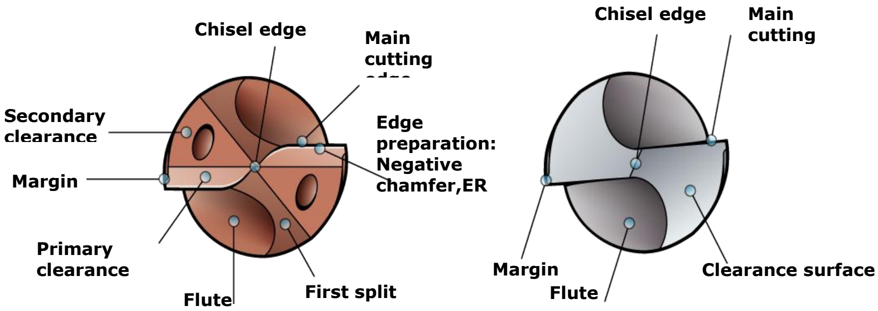
Definition of terms used in Drilling:



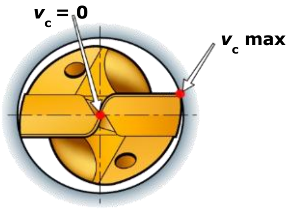
- *n* = spindle speed (rpm)
- v_c = cutting speed (m/min)
- f_n = feed per revolution (mm/rev)
- v_f = penetration rate (mm/min)
- D_c = drill diameter

$Vc = \pi \times Dc \times n/1000$; $Vf = f_n \times n$

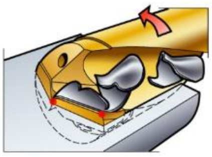
The description of the nomenclatures of used in understanding a modern SCD point and HSS drill point is shown below:

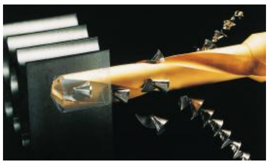


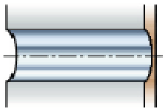
As can be seen from the figures the point geometry of the HSS drill is quite simple compared with the SCD.. why? Carbide being very brittle, it also cannot cut at Vc = 0 at the drill point, nor can the SCD point extrude the material being drilled like a HSS drill.

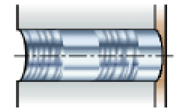


The cutting action of the SCD point geometry plays an important role in forming the chip at the centre where Vc is zero and then directing the chip flow into the drill flutes…..

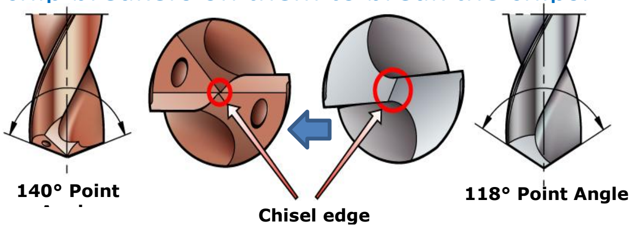





A hole with good chip evacuation.


A hole affected by chip jamming.

It is this point and flute geometry that has to vary, based on the chip breaking character of the materials being drilled … especially as drills have no chip breakers on them to break the chips.



Before we turn to selection of SCDs per application and different materials its important to understand the cutting action of a modern SCD point;

Irrespective of the materials being drilled by modern SCDs with modern PVD coatings would always work at 5-6 times higher Vc-m/min than the Vc of HSS drills in the same material; however carbide being brittle and the fact that carbide cannot cut at Vc= 0 the point geometry needs to be redesigned, to have a very thin chisel edge, that ensures a certain minimum Vc near the centre that allows the drill to cut chips and "push" them into the flutes… this action causes the chips to break and it is this point geometry and flute geometry which is differently designed for different materials and is also very different for different SC Drill manufacturers.

This is generally why different SC Tool manufacturers can have different parameter recommendations; its for the reader to select the Tool Manufacturer who can give him the SCD for the material/Application and recommend the highest "secure" parameters.

Selection of the Right Solid Carbide Drill(SCD) for different materials and Applications:

For SC, every Tool Manufacturer has a different approach to arrive at Drill variants specific to a material or application, based on their Market-Application knowledge, manufacturing techniques and their understanding of the cutting action of the SCD; so it is necessary for the reader to select the SC Tool manufacturer and then ask him to supply SCDs suitable for "Steel" or "Cast Iron" or "Stainless Steel" or an "Aluminium.

This will generally mean the right combo of:

1. Grade of Carbide.
2. The right geometry of the drill point (chisel edge value, concentricity, cutting edge preparation- to make it sharp but still have the appropriate sharpness needed for the material being drilled) & the right flute geometry (margin, back taper, flute shape etc).
3. The right type of PVD coating to ensure an optimum tool life at the parameters recommended by the Tool manufacturer.
4. The right Tool holder for secure and concentric holding of the SCD.

1. Carbide Grade:

Since a carbide drill cuts from almost zero Vc to the maximum at the OD of the drill, the carbide grade needs to be tough and yet highly wear resistant.. Generally carbide grades used to manufacture drills have 8-10% Co;
In most applications since the chips flow in the flutes its important to have a good coolant flow to push out the chips from the flutes. For difficult to machine materials like Stainless , Titanium, its always recommended to have internal coolant thru the drill and then, to have this the carbide rods should have internal coolant holes in them.

2. The right Flute and point geometry:
We have seen above that a modern SC Drill requires a very thin chisel edge- which is a common requirement for most SC Drills designed to drill in different materials….. and at the same time the Drill Flute geometry has to be optimised to accommodate the chips which are a characteristic of the material being drilled. It is difficult reproduce consistently -the optimum point and flute geometry combinations that are designed per material and application on conventional grinding machines. Thus such SCDs have to be manufactured on sophisticated CNC Tool and Cutter Grinders like the ANCA which have the CNC Programs to manufacture SCD and the drill points. These are generic drill manufacturing programs with software support where the Tool manufacturer has to design the drill and enter the design values of the drill as designed by him into the generic programs.

So if a SCD is to be manufactured for drilling in stainless, the Tool manufacturer must be able to specify values of the chisel edge , flute form etc in the grinding machine software and only then be able to produce the drill and then test it in SS and evaluate if the results meet the market requirement or else the Tool Manufacturer has to re-design and start all over again.
The Grinding Machine maker will offer patented Drill point programs for different MNC drills at extra cost to the Tool Maker… but these Programs are so designed that they can be used only for regrinding used drills and not for manufacturing new drills.
Hence most Tool makers try to reverse engineer the drill geometries from the drills working on the Market and then produce them on these machines.

ravinaikconsultingspecialist

My Client – M/S Aayudh Tools has been able to design and establish different Drill geometries (Geometry+ coating combos) like
Aayudh P for Steel drilling, Aayudh K for Cast Iron drilling, Aayudh S for Stainless Steel Drilling , Aayudh N for Aluminium.
A few Case Studies of these geometries are attached below……
So the user has to ask the tool maker for the SCD based on the application/material to be drilled.

3. The right type of PVD coating will be selected by the Tool maker based on the application which the SCD drill is targeting.
The Tool manufacturer based on the carbide grade, drill geometry and the coating will recommend the cutting parameters to the user, who can then benchmark with the best on the Market and decide to go in for the SCD from this Toolmaker or not.

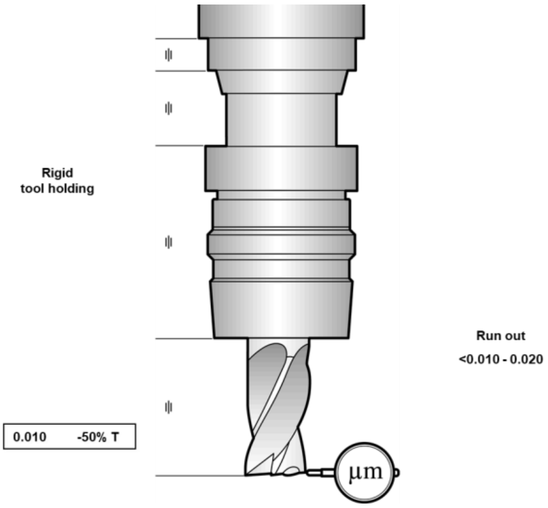
4.The Right Tool Holding:

Another factor which is very important for drill performance and security is the Tool holding used for the SC drill. Conventionally the most commonly used holder for SC Drills use to be the ER Collet Holder; But with Modern Machining Centers becoming the mainstay for drilling applications the metal cutting industry is rapidly upgrading to high precision Hydraulic holders for process security at high cutting speeds of Vc= 80 to 120m/min; Hydraulic Holders give more secure gripping on the drill shank and maintain the TIR(Total indicated reading) on the Drill corners under 5-6 µ .

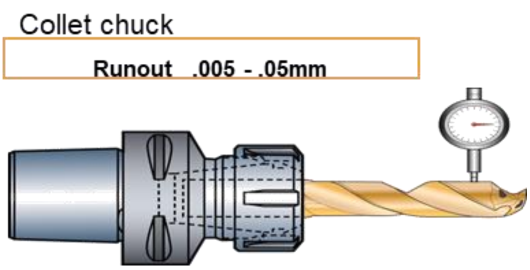
Commented [R1]: This para about holder may be substantiated by some data in terms of gripping load (Force) of Mechanical Vs Hydraulic Drill Chucks .

The "why" of this can be seen from the figure below:

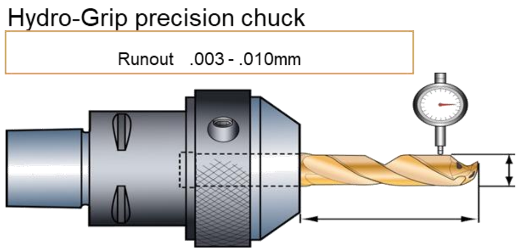
ravinaikconsultingspecialist



A good rule of thumb: For every 10 µ increased runout, the tool life decreases by 50%.



An ER Collet chuck will transmit upto 45-50Nm torque on a 16mm drill shank(h6 quality) upto a maximum of 40-45Nm..



*HYDRO-GRIP is fom ETP Transmission of Sweden

A HYDRO-GRIP Holder will transmit a torque of @ 160Nm on a 16mm drill shank(h6 quality)