Drilling Aluminum: Notes and Common Practices

Drilling Aluminum

The question arises on drilling aluminum of why the strong squeak during drilling, and the larger the drill and deeper the hole the more it squeaks. Furthermore, the drilled hole becomes enlarged beyond specification and the hole surface is poor. It is also noted that the softer the aluminum material the more the tendency to squeak increases i.e. EN AW-6060i and EN AW-2007; it also shows up also in easy to machine materials such as aluminum casting EN AW-5083.

The squeak bespeaks the sound of tearing (shearing/ galling) aluminum when drilling these aluminum alloys.
Lubricity-feed-speed are not in agreement, so metal-to-metal contact occurs, causing welding of aluminum to the drill bit –and immediate tearing (shearing). The operator is used to using hazardous cutting oil additives without a doubt, but it works – up to a limit point as well, and is efficient as cutting/lubricating oil but hazardous; it's cheap to purchase as well. Disposal costs and health costs are of course additional components to the hazardous cutting oil.

The issue with aluminum is its softness and low melt temperature (Table 1.) which makes it very "stringy", especially with drilling. As the drill bit face cuts into the bottom of the aluminum hole, causing heat build-up, the cut aluminum 'slice' is momentarily stationary and then wraps itself into the 'flute' or 'land' of the drill bit where it forms a continuous aluminum twist, causing binding of the drill bit (Figure 1.) which exacerbates the heat build-up of the drill bit. All materials will do this to some extent due to the nature of the drill bit to clear materials out.

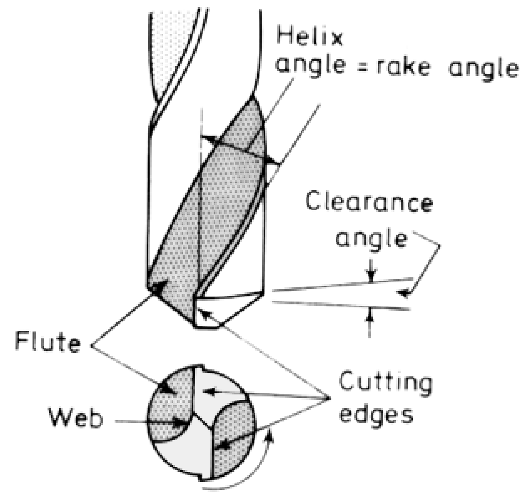
Table 1. Melting Points of Various Metals

Metal	Melting Point (°C)	Melting Point (°F)
Aluminum	660	1220
Aluminum Alloy	463 - 671	865 - 1240
Brass, Red	1000	1832
Chromium	1860	3380
Cobalt	1495	2723
Copper	1084	1983
Hastelloy C	1320 - 1350	2410 - 2460
Inconel	1390 - 1425	2540 - 2600
Iron, Gray Cast	1127 - 1204	2060 - 2200
Magnesium	650	1200
Magnesium Alloy	349 - 649	660 - 1200
Nickel	1453	2647
Steel, Carbon	1425 - 1540	2600 - 2800
Steel, Stainless	1510	2750
Titanium	1670	3040
Tungsten	3400	6150
Zirconium	1854	3369

Figure 1. Welded Drill Bit During Aluminum Drilling

Welded drill bit end caused by melted aluminum

Flute for chip removal



If the operator just hammers the drill down, forgetting that the stringiness of the aluminum twists when drilling causes the “lands” or flutes of the drill bit to load up, causing more heat, welding and galling. Here the feed is more the issue of blame. What should be done is to:

1. choose the right type of drill bit for drilling aluminum in order to clear the chips effectively
2. reduce the speed of drilling to reduce the temperature, hence aluminum welding
3. use the “Peck Drilling” retract cycle on drilling so that the lands of the drill bit clear on the retract cycle (See note below). On smaller holes you would clear very frequently to prevent problems. This is a well-known issue in drilling and the experienced machine operator deals with it as a matter of course.

So the question on the Drill Press and the VHM Reamer is: do we increase the cost of the coolant, i.e. “GreenCut Cutting Fluid” by increasing the mix ratio to perhaps 15% - 20%, and/or changing the feed/speed ratios so that it works well, or do we sacrifice safety and disposal costs by staying with the existing cutting oil. There is obviously a cost versus safety decision on the drilling machine that has to be made here by the Client.

We do not find these issues in working with the steel and/or other alloys. Aluminum alone is the culprit, due mainly to its low melting temperature as compared to steels and other alloys such as carbon/stainless steels, Inconel, titanium, and brass.

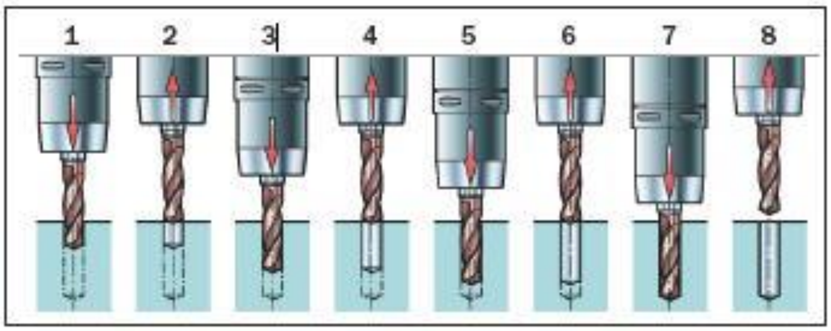
What is "Peck Drilling"?

Peck Drilling

A term you'll hear a lot is "peck drilling". This is the practice of drilling a little ways (the peck distance), back off some distance, and then going back down to the bottom to take another peck (Figure 2). Think of the motion as being not unlike a woodpecker. The reason it's done is to evacuate the chips from the bore. Re-cutting chips is always a bad thing for tool life. There's only enough room down in the bore for the chips that fit in the flutes of the twist drill, and the deeper the hole, the harder it is to evacuate those chips out of the hole. Peck drilling helps in two ways. First, even a very short peck where the retraction is minimal helps to break off the chip resulting in shorter chips. Shorter chips are much easier to evacuate.

Second, if the twist drill retracts a substantial distance, this helps reduce the distance the helix of the twist drill has to carry chips.

Figure 2. Peck Drilling



Source: SANDVIK Coromant

One thing that is important to avoid when peck drilling is letting the coolant or air/mist blast wash chips back down the hole. For that reason, the best peck drill cycles will not pull the twist drill completely clear of the hole.

There are some rules of thumb about when you need to start using a Peck Drilling Cycle as opposed to just plunging straight down. Most tooling manufacturers will suggest you start when the hole is four diameters deep.

Milling Aluminum

The operator notes on the milling of same material where he states that “Milling of all div. Aluminum materials went very well”. Here the feed-speed-lubricity are in agreement. There is no tendency for the aluminum to form into twists that load up the flutes of a drill bit due to the open space (lack of a hole) and effective chip removal.

Benjamin Vroon,
Chief Engineer
LubeCorp Manufacturing Inc
Tel: 403-250-8448