

## Recommendations for Drill-Out Composite Plugs On Threaded Pipe

Improving frac plug drill out in multi-zone completions is an important step in enhancing the development of unconventional assets. The key challenges are efficiency and durability in drilling the diverse materials that make up the 10 to 50 plugs in a typical completion, and addressing the resulting pressure spikes, composite material, sand concentration and exposure to high-hydrocarbon fluids that can reduce bit life.

Careful selection of a bit is crucial to a safe and smooth drill out. I would recommend a roller cone type, max OD, tri-cone short tooth hard rock formation bit for drilling out the composite frac plug on threaded pipe.

Roller cone bits are used in horizontal wells to reduce the risk of casing damage. Roller cone bits have the advantage of a lesser tendency to stall.

This type bit also puts less torque in the tubing. These qualities tend to give longer motor life with less tubing fatigue. Roller Cone bits require greater WOB than mills because the bit relies on crushing action rather than shearing to remove the plug.

The disadvantages are the bit's roller bearings are more suited to low RPM operations rather than the long duration, high RPM milling used in plug drill outs. Roller cone bits also seem more adversely affected by plug metal content than a mill.

**Roller Cone Bits having the following characteristics are known to give good results.**

Bit Diameter: 92-95% of casing drift diameter.

Bits with too small OD will allow larger cuttings to get behind the bit. The risks of the tool string getting stuck or large pieces ending up in the surface equipment increase.

Run in the hole with the drilling assembly (BHA) and gently tag the plug. Pick up several feet and then engage the pump and start rotating the pipe. Slowly set down on the plug to begin drilling.

While drilling the plug with the bit described above, the following parameters are recommended.

# *RMS Technology*

- Pump Rate 3 – 6 bbl. /min
- Rotational Speed: 90 – 120 rpm
- Weight on Bit: 2,000 - 8,000 lb.

Drill the plug with a consistent amount of weight on the bit. DO NOT SPUD ON THE PLUG. This will help to keep the plug anchored to the casing until the bottom slips are drilled through, giving the bit a stable drilling platform against which to drill. This will ensure that the plug is drilled up in the most efficient manner and that the cuttings are as small as possible. Spudding on the plug will break it free from the casing faster, but will result in much larger cuttings that must flow up-hole, as well as a larger bottom piece of the plug that must be pushed down-hole.

After the plug has been freed from the casing, continue to push the bottom part of the plug down-hole onto the next plug to be drilled. If significant amounts of sand are encountered while going down-hole, it may be necessary to simultaneously rotate and circulate down the tubing while continuing to run in hole. When the bottom parts of the undrilled plug make contact with the plug below, continue the drilling operation.

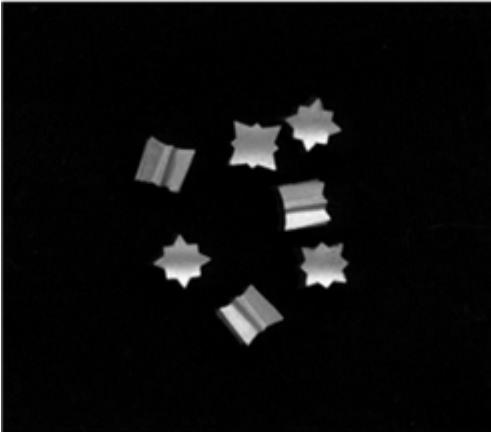
It is recommended drilling 3 to 4 plugs, then making a short trip, and pumping gel sweep and circulating the well bore clean. (6 to 15bbl min)(Get bottoms up 1 or 2 times)

Once the last plug in the well has been drilled to the point at which it breaks free from the casing, it may be pushed to the bottom of the well, or at least a safe distance below the bottom set of perforation.

## Drill Bits

	<p><b>Example Of Bit Type</b></p> <p>A roller cone type, max OD, tri-cone short tooth hard rock formation bit for drilling out the SCS Frac plug on threaded pipe or coil tubing.</p> <p>“A” Tooth Type</p>
	<p><b>Example Of Bit Type</b></p> <p>Here is a roller cone type with tungsten carbide inserts along the outside of the cone for hard drilling, such as cast-iron or hard ceramic slip material, and steel teeth for the drilling of the composite material that make up a composite plug.</p>

## 4 to 5 Blade Junk Mills

	<p><b>Example Of Mill Type</b></p> <p>The best mill for milling all composite bridge plugs and composite frac plugs is a junk type 4 or 5 (blade) mills that have a 15 to 20 degrees inward taper from the outside to the center of the mill. The blade number should be 4 to 5 blades.</p> <p>Flat type mills have larger milling surfaces but do not work as good as bladed type mills. When sizing the mill to be used use 92% to 95% of casing drifts.</p>
	<p><b>Example Of Carbide Type</b></p> <p>Tungsten Carbide</p>  <p>Star-Cut</p>