

Recommendations for Mill-Out on Coiled Tubing

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 or mill is crucial to a safe and smooth drill out. It's recommends a roller cone type, max OD, tri-cone short tooth hard rock formation bit or a 4 or 5 blade mill for drilling out the composite plugs; on coil-tubing mills take longer to mill-out.

Motor Size

Positive Displacement Motor (PDM)

For horizontal wells, most PDMs used in composite plug drill outs are 2 7/8 and 3 3/8 inch diameter.

The best practice is to choose the largest appropriate motor. A larger PDM has the advantages of higher torque ratings, a greater resistance to stall, better well bore cleaning, and a reduced risk of being stuck in a well.

Motors with equidistant style stators are preferred for their higher torque, longer life, and higher operating temperatures.

Bit Type

Roller Cone Bit Selection

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.

The SCS plugs are often drilled out using short tooth roller cone bits (aka tri-cone or rock bits). 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. They also put less torque in the coil tubing. These advantages tend to give longer motor life with less tubing fatigue.

Roller cone bits will require greater WOB than mills, because the bit relies on crushing and tearing action rather than just a tearing action like a mill to remove the plug.

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

Superior recommends that the bit diameter be 92-95% of the casing drift diameter. Bits with too small of an OD, will allow much larger cuttings to get behind the bit or mill. The risks of the tool string getting stuck or large pieces ending up in the surface equipment will increase. Use a bit whose cutting face is compatible with the plug's features. There should not be gaps in the teeth rows that would allow the bit to merely wear against an uncut surface rather than the tearing action that the bit produces.

Mills for Drill-Out

The best mill for milling all composite bridge plugs and composite frac plugs is a junk type 4 to 5 (blade) mills that has a 15 to 25 degrees inward taper from the outside to the center of the mill. The blade number should be 4 or 5 blades. Flat type mills have larger milling surfaces but do not work as well as bladed type mills. When sizing the mill to be used, use 92% to 95% of casing drifts.

Mill OD's that is too large can prevent proper circulation of fluid up the annulus and prevent larger particles from passing by the mill. Proper size mills will perform better due to improved fluid movement by the mill during the milling operation and keep the big chunks from getting beside the BHA and becoming stuck.

The Kutrite / tungsten carbide size and type have a great deal to do with the tearing of the composite material, we do not want to cut the material, we want to tear it up.

In the laying of the Kutrite / tungsten carbide on the mill with standard cut rite will work, but milling time will be longer. For the fastest and best milling time, the mill should be dressed with Star-Cut, starting with 3/8" at the outside then 1/4" to the center.

Please do not forget that you have a stall factor in the motor that will play a big part on your size and type of mill you will be running. DO NOT SPUD ON THE PLUGS when milling.

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Drill Bits

	<p>Example Of Bit Type</p> <p>Superior recommends 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>Example Of Bit Type</p> <p>Superior recommends 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 typically makes up the center of a frac plug.</p>

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4 or 5 Blade Junk Mills



Example Of Mill Type

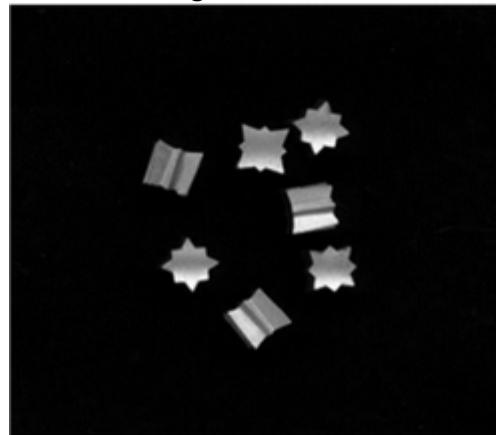
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Example Of Carbide Type

Tungsten Carbide



Star-Cut