

FREQUENTLY ASKED QUESTIONS



What are some applications in which you've successfully used this product?

- New Completions
 - Stage by Stage Diversion
 - Between Frac plugs for Intra-Stage Diversion
 - Replace Frac Plugs with Perf PODs
 - Full Wellbore Diversion
 - Perforate extended length section or full lateral at once. Use Perf PODs between proppant cycles to "Hail Mary" frac
- Recompletions or Re-Fracs
 - Full wellbore, using Perf PODs between proppant cycles to "Hail Mary" frac
 - Chemical treatments, pumping acid for scale cleanup/perf damage
 - Salt water disposal wells
- Casing Problems
 - Liner leaks
 - ID restrictions
 - Eroded perforations or holes in casing

How many wells have you completed, replacing all bridge plugs?

As of February 2019, we have finished 20+ new completions, replacing all bridge plugs. Using the Perf PODs as isolation between intervals has shown to decrease completion costs while maintaining same or better production outputs as the standard plug-and-perforate design.

What temperature range are the Perf PODs rated? How long does it take to degrade?

We currently have three degradable Perf POD materials available:

- Bio-Rez® LO will degrade at >150°F in 14 days
- Bio-Rez® HI will degrade at >175°F in 14 days
- Thal-Rez® will degrade at >280°F in 14 days

The degradation rate of all three materials will increase when exposed to higher BHT than the temperatures listed above.



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How much pressure differential can the Perf PODs withstand?

The pressure rating is dependent on the perf EHD (Entry Hole Diameter) as well as the size of the Perf POD. We have built custom sizes based on EHD, type of application, camera/caliper data, etc.

Our standard Perf POD size for new perforations is rated for a 0.50" EHD; the degradable materials will hold 7,500 psi and millable materials will hold 10,000 psi of differential pressure. We recommend a slightly larger size Perf POD for recompletions or refracs, due to perf erosion or higher probability of eroded perfs.

What is the experience with Perf PODs for refrac or recompletion programs?

We have completed over 160 refracs, both vertical and horizontal.

We recommend (but do not require) running a caliper log or camera initially to determine the condition of perforations (i.e. washing, erosion, hole size) and ensure casing integrity. We typically recommend the millable material for these applications, as we can build a larger Perf POD due to the higher tensile strength fibers. Our standard size Perf POD for a recompletion/refrac is rated for 0.75" EHD and will hold 10,000 psi differential pressure. We have built custom sizes for various applications ranging from 0.234" up to 1.25" holes, as well as some irregularly shaped holes/slots seen with casing damage.

Will the Perf PODs dislodge from the perforations during shutdown between stages?

The Perf PODs can be removed from the perforation by surging the well or seeing a pressure drop in the wellbore. Depending on the Perf POD size, hole size and pressure applied to the wellbore when seating the Perf PODs, the corresponding pressure to unseat ranges from negligible to several hundred psi.

To reduce the likelihood of Perf PODs becoming dislodged during shut down, slight procedural changes can be made to reduce the water hammer effect downhole.

In the event of a premature screen out, surging the well can cause some Perf PODs to flow off seat and re-open the perforation.



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Once the Perf PODs are wedged into the perforation, can they be dislodged by the subsequent slurry stage?

We have completed testing on surface to prove against this, as well as used radioactive tracer to show that once Perf PODs are seated in a perforation subsequent proppant volumes and pump stages did not affect the seal or ability for the Perf PODs to remain on seat.

How many stages can be fractured using the Perf PODs and how does it compare (being more beneficial) with plug-and-perforate methodology?

We have completed as many as 55 stages in a single wellbore, using only Perf PODs for isolation between intervals. If utilizing the degradable Perf PODs, the limiting factors will be BHT and length of time to complete the frac schedule; in the event you see degradation or loss of isolation prior to completing the entire well, additional Perf PODs can be deployed to regain isolation.

When compared to neighboring wells in the field, the applications where bridge plugs have been replaced with Perf PODs has proven to either maintain similar production or increase production. By replacing bridge plugs (whether eliminating all or combining stages to reduce total plug count) with Perf PODs, the cost savings can range anywhere from \$400,000+ based on values from current operators deploying this technique.

If the well is put back onto production very soon after the frac, have you seen any problem with the Perf PODs causing issues with the downhole pump or surface equipment?

We haven't seen any issues with residual material left behind after the frac. Typically a cleanout trip is made post frac, which will pull any remaining Perf PODs from the perforation and circulate them back to surface with sand and/or plug debris. Whether cleaning out the well with jointed pipe or coiled tubing and a downhole motor, either a mill or bit can be used to remove Perf PODs from the wellbore.



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When designing a job, how do you know how many Perf PODs to use?

The Perf PODs are designed to seal a single perforation. The number of Perf PODs pumped is based on the total number of perforations within the stage, typically ranging from 25-65% coverage on a new well and 75-100% coverage on a recompletion. The total coverage is dependent on formation breakdown and wellbore parameters and can be adjusted on the fly to better optimize each stage.

At what point in the treatment is it recommended to drop Perf PODs?

For mid-stage diversion, most operators split the total proppant volume in half and pump PODs in the middle of the stage. Depending on stage size or if you are combining multiple stages together, multiple smaller pump stages could be beneficial, also resulting in multiple Perf POD deployments. Perf PODs are deployed after or during the flush cycle and then followed directly by acid or pad volume for the subsequent pump stage.

For plug replacement, some coverage can still be added as mid-stage diversion (same as above) which would leave open a portion of the perforations (30-50%) for the subsequent WL pump down. Once the new stage of perforations is made the following stage begins with Perf PODs before pad volume. The rate and treating pressure are kept below calculated frac gradient to ensure new perforations do not breakdown until Perf PODs have seated in the lower interval. If acid is required to breakdown the formation, acid can be pumped behind the Perf PODs so it is on depth for the new set of perms at the same time as Perf PODs sealing off the lower interval.

Where have you used the Perf POD technology?

To date we have completed over 1,375 jobs total. The majority of that job count is in the United States and Canada, however we have also completed jobs in Norway, Saudi Arabia, Colombia, Australia and New Zealand.

In the past it was assumed 2/3 of the perms were open to accept fluid, has this number changed with current charges?

The total number of open perforations is very much dependent on the formation and rock properties. Even within the same wellbore, each interval can react differently to the stimulation design. A step down test can be performed at the start of any stage to determine number of open perforations.



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Can Perf PODs be used on wells with conventional depleted reservoirs?

Yes, definitely. Perf PODs can be used to mitigate frac hits between offset wells (parent / child interaction). By sealing the dominant perforations mid-stage you stop the frac length from extending too far and communicating with other wellbores.

Do you need to size the Perf PODs for the expected perf hole size, or do they work over a range of perforation entry hole sizes? If so, how do you know the post-frac eroded size of the holes?

For most new completion applications where a typical EHD of 0.32" to 0.42" is shot, we use the Perf PODs rated for 0.50"; this allows for some erosion and washing of the original hole size. In some cases where the proppant volume is high or extensive erosion has been seen in the past we go with a slightly larger size to account for the bigger holes.

The only way to know the size of the perforations is to use a downhole camera or caliper log. These options can be expensive and time consuming, most operators elect to start with our standard size Perf POD. If pressure response looks like the Perf PODs may be going thru the perforations we can increase the size of the Perf POD to better suit the well parameters.

Can Perf PODs fully replace frac plugs in a vertical wellbore?

Yes. Vertical wells can be completed much the same as horizontal applications, however you have the ability to seal off all perforations at the end of the stage, as you no longer require the ability to pump down your subsequent WL BHA. This essentially allows you to pump enough Perf PODs to seal every perf and complete a pressure test of your wellbore, prior to starting the next stage.

In refrac or recompletion applications where new perforations are added, Perf PODs can be used to replace straddle packers or squeeze systems. Perf PODs will remain on seat of existing perforations, while WL is run in hole to perforate the new intervals. The Perf PODs can ensure you maintain isolation of the existing intervals while stimulating new rock.



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