# COST EFFICIENCY OF ELIMINATING POST-FRACTURING OPERATIONS BY USING DISSOLVABLE METALS AND PUMP DOWN CASING BAFFLES: SET-A-SEAT™

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## SUMMARY

Well Completions today can vary from simple one stage fracturing operations in vertical wells, to more complex multi-stage, multi-tool, operations in horizontal wells. The costs of these traditional operations have in the past been difficult to reduce due to limits in technology and application. The standard process always involved setting a plug, perforating the well, and fracturing the well. Afterwards, the plug had to be milled out. If all went as planned, this cost was considered standard and not given a second thought.

After developing the Set-A-Seat casing baffle, Peak Completions and its Partners have seen drastic savings in well completions without experiencing any reductions in oil recovery. Some Partners prefer the Plug-and-Perf method, which allows for the Set-A-Seat to perform as a casing baffle which then seals the lower stages with a dissolvable ball. This in turn behaves somewhat like a traditional composite plug while fracturing, but has the added benefit of having a large inner diameter to allow for flow back. In most cases, there is no need to mill out the Set-A-Seat. After doing a clean out run, Peaks' Business Partners have experienced savings of $150,000.00 or more per well which has led to millions in savings.

The Set-A-Seat has a success rate of 99.99% and has been installed in all major basins in the United States; Permian, Delaware, Eagle Ford, Marcellus, Bakken, Woodford, and Anadarko Basins. The Set-A-Seat has also had great success in overseas operations. The Cooper Basin in Australia has installed Set-A-Seats making this the first time in the history of the field that no remediation was required to assist flow back of the wells. For three wells, Peaks' Business Partners have seen savings exceeding $450,000.00 completely eliminating the need for expensive high temperature clean outs.

## INTRODUCTION

Improvements in horizontal drilling practices, techniques, and technologies have increased the length and quality of shale wells across all major United States hydrocarbon producing basins. With the increased length of wellbores, conventional plug and perf methods of completing at the far reach of the well can be problematic due to the need to clean out the plugs, placed as zonal isolation tools, between each fracturing zone. This is due to the limitations of remediation options available to the oil and gas industry, specifically coiled tubing units, having length limitations in order to reach out far enough to remove each zonal isolation tool from the furthest reaches of the well.

Essentially, horizontal drilling practices have exceeded the capabilities of the post completion well remediation options. To combat this, Peak Completion Technologies, Inc. started development in the third quarter 2014 on a revolutionary tool that had the ability to virtually eliminate the need for post-fracturing remediation of these toe stages. The tool would eventually outgrow this niche well placement and become a full well option.

There were already a few large bore plug options on the market through various competitors, all falling short of the true goal of ZERO need for remediation. Downfalls included introducing very hard materials into the construction of the isolation devices making them hard to remove, should the need arise, and inner diameters for flow through that fell short of removing potential chokes in the well.

## IDENTIFYING THE PROBLEM

Moving forward, Peak knew we had to look at the problem differently so we abandoned conventional plug designs and focused on a “pump-down casing baffle” design, which would allow us to place a seat in the casing wherever the operator wanted to isolate the stage, giving maximum flexibility to the Operator by allowing placement at any depth in case they changed “on the fly.” Stage isolation would then be created by using a large diameter dissolvable ball pumped in the pad stage of the fracturing or stimulation treatment to land on this placed seat, forming a seal, and isolating the new zone from the previously completed stage below. The fact that we were placing a seat in the casing led to the tool’s trademarked namesake, Set-a-Seat™. Several oilfield standards were not abandoned, however, with the highest priority placed on not having a higher risk pump down than conventional tools. With that stated, we knew the design philosophy must include the following criterion: nominal choke pressures for production, completely drillable, novelty in design, deployed using conventional wireline pump-down techniques, allow for clean out through the tool if needed without the need for unconventional clean out assemblies.

### Design

Over the next few months we were able to design and produce a tool that far out-performed all of its competition in pump down efficiency, stage isolation performance, ball dissolution and unimpeded production. In order to ensure that the Seat-a-Seat™ was field ready, there were various tests that were performed on the tool. All of these parameters needed to be met before releasing the tool to field trials.

Every prototype Set-a-Seat was set in the laboratory using a hydraulic setting tool that matched the characteristics and dimensions of the Baker 10 and Baker 20 setting equipment. This test fixture can be seen in figure 6. This was done, because we had the understanding that the majority of our customers would be utilizing this setting equipment on location due to its wide use and part sourcing. After the Set-a-Seat™ was set, the tool was then pressure tested in a custom made pressure vessel that simulated downhole conditions. An example of this pressure vessel can be seen in figure 5. This device had several pressure inlets that allowed us to test both the top, and bottom side of the casing baffle several times. This pressure vessel permitted the Engineering team to pressure up the tool beyond the advertised 10,000 psig rating. One example of the many different times that the tool was tested can be seen in figure 3. There have been several sizes of Set-a-Seats™ tested and confirmed in the field.

## FIELD RUNS

Current run histories of Set-a-Seat are approaching 7,000 individual runs in more than 200 wells in every major US basin and on two different continents since its introduction to the market in February 2015. The following paragraphs highlight some of our successes with Operators currently using our technology. There are several sizes of Set-a-Seats™ which can be seen in figure 1.

The Mississippi Lime formation is a shallow horizontal play in Oklahoma. To date, for one customer, we have completed 66 wells comprising 1056 stages, utilizing 990 Set-a-Seats for stage isolation for large Acid fracturing stages. Particularly challenging wells, with 7” X 4.5” well geometry and liner hangers set at 70+ degrees inclination, this reservoir has very low bottom hole pressure making it quite difficult to clean out conventional composite plugs due to not being able to circulate fluid to raise cuttings and the need for nitrogen assist to aid in lifting plug cuttings to surface. Many times, a velocity string would need to be installed and stung into the liner hanger receptacle to increase annular velocities. The Set-a-Seat can be seen made up to a baker tool on location in figure 4.

The replacement of composite plugs with Set-a-Seats™ eliminated both of these costs, i.e. coiled tubing drill outs and velocity string rentals, amongst other associated costs and risk. These wells are now completed down the 7” x 4.5” production string and placed on production within 2 hours of the last fracturing stage, allowing this operator to bring their product to market 15 days earlier on average compared to the previous method of completion. In addition to being able to possibly capitalize more quickly on volatile commodity pricing, the operational savings of $425,000 per well on a 6 month average compared to prior method averaged over a 6 month period. This has resulted in a cost savings of over $28MM in a 10 month operating period. These wells utilize Set-a-Seats™ to isolate every stage for the entire wellbore.

An operator in the Permian Basin, active in both the Wolfcamp Shale and Delaware Basin has also embraced the use of the Set-a-Seat™ technology to reduce their capital expenditure, reduce man hours on location, and significantly reduce the need for auxiliary services. To date, for this operator, Peak Completions has completed 71 wells utilizing

Set-a-Seats™, comprising of 1439 tools, isolating 1633 fracturing stages. The Set-a-Seat also has an impressive resume in this basin. As expected, in a high sand concentration, majority slick water fracture design, sand bridging and sand production is an issue that has arisen.

## Cost Efficiencies

By modifying our flowback procedures we have been able to reduce the number of wells requiring a sand clean out down to 20% of wells. Looking at this number more closely, we have reduced post-well intervention of slick water sand fracturing jobs by 80%, or in this case 57 completed wells in the Permian Basin have not required any sort of post well intervention for this one operator. This has been verified with the use of production tracers captured in our flowback fluids to verify production from each stage. Further to that effort, in the 20% of wells that did require a clean out, no drill out was required, so the risk was mitigated down to a clean out from a drill out, simply washing/drilling through sand bridges as opposed to drilling out plugs, introducing more debris into the wellbore and complicating the clean out.

Clean outs are completed with much more expediency than drill outs. Figure 7 shows a mill being passed through a baffle. We were asked to provide choke calculations for the Set-a-Seats™ in these wells and at conventional flow back rates using Bernoulli's principal and the equivalent pressure drop at each Set-a-Seat™ is less than 0.01 psi (see figure 2), creating a nominal choke point and essentially ZERO flow restriction. On average wells are able to go online 18 days prior to previous method and a 6 month average AFE vs AFE close out compared to prior methods show a $165,000 per well savings, or $11,715,000 over the project. Those numbers are taking into account the 20% of clean outs required.

Lastly, moving across the globe to Australia's Cooper Basin, a different wellbore geometry is utilizing the Set-a-Seat™ technology. The wells in this basin are deep vertical slightly deviated wells in excess of 350 degrees Fahrenheit bottom hole temperature. Due to the difficulty and cost of cleaning out in these high temperature environments, a 3 well pad test phase was designed for the Set-a-Seat™ to test its feasibility in this scenario. These are vertical wells, so gravity was used to float the set-a-seat on depth with wireline. All tools were set and positive ball indication was seen on each stage. After the wells were completed, they were shut in for 24 hours to allow the dissolvable stage isolation ball to dissolve below the Set-a-Seat™ ID, therefore removing any potential for production blockage. All three wells were then produced and mapped against an offset pad using conventional completion techniques. The test pad proved that the Set-a-Seat™ had eliminated the need for a conventional wellbore clean out post-fracturing treatment. Estimated cost savings in this scenario are upwards of $450,000 per well or over $1MM per pad. The Set-a-Seat™ is now an integral part of the completion methods moving forward across multiple Australian basins.

## CONCLUSION

In closing, the Set-a-Seat was designed with the thought that we could significantly reduce the need for post-well remediation. One goal was to eliminate the need for post fracture drill outs, reduce risk, man hours, and cost on the job site. Compared to any other tool on the market, we are confident in saying the Set-a-Seat has come closer to the goal of eliminating post-fracture entry into wellbores than any other product on the market.

The cost savings that have been generated for the project in the Mississippi Lime have been estimated to $22,525,000.00, while the total savings in the Permian Basin have been projected to $6,435,000.00 per operator. The projects in the Cooper Basin have seen savings of $450,000.00 for three well pads, and the overall quantity of Set-a-Seat installations is increasing.

The novelty of the design has allowed us to submit several patent application versions of the tool and methods and will be a product that we can use as a base to expand our position in global completion markets. These types of innovations are what keeps Peak Completion Technologies at the top of the ever-evolving oilfield completion technology market.

## REFERENCES

"Set-A-Seat™." *Set-A-Seat*™. Peak Completions Technologies, n.d. Web. 22 Mar. 2016.

Various Set-a-Seat Sizes

| PRODUCT NUMBER | SIZE | WEIGHT RANGE | O.D. | I.D. | BURST | COLLAPSE | OVER ALL LENGTH |
|---|---|---|---|---|---|---|---|
| 2090-35A-A00 | 3.5" | 9.3# | 2.781" | 1.906" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-45A-A00 | 4.5" | 9.5# | 3.813" | 2.938" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-45B-A00 | 4.5" | 10.5# | 3.781" | 2.906" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-45C-A00 | 4.5" | 11.6# | 3.750" | 2.875" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-45D-A00 | 4.5" | 13.5# | 3.656" | 2.781" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-45E-A00 | 4.5" | 15.1# | 3.563" | 2.688" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-50A-A00 | 5" | 15# | 4.125" | 3.250" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-50B-A00 | 5" | 18# | 4.000" | 3.125" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-50C-A00 | 5" | 21.4# | 3.875" | 3.000" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-55A-A00 | 5.5" | 15.5# | 4.750" | 3.875" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-55B-A00 | 5.5" | 17# | 4.625" | 3.750" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-55C-A00 | 5.5" | 20# | 4.500" | 3.625" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-55D-A00 | 5.5" | 23# | 4.375" | 3.500" | 10,000 psi | 9,200 psi | 10.50" |
| 2090-55E-A00 | 5.5" | 26# | 4.250" | 3.375" | 10,000 psi | 9,200 psi | 10.50" |

Figure 1

| Pressure Drop Calculations, Set-a-Seat, values in psi (backpressure created) | | | | | |
|---|---|---|---|---|---|
| I.D. | 2.781 | 3.625 | | | |
| TOOL | 4.5" 13.5# Set-a-Seat | 5.5" 20# Set-a-Seat | | | |
| Flow Area | 6.074 | 10.321 | | | |
| Fluid Weight | 8.400 | | Flow Rate | | Combined PD (psi) |
| BPM | PD | PD | bbls/day/stage | bpd/well | |
| 0.10 | *0.0004246* | *0.0001471* | *144* | *2880* | *0.01* |
| 0.11 | *0.0005138* | *0.0001780* | *158* | *3168* | *0.01* |
| 0.12 | *0.0006114* | *0.0002118* | *173* | *3456* | *0.01* |
| 0.13 | *0.0007176* | *0.0002486* | *187* | *3744* | *0.01* |
| 0.14 | *0.0008322* | *0.0002883* | *202* | *4032* | *0.02* |
| 0.15 | *0.0009553* | *0.0003309* | *216* | *4320* | *0.02* |
| 0.16 | *0.0010869* | *0.0003765* | *230* | *4608* | *0.02* |
| 0.17 | *0.0012271* | *0.0004250* | *245* | *4896* | *0.02* |
| 0.18 | *0.0013757* | *0.0004765* | *259* | *5184* | *0.03* |
| 0.19 | *0.0015328* | *0.0005309* | *274* | *5472* | *0.03* |
| 0.20 | *0.0016984* | *0.0005883* | *288* | *5760* | *0.03* |
| 0.21 | *0.0018724* | *0.0006486* | *302* | *6048* | *0.04* |
| 0.22 | *0.0020550* | *0.0007118* | *317* | *6336* | *0.04* |
| 0.23 | *0.0022461* | *0.0007780* | *331* | *6624* | *0.04* |
| 0.24 | *0.0024456* | *0.0008472* | *346* | *6912* | *0.05* |
| 0.25 | *0.0026537* | *0.0009192* | *360* | *7200* | *0.05* |
| 0.26 | *0.0028702* | *0.0009942* | *374* | *7488* | *0.06* |
| 0.27 | *0.0030953* | *0.0010722* | *389* | *7776* | *0.06* |
| 0.28 | *0.0033288* | *0.0011531* | *403* | *8064* | *0.07* |
| 0.29 | *0.0035708* | *0.0012369* | *418* | *8352* | *0.07* |
| 0.30 | *0.0038213* | *0.0013237* | *432* | *8640* | *0.08* |
| 0.31 | *0.0040803* | *0.0014134* | *446* | *8928* | *0.08* |
| 0.32 | *0.0043478* | *0.0015061* | *461* | *9216* | *0.09* |
| 0.33 | *0.0046238* | *0.0016017* | *475* | *9504* | *0.09* |
| 0.34 | *0.0049082* | *0.0017002* | *490* | *9792* | *0.10* |
| 0.35 | *0.0052012* | *0.0018017* | *504* | *10080* | *0.10* |

Figure 2

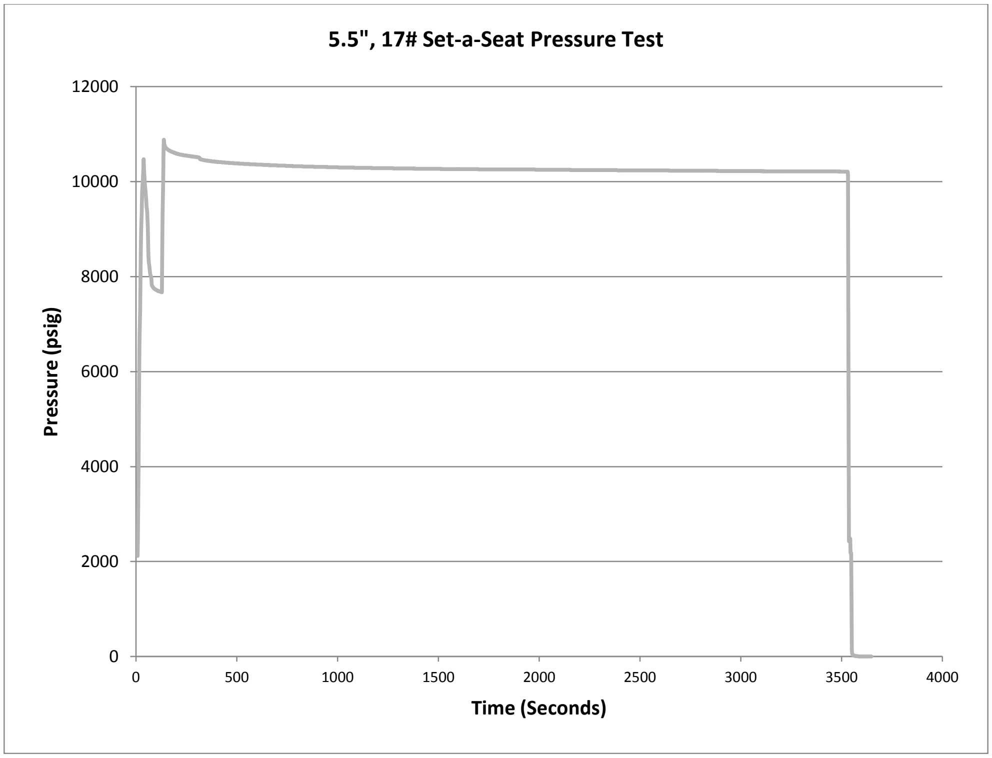


Figure 3

Figure 4

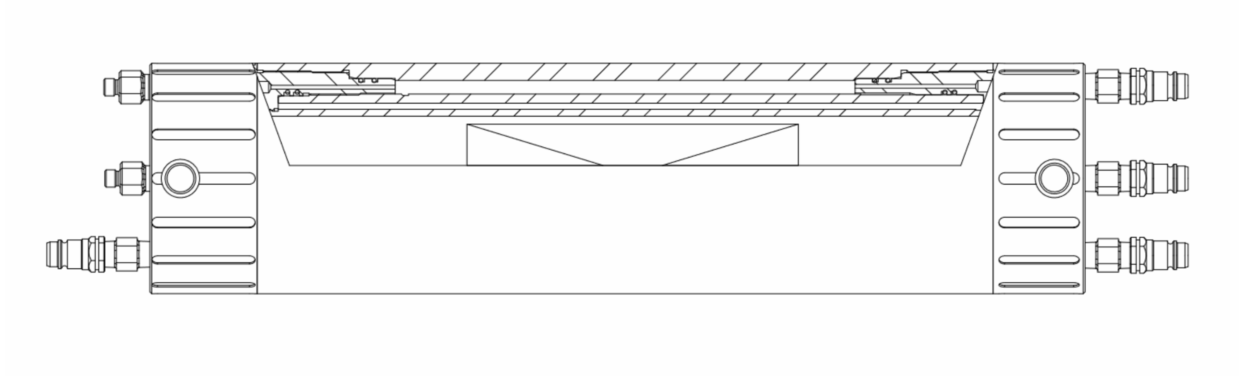

Figure 5

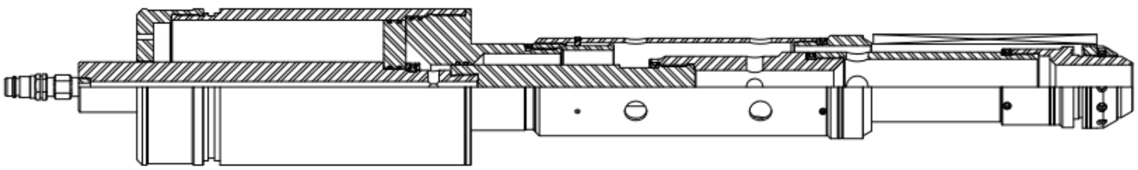

Figure 6

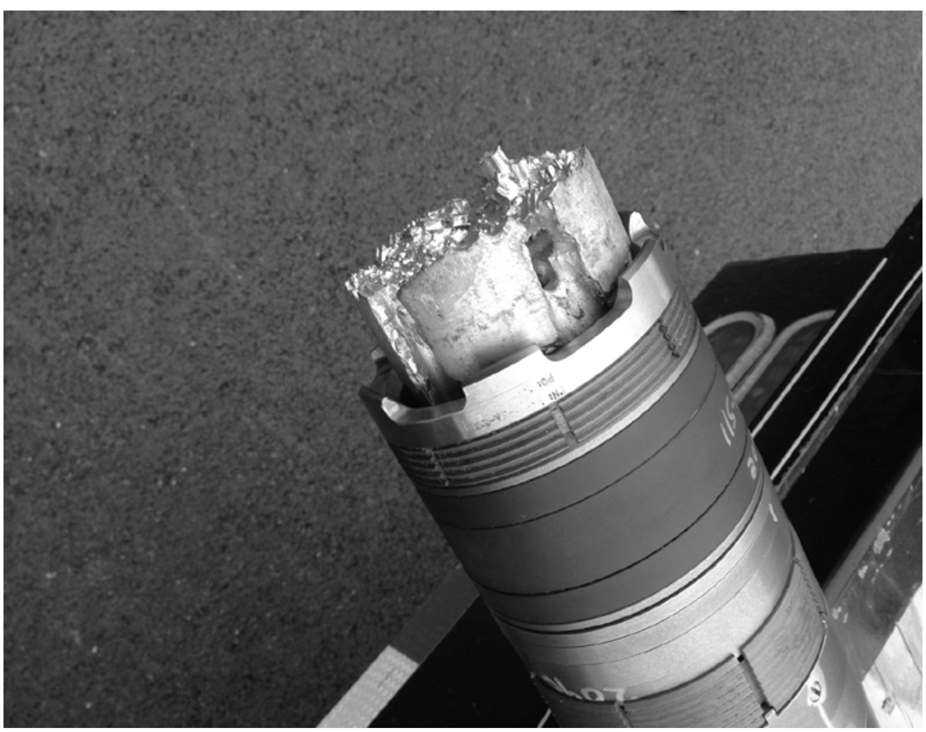

Figure 7