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THRU TUBING FRACTURING EXPERIENCE IN TIGHT SAND RESERVOIR, OFFSHORE NORTH WEST JAVA

(Pengalaman Perengkahan Hidrolik Melalui Tubing pada Tight Sand Reservoir, Offshore North West Jawa)

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ABSTRAK

Akhir-akhir ini rekahan hidrolik menjadi stimulasi umum untuk meningkatkan ekonomi dengan meningkatkan produksi dan menambah cadangan melalui permainan nonkonvensional dari Tight sand Reservoir. Perawatan rekah menciptakan jalur yang sangat konduktif untuk meningkatkan produksi dan drainase sumur yang mengarah pada menambah cadangan. Sebagian besar, perawatan perekahan hidrolik telah dilakukan di sumur pengembangan baru dari sumur pengembangan. Setelah berhasil menghasilkan kampanye rekah hidrolik di sumur pengisi baru, ada percobaan untuk melakukan rekah hidrolik di sumur yang ada melalui penyelesaian pipa yang ada. Sumur pertama yang terpilih sebagai yang pertama melakukan remedial frac, melalui hydraulic fracturing tubing dianggap sebagai cara yang lebih murah untuk melakukan perekahan hidrolik tanpa rig dibandingkan dengan hydraulic fracturing dengan rig. Tantangan utama selama operasional berasal dari keterbatasan penyelesaian eksisting, beberapa penyesuaian desain dan operasional harus dilakukan hingga optimalisasi selama pekerjaan rekahan. Makalah ini menyajikan pengalaman termasuk batasan rekahan dan desain rekahan selama melakukan rekahan hidrolik melalui tubing pertama di tight sand reservoir di Offshore North West Java.

Kata Kunci: *produksi, perekahan hidrolik, tubing, completion*

ABSTRACT

Lately, hydraulic Fracturing become common stimulation to improve economic by increase production and adding reserve through unconventional play from tight sand reservoir. The fracturing treatment creates highly conductive pathway to enhance production and well drainage which lead to add reserves. Mostly, Hydraulic Fracturing treatment had been performing in new development wells of infill wells. After successful resulted hydraulic fracturing campaign in new infill wells, there was a trial to perform hydraulic fracturing in existing well thru existing tubing completion. First well which was selected as first to perform remedial frac, thru tubing hydraulic fracturing is consider as a cheaper way to perform rigless hydraulic fracturing compare to hydraulic fracturing with rig. The main challenges during operational come from limitation of existing completion, several adjustment in design and operational should be perform to optimization during fracturing job. This paper presents the experience including fracturing limitation and fracturing design during performing first thru tubing hydraulic fracturing in tight sand reservoir in Offshore North West Java.

Keywords: tight sandstone, shally, low permeability, hydraulic fracturing, frac, completion

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I. INTRODUCTION

The ONWJ area is located on the north Coast of Java Island in Indonesia (see Figure 1). The ONWJ PSC is operated by PT. Pertamina Hulu Energi ONWJ since 2009. The PSC consist of several fields and has been producing since 1971 with more than 700 wells and 150 production platform. Those platforms and flow stations are connected by using 350 pipelines with total length of 1700 km and all of the liquid is collected and processed at a single Central Plant. ONWJ (Figure 1) reached the peak oil production of 180,000 BOPD in 1984 which has now declined to around 32.5 mbopd which is derived from 10 different structures/fields, 36 producing platform and 230 active wells. Gas lift was selected as the main artificial lift method in the ONWJ. The typical ONWJ reservoir is a multi-stacked sandstone reservoir with main contribution from Main and Massive formations. Both formations have many productive zones with good rock quality, in terms of porosity and permeability. These zones have been produced since the early field development. Continuous infill and workover programs to maintain production and adding reserves have become a major challenge since the reserves are increasingly marginal. As the field production decline, integrated subsurface strategy was initiated on the tight sand reservoirs which was initially not commercially attractive and always considered as secondary targets. The study suggest significant potential exist in the tight sand reservoirs and Low resistivity requires hydraulic fracturing stimulation to maximize oil production and reserves from these zones. Developing reservoir through hydraulic Fracturing was then became one of ONWJ strategies in increasing and sustaining oil production.

II. METHODOLOGY

A. Hydraulic Fracturing History

As more hydraulic fracturing wells were performed and produced through new infill wells or sidetrack wells, additional challenges arose that appeared, with declining of production from conventional reservoir, come up the challenge to get a new way to perform Hydraulic fracturing with lower cost but still meet with stimulation aspect to increase production in a more economic way. Frac thru tubing becomes a solution way to face the challenge. In the early Hydraulic Fracturing development over 5 years since 2011, common hydraulic fracturing was performed with new infill wells, hydraulic fracturing treatment performed with drill pipe after cementing

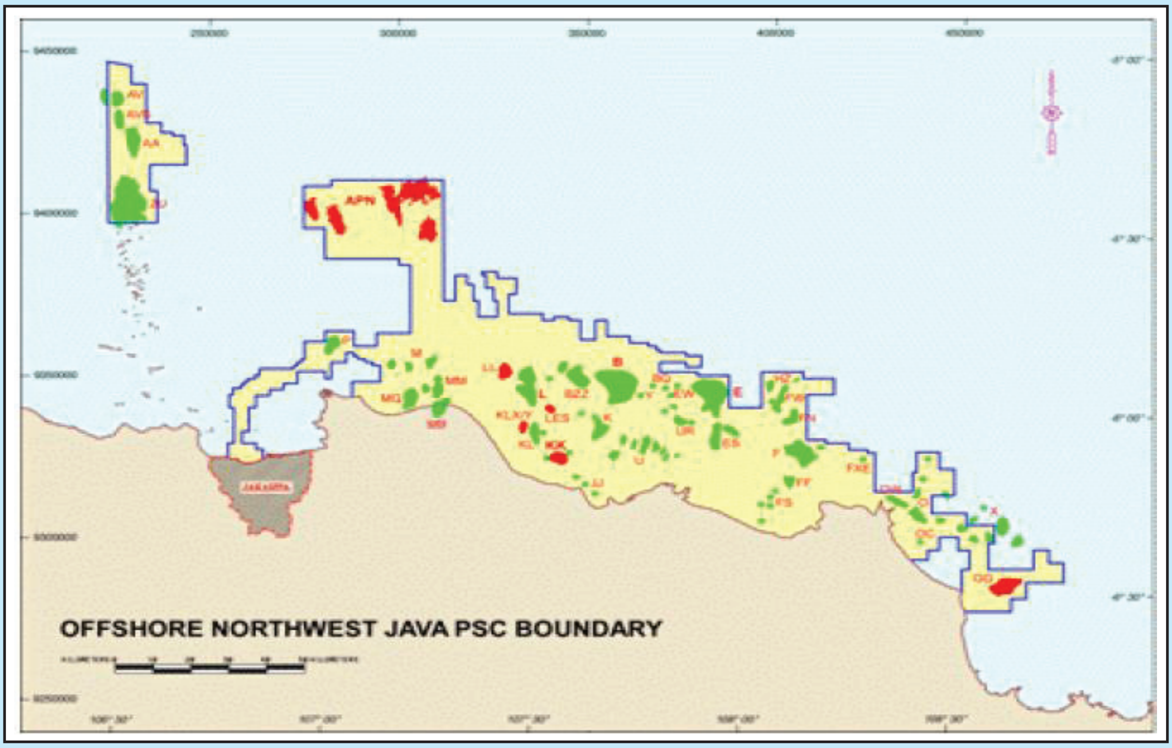

Figure 1
ONWJ area.

the last section of wells and before completion. Its take several days, often could be longer due to bad cementing at pay zone and needs to remedial cementing. In 2014, come up idea to perform frac thru tubing to come up with high service company rate, several studies were conducted to support this job. In the execution time on AD-34 and AD-47B wells was successful to achieve fracturing geometry as stimulation needs.

B. Reservoir Characteristic

Tight sand reservoir in ONWJ, are characterized with low contrast in Gamma Ray and Resistivity log. The resistivity ranges from 1.8 to 2.5 ohm which is quite close to the shale reading. Typically the reservoir is quite shally from cuttings information (Figure 2 AD-34 and Figure 3 AD-47). Integrated petrophysics and mud log evaluation were done to understand the potential of these tight sand reservoirs. Reservoir has porosity ranges from 10% to 15% and permeability from 5 to 12 mD.

C. Well Selection and candidate

Selection of well candidates to do hydraulic fracturing need to considering the position of fracturing zone depending on the type of completion it has. In monobore completion types we can do frac thru tubing in the existing zone and new zone that has not been perforated by plug or cement previous zone. On the contrary, if the type of completion is single selective, only the rat hole zone could be performed hydraulic fracturing. For this reason, most likely frac thru tubing in single selective completion is to perform remedial job in current reservoir zone which previously failed to be diffused due to equipment failure during operation. Whereas on monobore we can do fracturing job on new zone by cement or plug previous reservoir zone, like what has been done on AD-47.

D. Wellhead and Tubing treatment

Frac thru tubing uses existing wellheads, therefore it is necessary to use additional equipment to prevent operational failures, the tools is Tree saver. This tool is also used for replacing the wellhead valve control during fracturing operation and with a stinger with seal isolates and locks-out wellhead valves. The use of a tree saver is essential because it can protect the existing wellhead from a high treating pressure (around 3000 psi), protect the existing well and abdominal erosion from fracturing. Frac thru tubing is done using existing tubing that has been installed, so it is necessary for quality control and quality insurance from the tubing to be used. To prevent damage to the

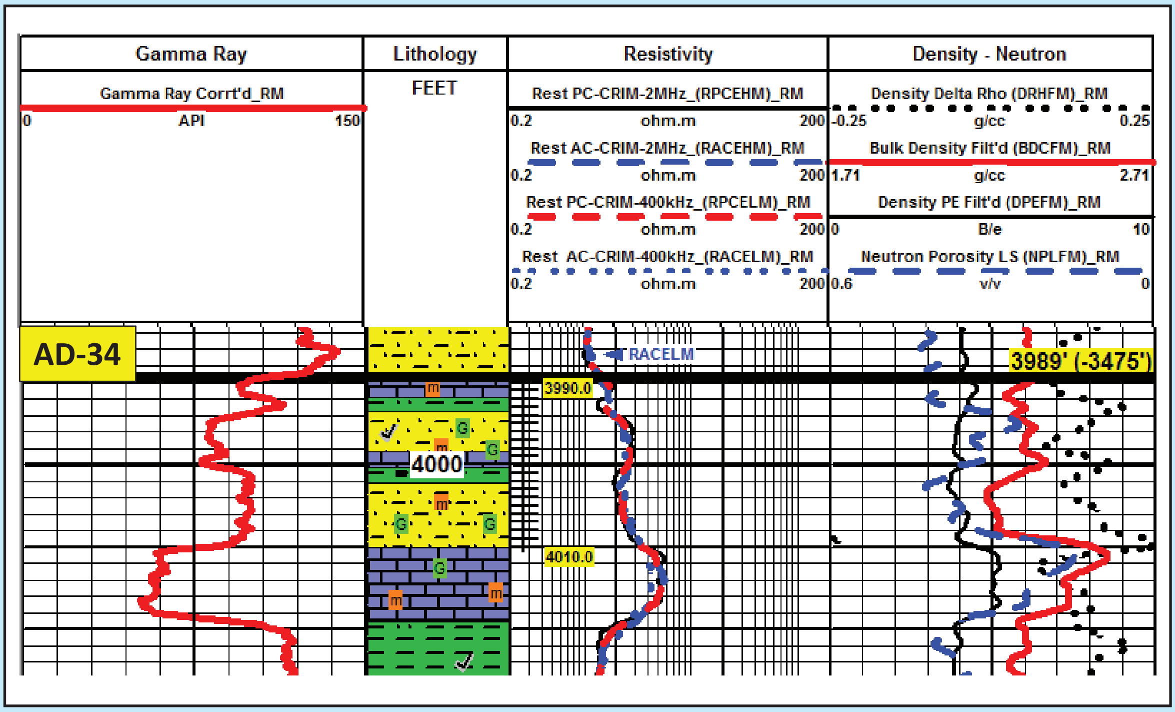

Figure 2
AD-34 Completion Log.

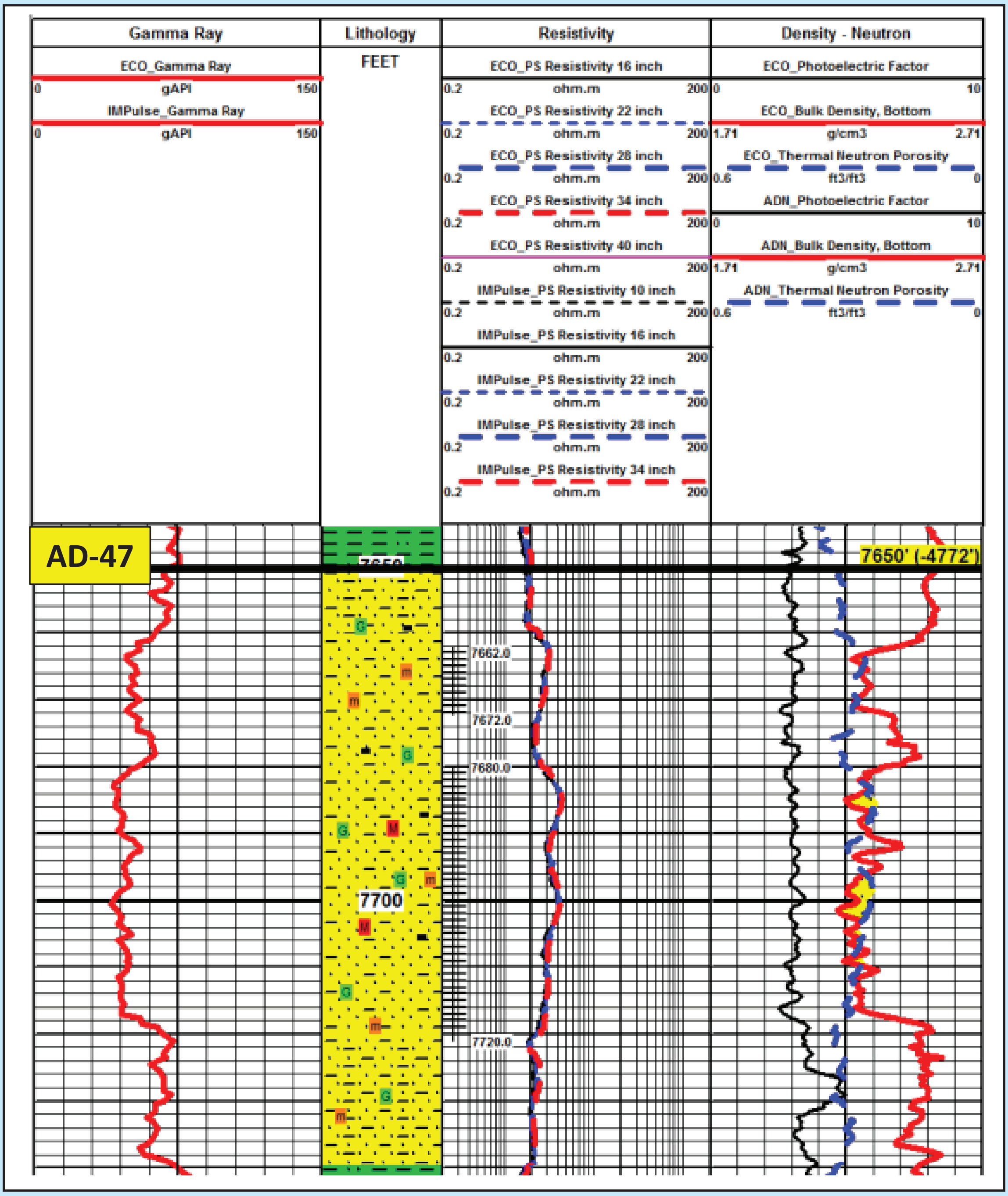

Figure 3
AD-47 Completion Log.

tubing, screening should be considered a well that is not more than 3 years to maintain the integrity of the tubing to be used. In a well with a gas lift as an artificial lift it is necessary to replace the valve into a dummy to prevent damage to the valve due to high pressure from treating pressure. (Figure 4. Before-after completion diagram) Figure 4. Before-after completion diagram Perforation Design & Fracture Entry Friction The perforation plan is a major element in hydraulic fracturing design, in new infill, common completion was perforated using big hole charges with 12 SPF phasing degrees, however due to limitation of gun perforation that can be used, in the frac thru tubing big hole perforation will be limited cannt use, therefore must maximize the use of deep penetration gun by doing with twice running. To achieve maximum frac geometry as per plan during main frac operation, the perforation strategy was

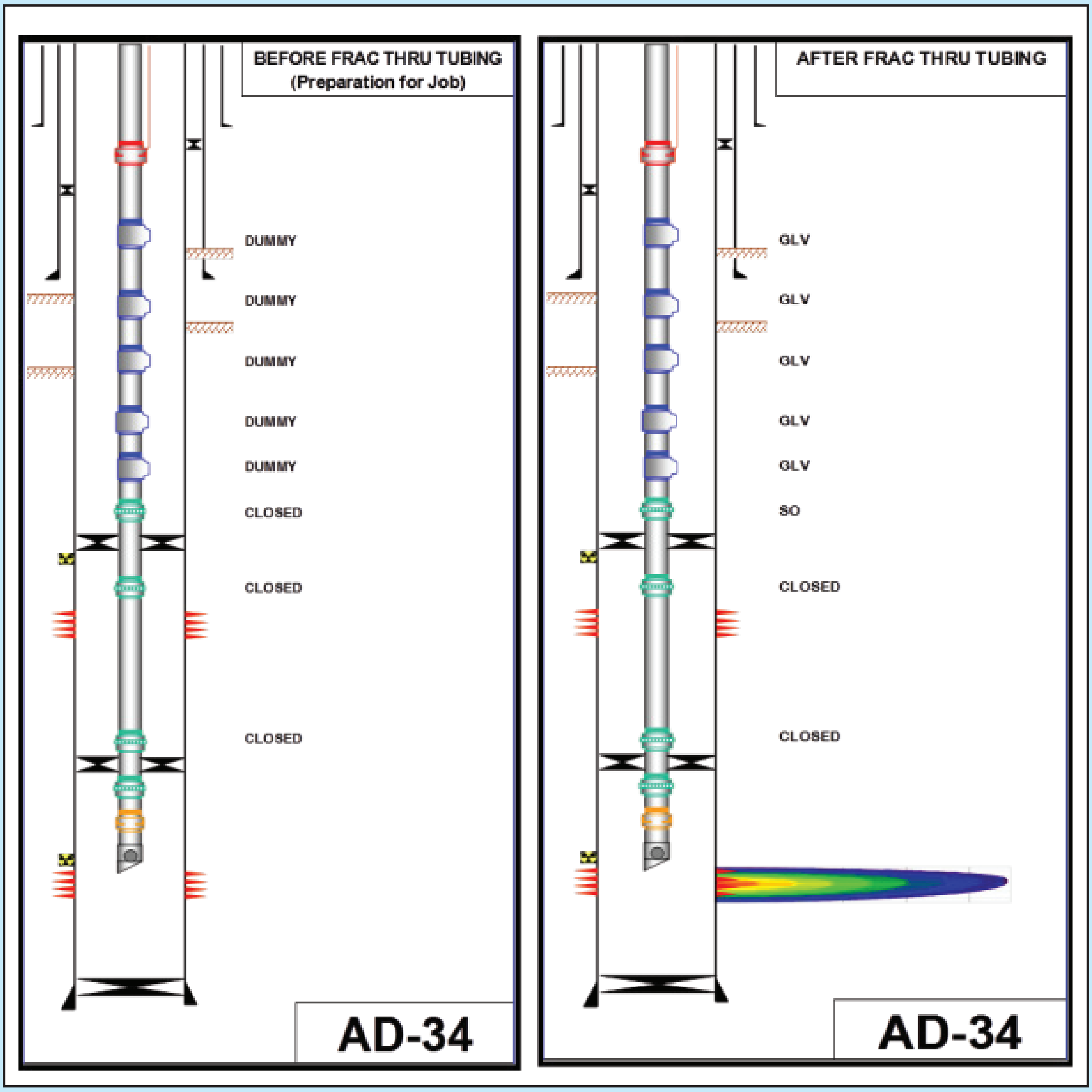

Figure 4
Before-after completion diagram.

chosen to reduce near well pressure friction losses and perforation friction due to tortuosity and perforation restrictions. Total perforation friction below 1000 psi is needed. In addition, the consideration is to maximize the flow of proposals to minimize the early plug-in proposition in the area (or early screen out). Hydraulic Fracturing Design The fracture treatment was designed to obtain proper geometry with optimum half length and FCD toward ensure good fracture conductivity and good wellbore fracture communication. For single selective completion was using a single stage hydraulic fracturing. commonly, in new infill well with hydraulic fracturing the design used two different sizes of proppant for the treatment, where the 20/40 mesh BauxLite were used as lead proppant during early stages and 12/18 mesh BauxLite were used as tail proppant during late stages. The advantage of using a smaller proppant size during early stages is to reduce perforation friction while smaller proppant act like sandslug scrape and open way on perforated hole during pumping decrease the chance of early plugged. Meanwhile the bigger proppant can more easily enter the frac path and make good conductivity. Fracturing fluid used was crosslinked. However, in frac thru tubing using existing tubing and small perforation diameter that will increase pressure treating due to smaller inside diameter compare to drill pipe that has been used during new infill with hydraulic fracturing. Higher treating pressure tends to increase risk during operation job pump failure, screen out, etc. In frac thru tubing as mitigation to avoid early plug and screen out due to small diameter perforation, its need to use smaller proppant, only one size proppant commonly used with 20/40 mesh. First sequence during Hydraulic Fracturing, a perforation breakdown (includes step-up and step-down test) and mini-frac were performed to gather more information about the rock and frac fluid properties and efficiencies. Therefore any optimization on the fracturing treatment can be done from the initial design. Step rate test used 100-150 bbl of 7% KCL slick gel. The objectives were to estimate initial shut in pressure (ISIP), closure pressure and reservoir pressure. In addition, the test also provides information on permeability and fracture entry friction. Figure 5. Step Rate Test step-down tests (see figure 5) are run to determine the pressure in the fracture when the fracture is open and the pressure when the fracture is closed. If there is excess pressure drop near the wellbore because of poor connectivity between the wellbore and the fracture, the interpretation of in-situ stress test data can be difficult. In naturally fractured or highly cleated formations, multiple fractures that follow tortuous paths are often created during injection tests. When these tortuous paths are created, the pressure drop in the "near-wellbore" region can be very high, which complicates the analyses of the pressure falloff data.

Best practice to mitigation domination of near wellboare friction by adding sand slug during early stage of main frac, if the perforation friction is dominate the recommendation to re-perforate, better with larger perforations diameter. Thus, the fracturing design can be optimized whether remedial treatment pre-frac should be done or not by performing re-perforation or applying sandslug. Figure 6. Mini Frac Mini frac (see Figure 6) was performed by pumped crosslinked gel 70-100 bbl at 18 bpm. The minifrac provide information on the leakoff coefficient and fluid efficiency of the crosslinked gel. In addition, net pressure sensitivity to pad volume information was also gathered. Thus, the crosslinked gel composition can be optimized on the fly during the main fracturing treatment in order to achieve the desired fracture dimension.

E. Hydraulic Fracturing Treatment

The job on AD-47 zone was performed thru tubing via monobore completion with deep penetration gun by pumping 41,055 lbs 20/40 carbolite with 408.5

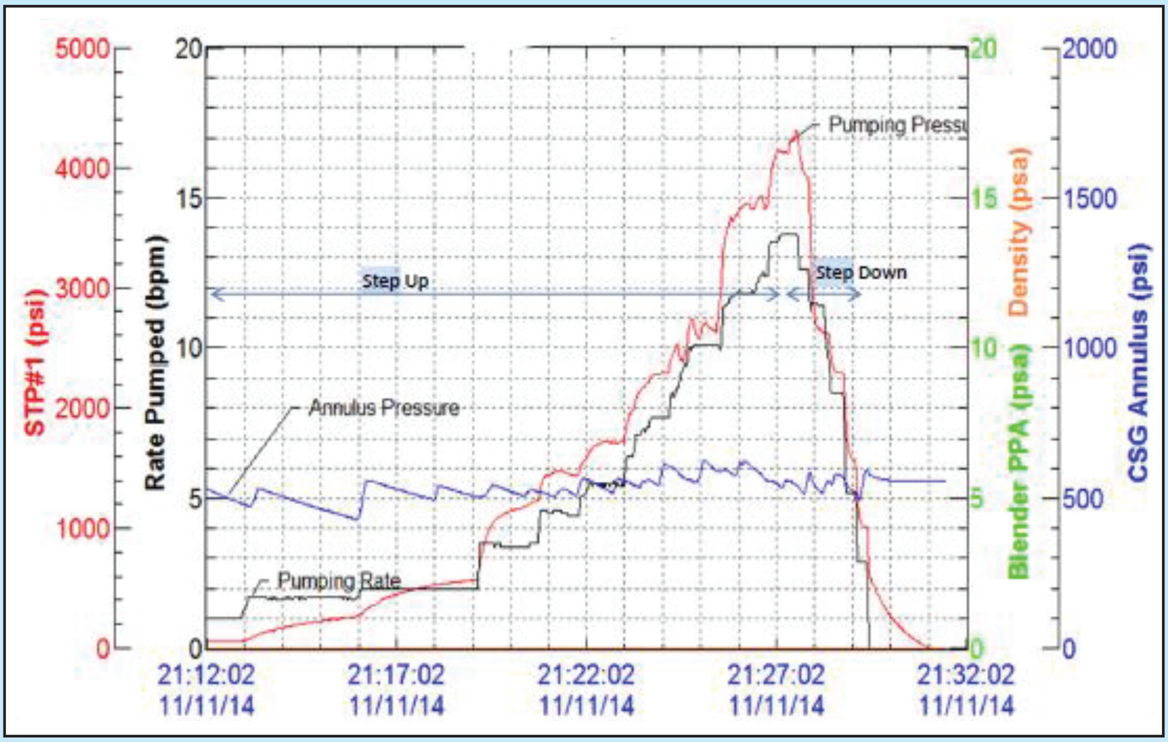

Figure 5
Step Rate Test.

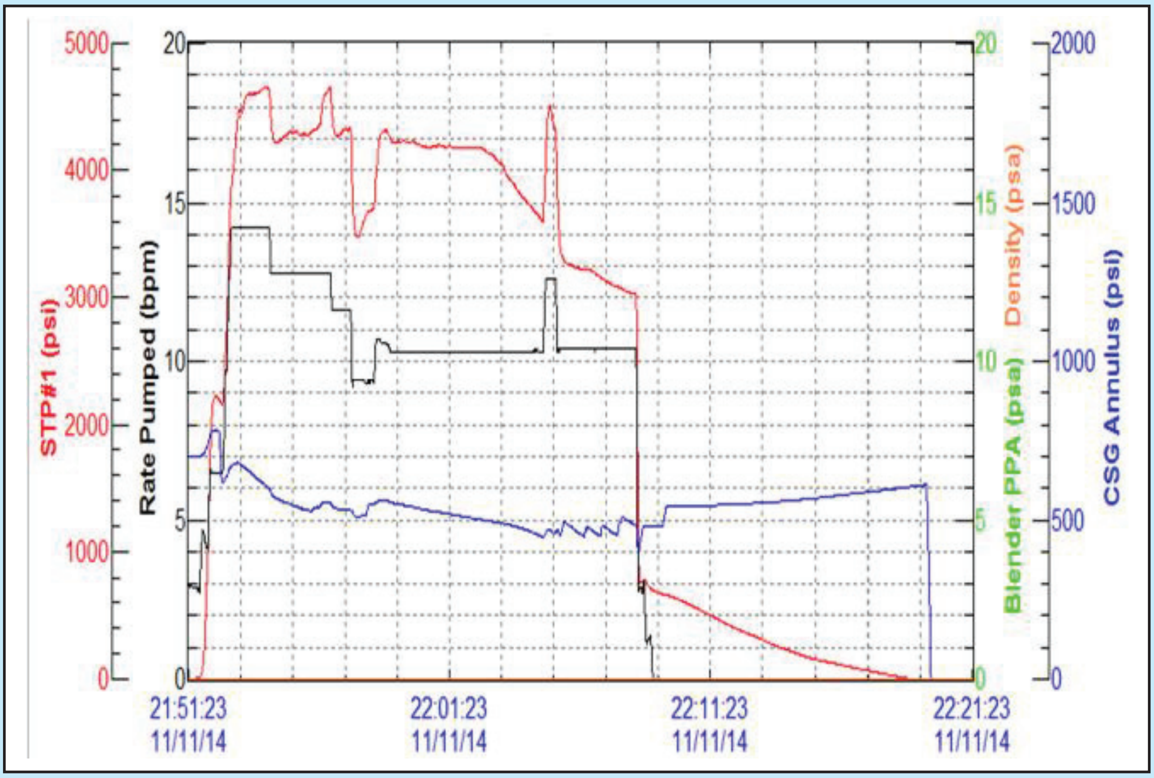

Figure 6
Mini frac.

Table 1
Fracturing Treatment AD-47

Frac Program		Preliminary	Final	Actual
Base fluid	Bbls	399.5	404.7	365.3
Pad Volume	Bbls	166.7	190.5	193.2
Slurry Volume	Bbls	448.2	447.9	408.5
Flush	Bbls	61.2	64.5	64.8
Sand Pumped	Lbs	50300	41000	41055
In Formation	Lbs	49523	40177	40034
In Wellbore	Lbs	777	823	1021
WH Treating Pressure, Psi		3987	4203	3651
Pumping Rate	Bpm	14	10	10
Fluid Efficiency	%	38.8		29.16

bbls slurry with maximpum pumping rate 10 bpm until 8 ppa sand. The job execution was modified from job preliminary due to different formation pressure response during pumping. The 5 ppa stage was skipped and jump to 6 ppa stage. Additional 8 ppa stage was added during pumping after observation pressure treating to obtain high conductivity. All the proppant was pumped and got tip screen out (TSO) at the end job. Based on Meyer simulator (BJ), the AD-47 zone treatment was penetrated to 231 ft propped, 738 ft vertical height and 0.2" width. 1.38 lbs/ft2 proppant after closure. 6,505 md-ft conductivity with 0.77 FCD. (Seen Tabel 1) Meanwhile ED-9ST2 philosophy was to remedial stimulation due to failure fracturing job in single selective well with big hole size diameter perforation. The job on AD-34 was performed by pumping 44,000 lbs 20/40 carbolite with 332.6 bbls slurry staging from 1 ppa until 10 ppa sand. The job execution was limited to BHTP (bottom hole treating pressure) of 5000 psi due to production packer will not hold at more than 5,000 psi BHTP and will caused communication between tubing and annulus pressure. All the designed proppant was pumped into formation. Based on meyer simulator, AD-34 was penetrated to 217.51 ft propped, 90.93 ft vertical height and 0.28" width with 6,598 md-ft conductivity with 3.61 FCD. (seen Table 2)

III. RESULTS AND DISCUSSION

A total of 2 wells have been fractured thru tubing to develop tight sand reservoir AD-34 and AD-47B, all of them were fractured in single stage fracturing. Commonly, conventional fracturing with frac string gave wider operation mode we could pumped higher and bigger concentration of proppant. That were achieved better frac geometry compared to frac thru tubing that was limited by smaller perforation hole, higher friction in smaller tubing size and the complicated of tubing movement. Need better understanding in final design to come up with multiple challenge that was given from existing wells. Several adjustment in proppant size, proppant concetration and pumping schedule during main frac should be considering as optimum as possible to achieve optimum production with economic aspect. In this study we attempted to understand fracturing geometry impact tends to correlate with frac thru tubing design. The fracturing geometry shows smaller half-length and height but still acceptable with stimulation target needs to get economic production which is faster and lower cost.

IV. CONCLUSIONS

Based on the experience during frac thru tubing, the following conclusions can be drawn. 1. Frac thru tubing has become proven novel treatment and suitable performing at monobore and single selective completion in PHE ONWJ and a best approached for economical aspect to reduce cost compare to conventional frac treatment in ONWJ (with HWU or drilling rig). 2. Frac geometry most likely will be smaller compared to hydraulic fracturing with frac string, but with futher design will made frac geometry which still fulfills stimulation target needs.

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Table 2
Fracturing Treatment AD-34

Frac Program		Preliminary	Final	Actual
Base fluid	Bbls	423.0	283.3	285.4
Pad Volume	Bbls	175.0	54.8	59.8
Slurry Volume	Bbls	480.0	330.2	332.6
Flush	Bbls	38.0	34.5	32.9
Sand Pumped	Lbs	54768	44500	44000
In Formation	Lbs	54659	43523	43215
In Wellbore	Lbs	109	977	785
WH Treating Pressure, Psi		3837	2496	2318
Pumping Rate	Bpm	16	16	16.3
Fluid Efficiency		35.15	74.4700	74.092

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