NEW KID ON THE BLOCK

JJ Herman, Shear Bits, Canada, discusses recent hybrid technology advancements and their application through case studies.

One could argue, that the level of economic pressure and competition on the oil and gas drilling industry has never been so high. At the pointy end of this stick is where the drill bit resides and where all these economic pressures of risk and reward converge. No single role compares to the low cost of renting or purchasing drill bits versus the value that this product and service can contribute to the economic benefits of the drilling operation. This key factor is what drives the extreme pressure on drill bit development and where the results of the performance of drill bit technology have such a clear outcome of win or lose. Since all components of a drilling operation bear their weight on the drill bit, it often takes the blame for factors entirely outside of its control. There are more opinions and emotional loyalties tied to drill bits than any other component sitting around the drilling rig. Competition is fierce with all the largest service companies having their own drill bit line and matching those drill bit designs to their own bottom hole assembly components. One bit holds the title on each interval of each well and the other bits are trying to steal that title away – like a heavyweight title fight every run. This is where the concept of merging technologies together and creating new ways to fracture rock was born and where hybrid drill bit technology has been emerging from for decades.

New hybrid on the block

The latest hybrid design introduced back in 2013 is Pexus™ Hybrid technology from Shear Bits. Since its introduction, Pexus technology has taken on an evolutionary adaptation moving at a higher rate than any hybrid technology preceding and the platform of flexibility to drastically adjust the build specification in such a short time frame is unmatched. Utilising two separate cutting structures, each on their own radial and axial plane, and own fracturing mechanisms is what gives this technology a unique geometry. Features and changes can be applied to the final build specification within days or minutes depending

on the adjustment required. The finest of adjustments between the relationship of these fracturing components drastically changes how the energy being applied by the drilling rig is transferred into the rock. This level of precision manufacturing and finite adjustments are what has made the challenge so great to overcome. Workload, shear length, heat, force, helical drilling path, downhole pattern, wear relationship, cooling demands, cleaning demands, and fracture efficiency are all factors and change with every adjustment. The challenges begin with the analysis of the application, which demands skilled and experienced individuals to decipher and define the root causes and critical aspects of the drilling environment. There are many critical components to the design strategy consisting of extreme demands on the design software platform, CFD algorithms and execution of the engineering team. These high standards continue through to the highest quality machining capabilities and programming experience followed by a very high level of quality controls and finish manufacturing processes. Using only leading-edge materials and components can this technology be produced and implemented. All these factors lie on the need for strong communication and team effort shared between the drilling operator and sales and application teams

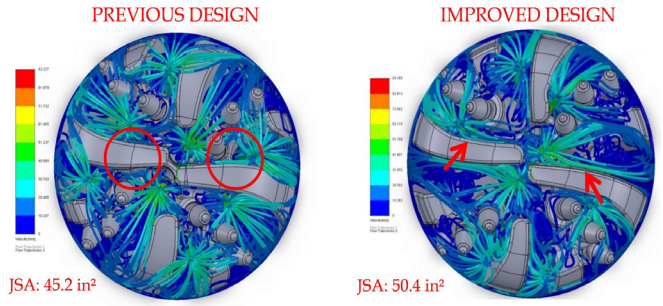

Figure 1. *New CFD platform example.*

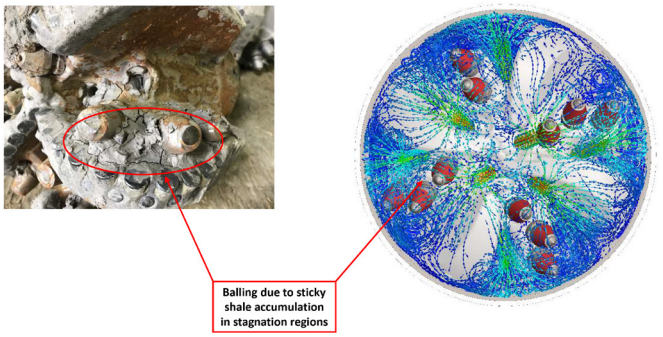

Figure 2. *Overcoming the challenge – CFD balling.*

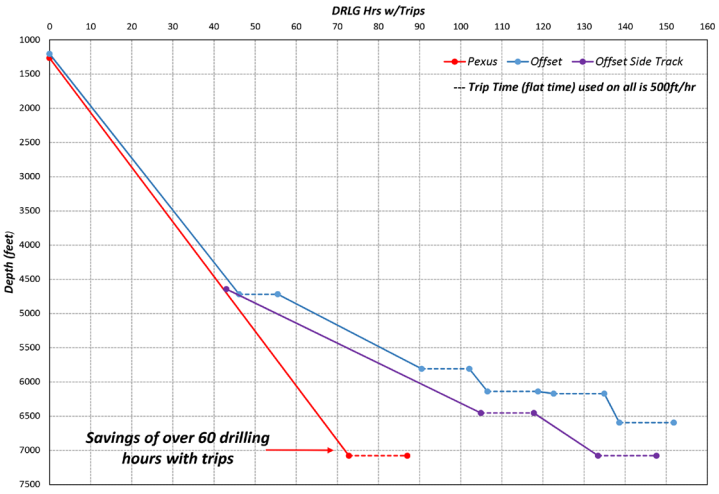

Figure 3. *Eastern Europe case study graph (12 ¼ in. interval).*

of the drill bit company so this whole process has a strong foundation to build from.

Overcoming the challenge

Shear Bits realised how important overcoming these challenges would be, which led the company to make the investment and commitment to completely reinvent its engineering and manufacturing processes from the ground up. This transformation included developing and implementing API Q1 certification (April 2016), moving to Creo Pro-E design software (February 2017), training new individuals with varying backgrounds to mould into bit designers who could collaborate more closely with the engineering team, creating a Quality and Technology Director position in the organisation, developing new sophisticated design models and writing a proprietary design manual. Elevation of the technology also required collaborating with specialists and universities to develop CFD modelling, working jointly with scientists and manufacturers to develop material grades and compositions unique to their design needs and attaining patent certification of the Pexus Hybrid family.

Case studies

Eastern Europe

An operator is drilling wells consisting of multiple hole sizes to reach depths ranging from 15 000 - 18 000 ft MD. The intermediate intervals are drilled in 12 ¼ in. and 8 ½ in. bit sizes and each interval most commonly takes multiple bits to complete each section.

The 12 ¼ in. section has an abrupt challenging transition at the mid-point of the interval which has demanded a bit trip on all the prior wells. Conventional PDC designs have been run on the top section, having trouble with balling in challenging shales and were not successful drilling the sand and carbonate transition at the mid-point. Therefore, rollercone tooth bits have been the primary choice for reaching the mid-point and being sacrificed in the transition. If the transition is not drilled entirely by the first tooth bit either a second rollercone insert bit is required or a PDC is sacrificed in a short run before another PDC can be run. The bottom end of the 12 ¼ in. interval requires multiple PDCs to reach casing point due to hard transitional carbonate drilling with low penetration rates resulting in long on bottom drilling hours. The first Pexus Hybrid design was run on a conventional motor BHA for this interval and replaced the rollercone tooth bit and a minimum of one additional rollercone and two PDC runs (4 - 6 total bit runs) while improving penetration rate by 22%.

The 8 ½ in. interval consists of hard dolomite with presence of abrasive sand lenses throughout with high bottom hole temperatures. Additional drilling challenges include a high mud weight environment and interbedded transitional drilling. The conventional PDC bits are pulled with impact damage to PDC cutters as well as wear and high thermal abrasion. Wear conditions often start in the centre of the bits continuing over the nose and shoulder to gauge. Chipping and breakage begins on the nose and continues through the shoulder to the gauge region of the profile after only 30 - 60 hrs of drilling. Multiple six (double row), seven (double row), eight and nine bladed conventional PDC designs have been utilised to drill this interval and on two wells back to back Pexus Hybrid technology has been implemented with impressive results. Multiple Pexus Hybrid runs with 80 - 120 hrs have been recorded with ROP improvements of 20 to 50% over conventional PDC designs. Dull grades on all of these Hybrid designs have been graded as good as 0 - 1 to 1 - 3 all in gauge with minimal to no signs of erosion.

Saskatchewan, Canada

An operator in the mid-western portion of the province drilled a multi-lateral horizontal play with 7 ⅞ in. PDC bits. The formation

consists of an array of transitional drilling challenges due to a mixed clast structure of shale and dolomite with scattered pyrite and calcite lenses throughout. Penetration rates of 30 - 90 ft/hr with bit runs of 1200 - 1500 ft was the expected performance based on prior runs with conventional PDC bits. Impact damage on conventional PDC cutting structures is the common dull characteristic due to the excessive vibration and abrupt changes in lithology. Predictive and consistent BHA tracking is also difficult to manage as reactive torque and changes in ROP tends to affect the direction of where the bits drill. The first Pexus Hybrid chosen for this application resulted in the length of the first leg being extended from 4200 - 5400 ft due to the drilling success. The BHA was then pulled back near the landing point and an open hole sidetrack operation was completed without making any changes to the bend setting of the motor or BHA. This successful sidetrack operation on the original bend setting after completing the first entire leg was a first for this application. After the sidetrack operation drilling continued until TD was reached on the second leg of over 2800 ft drilled. In summary, this was a single run drilling over 8200 ft with a penetration rate over 30% faster than conventional PDC expectations on the same BHA without changes to motor settings.

Figure 4. *Saskatchewan case study – Pexus dull condition.*

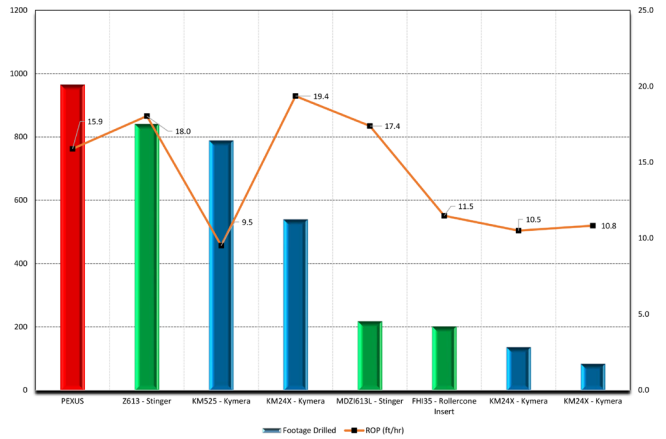

Figure 5. *Graph and data – North Western Alberta case study (imperial units).*

Figure 6. *Central Alberta case study – Pexus HDD application.*

North Western Alberta, Canada

An operator drilling a challenging 8 ½ in. turn and build interval through very abrasive sand shale transitions consisting of chert lenses and siliceous cemented sandstone stringers was taking multiple bits to complete the interval. Conventional PDCs had to be pulled for toolface and directional control before the interval could be completed, coming out severely damaged by both abrasion and impact. Rollercone or rollercone PDC hybrid bits were required to land in the horizontal zone where ROP was sacrificed for directional control. The operator chose to compare the performance of a Pexus Hybrid design and the result was a single bit run to TD with increased ROP and no issue with directional performance on a conventional bent housing BHA. The dull condition was in gauge with very smooth sharp wear across the nose and shoulder of the cutting structure with no impact damage. The cost savings of not having to trip, at a measured depth of over 9000 ft, and the increased ROP over conventional PDC, rollercone, and rollercone hybrid bit performance was significant.

Central Alberta, Canada

An operator wanted to drill a challenging HDD pipeline river crossing operation with a 14 ¾ in. pilot bit. The operator was aware of the presence of gravel and possible boulders intermixed with sand and shale for the duration of the 5500 ft interval. The directional profile was to drill down at a high angle under the river and then gradually steer back up and break surface on the other side. Multiple bit trips are usually required due to the demand to maintain a sharp gauge to perform the demanding directional operation while handling the gravel and expected boulders. These operations typically take weeks with multiple bit trips, hole condition challenges and high on-bottom rotating hours. The bit chosen for such an operation was a six bladed, rotating Pexus Hybrid insert design. The result was a single run on conventional bent housing motor in under 7 days to TD, drilling at higher ROP than ever previously achieved.

Surpassing past barriers

All this hard work, commitment to investment, and new team synergy to continue developing Pexus Hybrid technology has proven to be worthwhile in the achievements and performance attained. Pexus Hybrid runs are exceeding 8300 ft drilled in a single run, achieving average penetration rates over 750 ft/hr, and cumulative run footages over 40 000 ft drilled. Multiple hybrid runs have involved drilling for over seven consecutive days without the BHA or the bit being tripped. Even though other advancements have been made, these types of bit runs can only be achieved when the drill bit is delivering minimal downhole vibration, leaving a good hole condition and generating minimal cyclic stress on the downhole motor and other BHA components.

Conclusion

The industry has never previously documented the kind performance improvements that have been achieved by drill bit technologies over the past two years. The future is bright for operators who are embracing these new technologies and taking advantage of working with the teams overcoming these challenges. The slowdown the industry experienced in 2014 and 2015 was harsh and many service companies, operators and individuals were not able to survive and reinvent themselves. With extreme pressure on economics, instinct and survival come to the fore. Those who adapt and persevere with quality, innovation and retained experience and expertise will benefit, and the oil and gas industry will continue to navigate forward in this changing world.