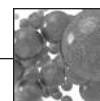


Extended Lateral Lengths, *Optimized Completions* *Define Eclipse’s Best Practices*

By Al Pickett
Special Correspondent

Independent operators continue to define and then re-define “best practices” to optimize well performance and bottom-line economics in America’s horizontal resource plays. The goal is to continually refine drilling and completion techniques to get the biggest bang for the buck invested in each new well, while also steadily increasing reserve recovery rates and flattening annual decline curves over time.

From the Wolfcamp in West Texas to the Marcellus in Appalachia, two nearly universal trends emerging from that effort are extended lateral lengths and greater proppant volumes in the stimulated interval. Eclipse Resources Corp. is setting the pace on both fronts in its Utica and Marcellus operations, drilling the longest laterals to date onshore North America and setting records for the total amount of proppant pumped (and total number of stages completed) in a month by a single fracturing crew.



The company's "super laterals" have extended-reach architectures with total measured depths pushing 30,000 feet and lateral lengths exceeding 18,500 feet, while its "Generation 3" high-intensity completion design incorporates increased proppant loading, tighter spacing and 100 percent slickwater treatments. The net result, as Eclipse Resources' Co-Founder, Chairman and Chief Executive Officer Ben Hulburt summarizes, is "an industry-leading operational proficiency in the Utica Shale, setting records on lateral lengths, well costs, completion designs and efficiency."

Oleg Tolmachev is the man in charge of engineering Eclipse Resources' super laterals and multistage completion designs in its 112,000 net effective acre leasehold in the core of the Utica Shale and liquids-rich Marcellus Shale. "Our initial goal with both super laterals and optimized completions was to reduce total cost per foot of completed lateral," says Tolmachev, who in January was promoted from senior vice president of drilling and completions to executive vice president and chief operating officer. "We have achieved industry-leading cost metrics in our operating area, while also improving the production performance of our wells and estimated ultimate recovery rates."

Increasing EURs per foot of lateral is the ultimate objective in ultralow-permeability resource plays in which the recovered percentage of the original hydrocarbons in place historically have been measured in single digits. In its fourth-quarter and year-end 2016 operational report, Eclipse updated its Utica condensate and Utica rich gas type-curve assumption, resulting in estimated ultimate recovery increases of 16 and 22 percent, respectively, based on the results of newly completed wells using the Generation 3 design.

Shifting To Innovation

According to Tolmachev, the State College, Pa.-based company's focus "shifted to science and innovation" in 2016. That included initiating its super lateral pilot program, successfully drilling the first well—the Purple Hayes, with a total measured depth of 27,048 feet and a lateral length of 18,544 feet—in only 17.6 days in a single bottom-hole assembly run, and completing the 124 frac stages in 23.5 days (see "Purple Hayes No. 1H Ushers in Step Changes in Lateral Length, Well Cost," *AOGR*, July 2016). The well's drilling and completion cost averaged \$835 per lateral foot, setting a new Utica standard, he notes.

In conjunction with launching super lateral drilling, Tolmachev says, the company also started its Generation 3 slickwater com-

pletions last year, further enhancing returns by reducing stage spacing and increased proppant volumes.

The extended-reach laterals and optimized completions are proving a powerful combination. In fact, Eclipse announced in February that the Purple Hayes produced a cumulative 2.4 billion cubic feet of gas equivalent (38 percent gas, 38 percent condensate and 24 percent natural gas liquids) during the first 185 days of production while exhibiting significantly shallower pressure declines than anticipated. Based on the well's performance since it began production in early May, Eclipse says it estimates that its first super lateral will outperform the company's "type well" reserve expectations by as much as 50 percent.

Tolmachev says a key part of the cost savings Eclipse has realized in both drilling and completions is a result of engineering optimization, including advanced directional planning, utilization of managed pressure drilling, slickwater completions designs, advanced water logistics planning, and casing-conveyed toe guns. Continued efficiency improvements going forward are expected to come from the optimizations of managed pressure drilling to allow reduced mud weights, water recycling, reusing/repurposing production equipment, and bi-fuel frac fleets, he reveals.

In 2017, Tolmachev reports that the company is focused on transferring the best practices and lessons learned the groundbreaking Purple Hayes to other super lateral wells. Among the 24 (gross) Utica and Marcellus wells budgeted for this year are 11 super laterals with planned lateral extensions greater than 15,000 feet, eight of which are located within the Utica condensate area and three in the Utica dry gas area. Tolmachev reports that at least two of those wells are expected to have lateral sections longer than the Purple Hayes.

Also in 2017, Tolmachev says Eclipse will begin testing its newest Generation 4 completion design, although he adds that many of the wells the company completes this year will use the Generation 3 design.

Value Creation Process

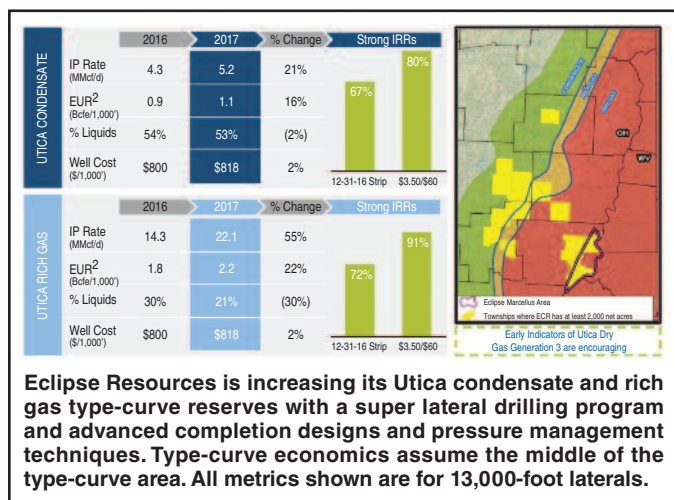
The value creation process for Eclipse Resource begins, of course, with selecting a pad site and planning the wells. Tolmachev says Eclipse pads contain between two and six wells, and an average of four. There are several reasons for that.

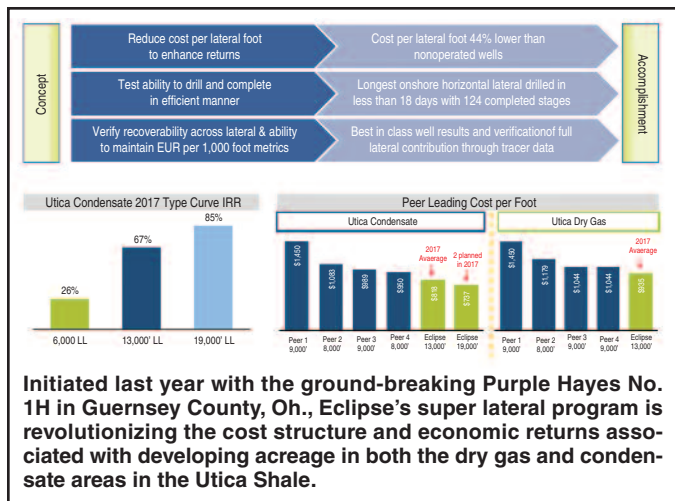
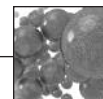
"We want to realize efficiency," he explains. "Of course, you save money in moving rigs when you have multiple wells on a pad. But at the same time, the more wells you have on a pad, the longer you have to wait for the pad's production to go to sales. You have to consider cash flow."

The ability to zipper (or simultaneously) fracture multiple wells at the same time is an advantage to pad drilling, Tolmachev observes. "We try to zipper frac every time we can," he continues. "Zipper fracs reduce cycle time and allow a higher number of frac stages a day. There are other advantages that enhance recovery. Moving between two laterals, the fractures create pressure distribution. That is the most efficient way to fracture the wells."

Taking all that into consideration, he claims four wells per pad seems to be Eclipse's most efficient method. On average across its wet gas, dry gas and condensate-rich areas, the company drills 1,659 feet of lateral a day.

Tolmachev also notes that Eclipse set a Halliburton record in October for the most fracturing stages by a single crew, as well as the most pounds of sand pumped in a month. In fact, the frac stage record was set in September and then broken by the same





crew the very next month, when it also pumped a record 82 million pounds of proppant in Eclipse wells.

He says Eclipse orients its laterals 15-20 degrees of north-south. "If you look at the historical geology in the United States, you want to drill perpendicular to the direction of maximum stress field," he explains.

Optimized Completions

According to Tolmachev, the company began the first phase of its eastern Ohio Utica Shale horizontal drilling program using 200- to 240-foot frac stage spacing and pumping 1,400-1,500 pounds of proppant per foot of lateral using a mixture of slickwater, linear gel and cross-linked gel. It then moved to a second-generation design with 100-percent slickwater. In Generation 3, the latest evolution of the company's preferred frac design, the all-slickwater treatments have tighter stage spacing and increased sand concentrations.

"By identifying important parameters, we now are using slickwater only and have tightened frac stages to 150 feet using 2,300-2,800 pounds of proppant per foot," Tolmachev explains. "Wells completed with the Generation 3 design pump 53 percent more proppant per lateral foot and have 38 percent tighter stage spacing than wells completed with the first-generation design."

Tolmachev indicates Eclipse has realized a 20 percent increase in reserves with its newest template. By eliminating the gels and going to 150-foot frac stages and pumping more proppant, he claims the company has "decreased cost and increased reserves."

Using slickwater fluids only, he says, allows Eclipse to reuse its flowback water and thus reduce saltwater disposal volumes. "Slickwater fluids are less viscous, which creates a more efficient fracture geometry, less damage to the formation, and higher fracture conductivity," Tolmachev relates. "A more complex fracture network also exposes more shale surface area, and in condensate areas, a more conductive propped fracture network allows gas and condensate to flow to the wellbore for a longer time."

In the meantime, he says, tighter stage spacing ensures proper frac initiations across all perforation clusters, and the higher proppant loading increases the stimulated reservoir volume and keeps a larger percentage of the fracture network propped open, leading to enhanced productivity and higher EURs.

Eclipse also has implemented an engineered flowback, according to Tolmachev. "If you flow a well back at too high of a rate, you can wash out the proppant, which means a loss of reserves,"

he warns. "The rate has to be high enough to flow back the fluid, but not so high that it damages the fracture geometry. There is a lot of science using engineering models to find the sweet spot because we do not want to waste our fracture stages."

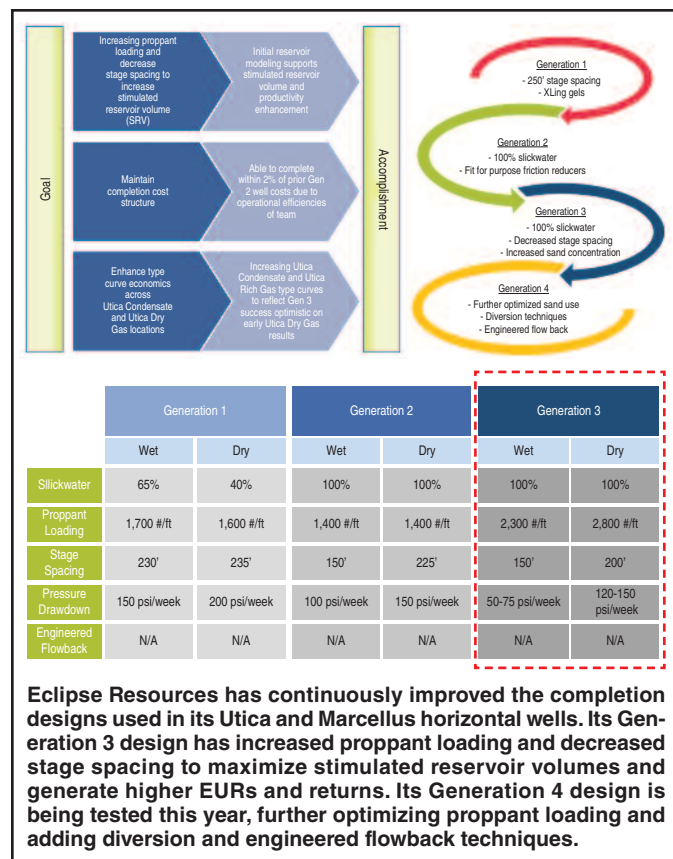
The results of the company's Generation 3 completion design, in conjunction with extended-reach laterals, are remarkable, Tolmachev says. Eclipse indicates that its initial production rate will increase 21 percent this year, from 4.3 million cubic feet a day equivalent in 2016 to 5.2 MMcfe/d in the Utica condensate window, thus increasing each well's EUR 16 percent from 900 MMcfe per 1,000 feet to 1.1 Bcfe/1,000 feet.

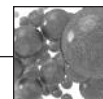
Meanwhile, in the Utica rich-gas window, Eclipse claims the Generation 3 design will increase initial production rates 55 percent, from 14.3 MMcfe/d to 22.1 MMcfe/d, while boosting EURs 22 percent, from 1.8 Bcfe/1,000 feet to 2.2 Bcf/1,000 feet.

The company is accomplishing all that with an equally remarkable modest increase in well costs, Tolmachev reports, raising total costs from \$800 to \$818 (0.02 percent) per 1,000 feet of drilled and completed lateral.

Douglas Kris, vice president of investor relations, points out those numbers demonstrate that while much of the industry has moved away from liquids plays to dry gas, Eclipse can make it work with a highly economic rate of return. "We are on the forefront of operators going back to more liquids," he claims.

Eclipse says its acreage in Guernsey, Noble, Monroe and Belmont counties in southeastern Ohio includes 41 percent Utica dry gas, 36 percent Utica condensate, 13 percent Marcellus condensate and 8 percent Utica rich gas. The company reports that all type-curve areas are generating returns better than 65 percent at strip pricing.





Super Long Laterals

“If you drill laterals shorter than 10,000 feet,” Tolmachev explains, “your rate of return (in the Utica condensate window) has trouble competing with the dry gas. But with laterals in excess of 12,000 feet, the entire calculus changes and makes it competitive with dry gas.”

The lateral lengths of the 24 Utica and Marcellus wells that Eclipse expects to drill this year in Ohio will average 13,300 feet. The 11 super laterals, with horizontal reaches in excess of 15,000 feet, include two wells with laterals longer than 19,000 feet, Tolmachev predicts.

“We have experience with the Purple Hayes,” he adds. “We clearly understand the risks and parameters of drilling a lateral that long, and also understand how to do it very efficiently.”

During the past 10 months, Tolmachev says Purple Hayes’ production has remained flat with only a shallow decline, producing 6 MMcf of natural gas and more than 1,200 barrels of oil a day, despite the company’s aggressive pressure management program.

The success of the Purple Hayes super lateral was the result of “very diligent engineering upfront,” from the drilling mud used to directional drilling, casing design and wireline, Tolmachev describes. “You cannot assume what works on a shorter well will work on a longer lateral,” he explains. “Preplanning and using the most advanced engineering techniques were the reasons for the Purple Hayes’ success.”

Moving Forward

About 41 percent of Eclipse Resources’ total lease acreage is in the Utica’s dry gas type-curve area, with 38 percent in the condensate area and 8 percent in the rich gas area. The remaining 13 percent is in the Marcellus condensate area.

Tolmachev says evaluating its Utica dry gas wells using the third-generation completion design is ongoing, but the company lists its dry gas initial production rate of 19.5 MMcf/d with an EUR of 1.9 Bcfe per 1,000 feet. That is based on a lateral length of 13,000 feet with well costs averaging \$935/1,000 feet.

Eclipse uses an average well spacing of 750 feet in the rich gas/condensate windows and 1,000 feet for dry gas wells, although Tolmachev claims that may “be a moving target, depending on commodity prices.”

“We are not resting on our laurels,” he contends. “We always are moving forward. In fact, we are piloting the first re-frac of a Utica Shale well this year.”

He adds that his preference is to drill with the toe up, which allows the produced fluid to gravity drain toward the heel.

“The further you go, you want to make sure all stages are producing,” Tolmachev points out. “We did testing that shows that all stages completed in the Purple Hayes are contributing. The Utica is pretty simple structurally. If you land in the right section, it is not hard to stay in the sweet spot.”

He says the company plans to test its Generation 4 frac design this year to further optimize sand use and use diversion techniques and engineered flowback methods. □