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POWER TO DRIVE FRACING 2.0 – MODULAR ELECTRIFICATION SOLUTIONS THAT EASILY SCALE

Dalia El Tawy

Siemens (dalia.el_tawy@siemens.com)

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Abstract

In recent years, there has been a great deal of discussion surrounding the bottlenecks that North American oil and gas producers are facing, particularly a lack of pipeline capacity. However, much less has been published about constraints and challenges surrounding power, which is becoming a serious threat to growth in many regions. Operators in unconventional plays are facing increased pressure to reduce completions costs and bring production on sooner. To achieve this, they must be able to deploy efficient power generating capacity rapidly.

As this paper will discuss, by using proven, safe and robust equipment from the mining and power generation industries, electrification of pressure-pumping operations with high density power solutions can boost efficiency, reduce emissions, and lower total lifecycle costs – helping improve productivity, agility, and profitability in unconventional oil and gas completions.

By deploying gas turbine packages that burn well-head gas or liquid fuels instead of diesel, operators can realize significant savings in fuel costs and reduce or eliminate flaring and emissions. This approach also eliminates the need for fuel deliveries from third parties, saving costs and relieving congestion and stress in and about the wellsite, as well as the public roads to get there. The turbines can then be used to drive generators, which supply power to prime movers, such as electrical motors and variable frequency drives. By eliminating traditional diesel generators and electrifying fleets, operators are able to achieve cleaner, more efficient fracturing operations.

Introduction

Unconventional energy production in North America has unlocked immense wealth in the U.S. According to the U.S. Energy Information Administration, prospects are bright for this good fortune to continue. The Administration forecasts tight oil to continue being the top source of U.S. crude oil production through 2050, although it expects output to plateau at 11–

12 million barrels per day (bpd) in the next few years [1]. Still, those levels are healthy by any measure and will far exceed a 9.6 million bpd record set in 1970.

Nonetheless, with the pain from the free fall of market prices in 2014-16 still fresh in mind, today's unconventional producers want to maximize their efficiencies, yields, and profitability in all market conditions. Even before that time, they were starting to implement new approaches and techniques in well stimulation and completion, then accelerated their efforts as margins eroded almost by the day.

Some might mark this period as the start of Fracing 2.0, the next-generation hydraulic fracturing of unconventional oil and gas resources marked by a focus on operational efficiencies and improving the return on capital deployed. Part of this story has seen the emergence of greater electrification, automation, and digitalization of fracing operations. This paper will focus on the electrification of pressure-pumping applications as a core trend in the fracing continuing evolution.

Unconventional Power Challenges

Multi-well pads, zipper fracing, and longer laterals, often stacked, have become less novel and more the norm. These trends are making the unconventional much more conventional — supported by greater automation to improve efficiencies, flexibility, and speed. After all, fraced wells produce most of their oil and gas in just 18 months, which means exploration and production (E&P) companies must drill faster and faster to keep pace.

But two key challenges are emerging that threaten to slow industry growth. They come from the greater operational density that these techniques bring. And that's in addition to the ever-expanding reach of E&P activities, often in remote areas where unconventional oil and gas resources are found.

One big challenge is the limitation of horsepower available on current pumping trucks, as well as the high associated maintenance costs. More and more horsepower is required to drive next-generation pressure-pumping equipment, and today's diesel drivers, whether mechanical or for power generation fall short and diesel fuel costs are proportionally increasing.

The other challenge is regulatory limits on the flaring of produced gas, which is flared because remote production wells often lack the gathering pipeline infrastructure to get it to market. It's estimated that some producers are wasting close to 10% of their produced gas due to flaring [2]. In the Permian alone, flaring rose by roughly 85 percent last year to 553 million cubic feet a day – which was enough to meet residential demand across the entire state of Texas [3]. Challenges associated with noise especially at locations close to residential neighborhoods continue to increase as well.

As regulations surrounding flaring tighten, producers will be forced to find ways to utilize produced gas sustainably. An increasing number of unconventional operators are addressing both power and environmental concerns by turning to high-density, mobile gas turbine packages that can burn wellhead gas to generate low-cost power, ultimately resulting in increased revenue and reducing noise significantly.

Electrifying Hydraulic Fracturing

The task at hand in unconventional plays is to deploy efficient, mobile power generating capacity that can be brought online rapidly. In many cases, the need is temporary and the mobile power plant may need to be relocated to perform a similar duty at a different location. Compact and modular turbine-based drive trains, which are truck-borne or on skids, are increasingly emerging as a solution for hydraulic fracturing of tight oil and gas resources. These solutions are highly scalable and can be used to economically power fracing operations using produced gas or other fuels that are more cost-effective than diesel.

The drive packages feature rugged, severe-duty, and outdoor-rated traction motors and drives that have been operating reliably in the mobile mining industry for nearly 20 years. They are used on huge mining trucks and excavators the size of large buildings, often operating in the harshest conditions. This includes places like Western Australia, where high ambient temperatures and penetrating dust is a constant threat. They also are deployed in Siberian mining operations, where winter operations consistently subject them to sub-zero Arctic cold.

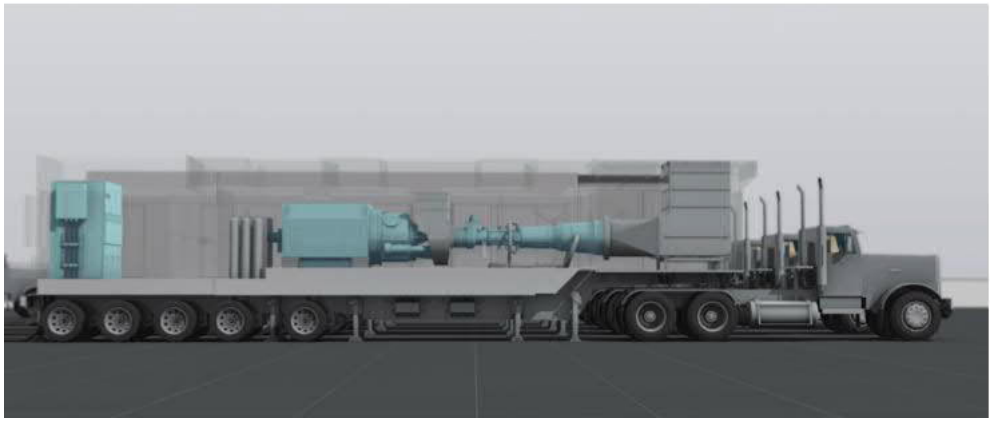

Figure 1. Representation of trailer-mounted mobile gas turbine package

The primary advantage to mobile gas turbine drive packages lies in the fact that they can deliver more hydraulic pump horsepower in a smaller operational footprint. Current diesel and gas-hybrid reciprocating engine drivers top out at roughly 2,500 shaft horsepower (SHP), which falls short of the 3,000+ SHP needed to drive next-generation pumps. These diesel or gas-hybrid engine drivers are simply too large to fit on a mobile trailer. In contrast, gas turbine packages can generate up to 10,000 SHP per pump trailer in a very compact footprint. In addition to the gas turbine, the packaged solutions are equipped with electrical distribution switchgear; inverters; generators; transformers; and other associated components.

Gas turbine packages are available in varying power block sizes to provide options based on specific power needs, pressure and flowrates, portability, available fuel source, environmental conditions, etc. In a typical configuration, one mobile power unit supplies three 2,500 SHP pump trains. But total power output can be scaled by simply selecting the required number of mobile turbine packages or using larger mobiles gas turbines. Larger gas turbines can be used to power larger HP pump trailers as well. The trains can be rigged quickly, both up and down, in just a couple of hours for smaller units and a day for larger ones.

These solutions also include wireless monitoring and controls, plus remote diagnostic technology. With such tools, operators can collect and analyze equipment data in real-time, with alerts to flag operating anomalies. This can provide actionable intelligence for condition-

based monitoring of equipment, even from afar. In turn, operators or their service providers can enact more precise, less costly condition-based maintenance models, leading to less downtime and greater asset utilization. Cloud-based digital services and analytics can also be deployed. This way, data can be gathered and analyzed across entire fracturing fleets to continually optimize operations.

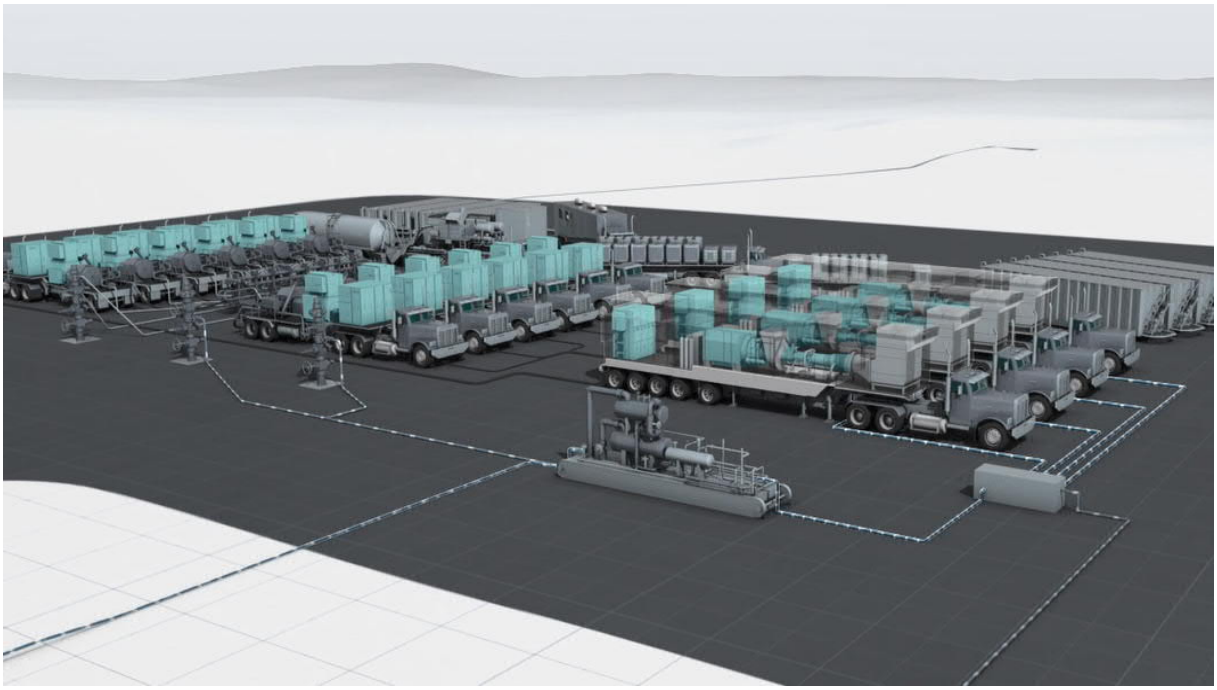

Figure 2. Representation of Unconventional Oil and Gas fleet – depending on electrification and large power density mobile gas turbine generator sets

Key benefits of high-power density gas turbine packages to electrify pressure pumping include:

- **Lower OPEX through savings in fuel, parts, and labor** -- Mobile gas turbines can be equipped to burn a range of natural gases, including wellhead gas (or liquid fuel), which enables operators to generate valuable power using what is a cheap source of fuel from nearby pipeline infrastructure or would otherwise be flared. In many cases, once enough gas is being produced from the wellheads on the pad or from nearby gathering infrastructure, there is no need to transport fuel onsite from third parties, saving costs and relieving stress on public infrastructure. In certain cases, high-power density gas turbine drive packages can cut onsite power-generation fuel costs by as much as 80 percent when compared to diesel-engine solutions. Maintenance costs can also be reduced by up to 60 percent, as gas turbines have longer service intervals than traditional diesel- or gas engine-based setups.

- **Reduced noise -** Gas turbines and generator sets can be packaged into noise-protected mobile trailer units with electrical distribution switchgear. This is a significant benefit for companies who operate well sites in close proximity to neighborhoods. In such cases, there may be upwards of 20 diesel generators running at any given time, generating enough noise to warrant the construction of embankment or walls for suppression, which can increase costs and congestion on space-constrained sites.

- **Reduced environmental impacts** – By using wellhead gas as fuel for gas turbine-driven packages, operators can eliminate flaring. Additionally, gas turbines utilizing dry low emissions (DLE) technology can achieve single digit NOx levels without the water-injection that competing solutions require.

- **Improvements in control and efficiency** – One of the primary benefits of all-electric drive trains is smooth power shifts. No mechanical transmission also results in precise power control at any level, along with a smaller operational footprint, faster rig-up/down capabilities, and increased scalability.

- **Increased uptime and operational visibility** -- Real-time data collection and analysis facilitates condition-based maintenance for maximum uptime. Operators are provided with a 360° view of pressure-pumping operations and can tap into data to realize greater operational efficiencies and improved decision support, both onsite and at a distance.

Conclusion

Reliable and scalable power has become a key enabler of growth in unconventional shale plays. Producers and oilfield service providers have historically relied on diesel-based power setups for fracing and associated operations. However, in recent years, high power density solutions that can deliver more horsepower in a smaller footprint have increased. Electrification using gas turbines has long been viewed as means for achieving those goals, but the concept has not been widely deployed due the perceived technical challenges.

Engaging early with a solution provider that can handle a significant portion of the supply and service scope can alleviate many of these concerns. From delivery of mobile gas turbines, motors, drivers, and electrification equipment, to engineering, construction, commissioning and service, having a single point of responsibility for a project can generate wide-ranging benefits through streamlined project execution, shorter delivery times, reduced schedule risk, greater uptime and availability as well as life cycle support.

In summation, by electrifying pressure-pumping operations using mobile, turbine-based packages instead of using traditional diesel solutions, unconventional operators and their service providers can realize significant efficiency gains — while also addressing their noise, flaring and emission issues. These solutions also enable operators to capture significant OPEX savings in the form of reduced fuel costs and maintenance costs. In many cases, the need for fuel deliveries from third parties can be entirely eliminated, thereby reducing completions cost and improving production economics.

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