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THE BRAVE NEW WORLD OF ELECTRIC FRAC

Jeff Fraser, ST9 Gas + Oil, USA, discusses new developments in electric fraccing technology.

There are plenty of options on the market for those interested in harnessing the power of electricity and applying it to fraccing. The electric frac pump configurations available now are largely comprised of existing mechanical units that are integrated into an electric system. This practice, however, can limit an operation's efficiency and performance. However, ST9's Project 38 Lightning (P.38), is the first purpose-designed electric frac pump system.

Contemporary contenders

At present, frac operators have two alternatives to choose from when in pursuit of a clean, electric fleet. The first option offers a dual-motor, trailer-mounted configuration coupled with up to two triplex pumps. This large, industrial-sized, and air-cooled system is capable of 3600 - 4500 hydraulic horsepower (HHP). The second option is a single-motor, skid-mounted configuration. The centrally located motor is connected by two quintuplex pumps via a through-spindle design. This larger unit is also air-cooled, and is capable of 6000 HHP. The question is, what do these systems offer the end-user? What applications do they excel at, and where do they fall short?

Positives

Following the advent of 'green' electric technologies from solar power to hybrid cars, it comes as no surprise that electric frac operators claim major advantages when it comes to environmental concerns. Electric systems allow end-users to almost entirely eliminate hydrocarbon emissions by using clean-burning well gas

turbines or local industrial power sources to fuel their operations. Noise pollution is also reduced by the removal of some of the loudest equipment on the pad, and electric configurations allow for cooling solutions that can be controlled to reduce or redirect most auditory nuisances. Electric fraccing systems also typically have a smaller footprint on-pad than conventional means. Maintenance can be simplified to a considerable degree, since heavy, cumbersome mechanical power units are replaced with smaller, less complex electrical power units.

Negatives

Despite the considerable benefits of electric frac systems, the options currently available to operators still have a number of flaws. Existing electric configurations experience inefficiencies in certain key areas. Contemporary offerings for electric frac configurations are composed of existing components from mechanical systems that are repurposed for electric applications. These components were not specifically built for electric systems. Consequently, effective horsepower is decreased due to design conflicts introducing hydraulic and mechanical resistance, as well as accelerated wear cycles as a result of violent harmonics and misalignments in provisional electric systems.

The inefficiencies do not end there: air-cooling solutions often leave something to be desired, as they are not capable of regulating the temperatures the motors generate, especially in environments where heat is a special concern. This leads to motors running hotter, and therefore, far less efficiently, which reduces the effective HHP of the entire operation. The inability to regulate running temperatures can also lead to premature failure.

There are other concerns regarding the integration of existing mechanical components and electronics, such as the optimisation of the ratios used by power end reduction gears. Electric motors are often mistakenly considered to produce the same results at any RPM. Even though they have flatter and more consistent torque and power curves than internal combustion solutions, this is not entirely true. Electric motors do perform best within a certain RPM range, and contemporary offerings have not taken full advantage of the optimisation that understanding provides. Reduction gear ratios that were not chosen for use in a specific electrical application, expose motors that drive them to possible premature failure, whether it be from spinning outside of the optimal range, or introducing harmonic imbalances and damaging the powertrain as a whole.

While those offering electric frac solutions have had considerable success in multiple applications, there clearly is room left for improvement in electric fraccing.

A new solution

Named after Lockheed's 'P-38 Lightning' fighter plane that served in the Second World War, ST9's Project 38 (P.38) was designed to honour its namesake. Lockheed's original Lightning deviated from traditional military aircraft of the era by housing all of its armament in the nose, directly in front of the pilot. This solution provided unprecedented, concentrated firepower that was effective in aerial combat. ST9's P.38 system continues this legacy of concentrated capability by way of advanced manufacturing technologies. This system has the highest power density on the market, offering up to 14 250 HHP per trailer unit. This means it achieves the highest HHP/kg of material utilised, while also minimising its footprint.

Complementary electric power technologies from the automotive sector were utilised and adapted for fraccing. This resulted in the creation of a multiphasic, pump-mounted direct drive system. Each of the motors on every unit individually generates 300 kW (402 hp). Also included is a through-spindle liquid cooling system so that each unit can run at 98% efficiency, while remaining at a safe temperature, which allows each motor to retain efficiency and power density throughout the operation. The motor's multiphasic technology makes them capable of being 100% individually controlled. Consequently, when one motor encounters a problem, the rest can pick up the slack. The motors are also far more compact and lightweight than most in this application, so not only is P.38 a sextuple-redundant system; it can also be serviced on-site with ease.

The power frame was designed to be strong and rigid, enough to be able to house an advanced lubrication system, as well as internal parts built to match the frame's capability. Six motors are directly attached to each power frame, and drive the system through gear ratios that are optimised for the best performance. The direct nature of the coupling results in lower mechanical losses, elimination of harmonic imbalance concerns, compact packaging, and ease of maintenance. Operators are not limited to a six motor unit, as 12 motor configurations will also be available for those that would like 14 250 HHP on a single trailer.

Figure 1. *Enclosed trailer unit.*

Figure 2. *Single pump unit.*

The P.38 is also equipped with XGen Fluid End that incorporates K-urve technology. Using CFD-Z models, the X-Gen Fluid End was designed to deliver efficient service to the market. K-urve offers improvements in flow efficiency through changes to the internal geometry. Optimised flow is maintained through the fluid end, increasing efficiency as well as effective horsepower, while minimising cavitation and greatly reducing the stress put on the fluid end.

Enclosed trailer unit (ETU)

The P.38 is compact, meaning that three units – capable of up to 14 250 HHP combined – can be mounted to a single trailer or skid unit for any application. The enclosed trailer unit (ETU) in Figure 1 is a force multiplier. Fitted with multiple novel systems and features, the ETU multiplies the benefits of P.38's pumping components. The system was designed for fast, long-distance travel.

The trailer platform can be accessed via its ISO/SAE compliant platform system, providing the crew with a safe, stable position from which they can perform routine maintenance on site. Storage for maintenance items is provided as well, negating the need for crews to transfer equipment across the pad. The trailer can also be configured with a full environment enclosure, creating a safe workplace environment even in extreme weather conditions. These optimisations reduce non-pumping downtime and increase crew safety.

The management of pump lubrication is a critical operation in all applications, and the P.38's enclosed trailer provides a superior solution to achieve precise control. Coolant from the P.38's components is routed to a top-mounted variable-angle radiator pack, which is easy to reconfigure. The angle of the radiator pack can be altered to increase cooling efficiency or reduce noise by controlling the turbulence of the circulating air. The radiator's fans are also capable of reverse drive, allowing the system to clear any debris from its radiative surfaces, thus maintaining maximum efficiency and ensuring stable temperatures. The radiator pack can be easily accessed via the rear-mounted personnel access platform for any necessary maintenance.

The design of the P.38's ETU also houses to a telematics suite. The telematics control unit is capable of communication via satellite, Wi-Fi, bluetooth, and GSM. Edge computing monitors the telemetry from sensors within critical systems, allowing personnel to monitor performance and increase efficiency on and off site, while avoiding unnecessary costs in repairs and maintenance.

All of the various components within the system are part of an integrated, self-contained single unit that makes up the ETU. The self-sufficient nature of the ETU decreases time spent on deployment, departure, and redeployment efforts. The trailer's enclosure is modular and can be removed for greater access to the fluid and power end components when necessary.

During deployment, the trailer's open body can fold together to form one solid outer body. Further minimising its footprint and increasing transit efficiency, the hydraulically actuated body panels create a trailer system that achieves a state of high-speed/low-drag.

The bottom line

Electric fraccing is a new part of the market that has received industry-wide attention. New developments in the world of electric frac have only just begun. Technologies, such as the P.38, are creating a new industry standard and operators are continuously seeking new ways to improve them.