

How to select generator sets for today's oil and gas drill rigs

Careful comparison and selection can improve performance and reduce costs

Modern horizontal drilling techniques used in oil and gas exploration require rugged, reliable and fuel-efficient on-site generator sets to supply electric power for the drawworks, drilling, mud pumping and camp loads. Today's oil and gas drill rigs have to drill deeper and faster than ever before. In addition, they have to use unconventional drilling techniques such as horizontal drilling and fracturing to improve petroleum extraction from less permeable geologic structures such as oil- and gas-bearing shale.

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Today's new drilling realities require more power than conventional wells and have given rise to the development of the AC/DC SCR drill rig powered by multiple generator sets. Deep horizontal drilling is a growing practice around the world and in areas of North America such as the Barnett Shale in Texas, the Haynesville Shale in Louisiana, the Fayetteville Shale in Arkansas and the Marcellus Shale in Pennsylvania/New York.

While AC/DC electric rigs with SCR controls dominate petroleum exploration today, operators are constantly looking for ways to increase total power availability, reliability and fuel efficiency. The economics of petroleum exploration demand that drilling costs be minimized and that drilling speed be maximized. Savings won on the drill rig translate directly to the bottom line for the exploration company or well service provider. These economic realities require generator sets to deliver high specific power, low fuel consumption and less maintenance.

THE MOVE TO ELECTRIC DRILL RIGS

In the search for new petroleum supplies and better production from existing wells, drillers have transitioned from boring simple vertical wells to boring horizontal wells using relatively new steerable drill motors. By drilling down and then turning horizontally once the petroleum structure has been located, more of the well bore is exposed to the oil- or gas-producing zone. Horizontal wells can therefore significantly increase production from a fossil fuel deposit while also reducing the number of secondary wells needing to be drilled.

Other techniques, such as hydraulic fracturing of the petroleum-bearing rock structure to increase the flow of oil or gas, are now almost routinely done as soon as drilling is completed. Today's wells are also significantly deeper than in the past – up to 30,000 feet – involving heavier well strings, higher drilling power requirements and higher mud pumping pressures. While these and

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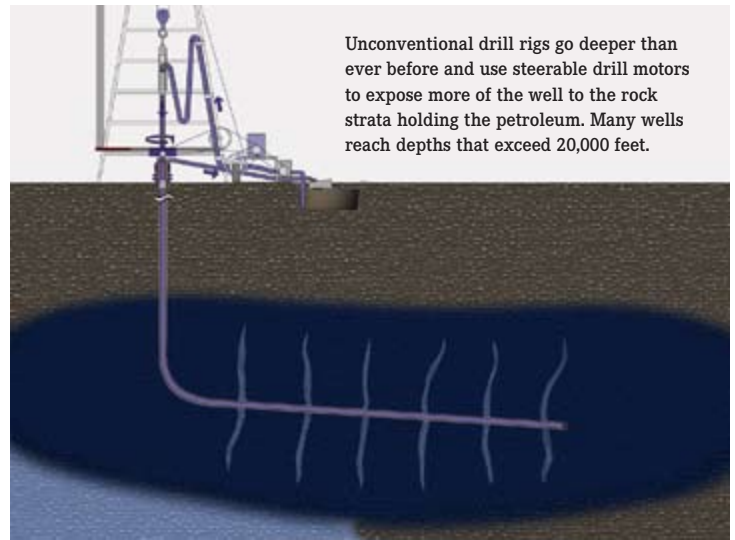
other techniques have greatly increased the rate of petroleum production from individual wells, they have also increased the need for larger and more flexible, economical and reliable power sources at the drill site.

AC/DC rigs with SCR deliver power and flexibility

Oil and gas drill rigs tend to be classified by the type of power used to operate the equipment on the rig. There are mechanical rigs, hydraulic rigs, DC/DC electrical rigs and AC/DC electrical rigs. Mechanical rigs use dedicated diesel engines to provide motive force for the mud pumps, drawworks, rotary drill table and other loads through a system of clutches and transmissions. Hydraulic rigs have dedicated diesel engines running hydraulic pumps, which, in turn, provide power to the necessary equipment. DC/DC electric rigs use dedicated diesel-electric direct-current generators to power DC motors that run the equipment. While mechanical, hydraulic and DC/DC systems are still used for conventional and shallower wells, they can be costly to operate and maintain, and lack flexibility. In addition, these older systems are less reliable. Since individual engines are dedicated to single functions such as driving the mud pump or operating the drawworks, a failure on any one engine can halt drilling altogether.

Today, the majority of the new oil and gas drill rigs are AC/DC electric rigs with SCR controls. These rigs use multiple diesel-electric generator sets running in parallel to produce the two to four megawatts of power needed at the drill site, including the power needed for camp loads such as lighting, heating and air conditioning for crew quarters. Power is generated as alternating current (AC) and then converted to direct current (DC) by a unit called an SCR (so called for the banks of silicon-controlled rectifier semiconductors that it contains). The SCR unit allows precise control of the flow of power to any of the rig's DC motor loads while the generators run at a constant speed.

The number of generators needed by a rig varies with the depth of the drilling operation, but today drillers have to go deeper vertically and sometimes just as far horizontally, and that requires more power. Generator sets can easily be added to the AC/DC SCR-powered rig to match the power requirements, making this design the most flexible. The number of generator sets running at any one time can be varied, depending on total load, to save fuel. This configuration is also more reliable because a failure of one of the generator sets does not necessarily cause a shutdown of drilling operations even though it may reduce the total amount of power available. An additional advantage of paralleled generator sets is that individual units can be taken offline for maintenance without greatly affecting the drilling operation.



GENERATOR SELECTION CRITERIA

In response to the power needs of modern oil and gas drill rigs, rig power manufacturers have developed special generating sets that are designed to stand up to the rigors of the petroleum patch while delivering maximum power and fuel economy with minimum maintenance. When selecting generator sets to power a modern drill rig, look for these key attributes:

1. Base frame stiffness, durability

A prerequisite for any electric drill generator set is rugged construction to take the often severe operating environments and rough handling that are typical in the field. The stiffness of the generator set base is a critical factor in its longevity because any distortion could affect the alignment of the coupling between the engine and alternator, resulting in severe vibration and damage. Ordinary structural steel does not have the necessary stiffness to prevent base frame distortion under severe handling or if placed on uneven ground. A base frame that uses high-strength, low-alloy steel such as A572 steel withstands the rigorous operating conditions. A three-point mounting system with rubber vibration isolators provides the best stability of the engine generator.

2. Ratings and performance characteristics

Drill rig generator sets are designed for continuous operation, and therefore are conservatively rated in terms of their kW output. A typical drill rig generator set has a nameplate rating of about 1,100 kW, although there are both larger and smaller units available. Since these units are likely to be subjected to severe service, generator sets with a 10 percent overload capability beyond their nameplate rating will meet most requirements. While engines on typical commercial 60 Hz generator sets operate at 1,800 rpm, well servicing companies have found that engines that operate at 1,200 rpm have a better record of longevity in the field.



Today's AC/DC SCR-controlled drill rigs use multiple paralleled generator sets to provide power for all drilling and pumping operations. These ruggedly designed generator sets are built for continuous use and rough handling.

3. Overload capacity

Due to the severity of the operating conditions in the field, generator sets are often called upon to deliver their maximum output – and then some. Generator sets should have at least a 10 percent overload capability beyond their nameplate rating. For further assurance, compare the ratio of cylinder displacement to rated horsepower of the generator drive engine. Generally speaking, engines with a larger displacement to horsepower ratio combined with a longer piston stroke will have more built-in reserve horsepower and torque than smaller, shorter stroke engines of the same horsepower rating. They will also exhibit greater fuel economy and durability.

4. Fuel consumption

Since drill rig generator sets operate continuously, fuel consumption accounts for the largest operational cost. Just a few percentage points of better fuel economy can add a significant number of dollars to the bottom line at the completion of a well. Diesel engines tend to be most fuel-efficient in proportion to their output when operated at 100 percent of their rated load. Engines are typically rated in terms of their brake specific fuel consumption (BSFC), which varies with the percentage of rated load. The BSFC rating allows specifiers to compare the fuel economy of generator sets before the units are in the field. For 1,200-rpm generators sets with a rating of about 1,100 kW, BSFC should be less than 200 grams of fuel per kW-h generated. And, for maximum fuel economy, always operate the generator sets as near their nameplate rating as possible.

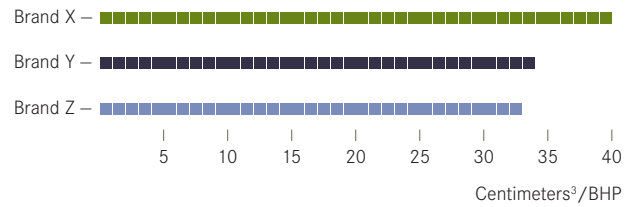
5. Oversized alternator

While the SCR unit on AC/DC drill rigs allows for efficient and precise control of power to the various DC motors loads, it causes the current in the system to lag the voltage, resulting in a low 0.7 power factor (PF) load on the generator sets. Ordinary generator sets are designed to operate optimally at about a 0.8 PF. The 0.7 PF load on the generator sets causes field heating in the alternator, and unless the alternator is properly oversized, damage can result. For a 1,200-rpm generator set with about 1,100 kW of capacity, look for its alternator to be oversized to at least 1,750 kVA to meet the low PF requirements. Also look for a 50-degree C ambient rating and minimum 80-degree C temperature-rise capability.

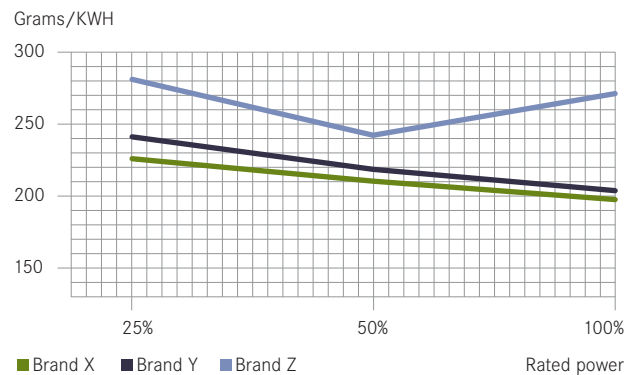
6. Control and monitoring

Precise control of the generator engine's speed and operating parameters yields good regulation of the power output and quick response to changes in the load. Generator sets with engines that feature an integrated electronic engine governor and electronic engine management system provide the most accurate control, protection and monitoring. These systems will also monitor alarm conditions and protect the engine from damage. They are also capable of communicating with external control systems for remote monitoring and control of the generator sets. This can be convenient when paralleled generator sets need to be started or stopped to match the load conditions. Mechanical gauges on the generator set skid should display variables such as lube oil pressure, oil temperature, engine coolant temperature, engine speed and operating hours. Also available are units that feature multi-page color LCD display panels for various performance and status readouts.

Overload capacity: Displacement/BHP



Fuel consumption



The upper graph illustrates that different engine manufacturers have different ratios of cylinder displacement to brake horsepower (BHP). This ratio is an important factor in a generator set's ability to respond quickly to changes in load and maintain voltage and frequency. Generator drive engines with the highest displacement to BHP ratio have more reserve horsepower, the lowest fuel consumption and the best durability.

The lower graph shows the fuel efficiency advantage that a large displacement to BHP ratio confers for Brand X. Fuel is one of the major operating costs on a drill rig and there are significant differences in fuel consumption rates between brands of generator sets. Since diesel engines are most fuel efficient at full power, it is important to not oversize the generator sets for the job.

MTU has recently introduced a new 1,100 kW Electric Drilling Package that is specifically designed to stand up to the rigors of today's drilling environment. Operating at 1,200 rpm, and featuring an oversized 1,750 kVA alternator, the package delivers long-lasting performance with a 10 percent overload capacity. The new system leads the industry with a brake specific fuel consumption (BSFC) of only 196 grams of fuel per kW-h, giving it approximately two percent better fuel economy than other products on the market. Since fuel consumption makes up a substantial part of drilling costs today, gains in fuel efficiency go right to the well service company's bottom line.



7. Maintenance requirements

All diesel engines require periodic maintenance to ensure good performance and reliability. Besides regular inspections, the most important maintenance procedure involves changing the engine oil approximately every ten days or 250 hours of operation. Generator sets that feature an engine-mounted lube oil centrifuge as standard equipment reduce the downtime required for oil changes. This device can significantly extend the lube oil change intervals, save money on oil and filters and increase generator set availability.

8. Single-source supplier

Generator sets from a single-source supplier that manufactures and tests the complete drill modules in a factory setting provide assurance of a higher quality product and faster repairs when they are necessary. There are many drill rig generator sets that are assembled by integrators using engines from one manufacturer, alternators from another and controls from still another. If the generator set breaks down for any reason, parts or service availability can be a serious problem if the unit was assembled by an integrator. Drill rig downtime caused by delays in getting repair parts can be very costly.

CONCLUSION

Today's deeper wells and horizontal drilling techniques require more power than conventional vertical wells and have given rise to the development of the AC/DC SCR drill rig powered by multiple generator sets. While these rigs represent the current state of the art, operators are constantly looking for ways to increase total power availability, reliability and fuel efficiency as a way to minimize costs and maximize returns.

When specifying generator sets for oil and gas drill rigs, it is important to work with single-source suppliers that can provide factory-built and tested products, and can back them up with a global service network and rapid parts availability. Generator sets that are specifically designed for oil and gas drill rigs have the rugged design features and performance that ensure reliable operation and low maintenance. By comparing specifications such as manufacturing quality, reserve power, control/monitoring functions and fuel consumption, drillers will be assured of selecting generator sets with the lowest operating cost and the best reliability.

ABOUT MTU

MTU is an off-highway diesel engine manufacturer with more than a century of global experience in producing durable, high-performance diesel engines for industrial and commercial applications. For years, MTU has played an important part in supplying efficient, reliable and strong diesel engines to the oil and gas industry. For example, the company's Series 4000 engines currently enjoy a 45 percent global market share for powering fracturing rigs. Engines used on "frac rigs" drive high-pressure hydraulic pumps that force a slurry of sand, water and gel down a well to fracture the rock and create collection channels in the petroleum-bearing structure. The success of these frac rigs combined with horizontal drilling techniques has been credited for much higher gas and oil production rates from treated wells.

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