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AUGUST 2016

Borehole Geophysics

**Shale Drilling
Optimization**

Flow Assurance

**Well Intervention &
Maintenance**

**Regional Report:
Norwegian North Sea**

**Special Section:
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- 3 Submit your entry

All entries must be submitted by January 31, 2017.

Questions? Please contact
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COMING NEXT MONTH The September issue of **E&P** will focus on production optimization. Other features will include unconventional exploration technology, multilateral/extended-reach drilling, and proppants as well as floating production, mooring and positioning. The regional report will focus on the Mediterranean and North Africa. As always, while you're waiting for your next copy of **E&P**, be sure to visit EPMag.com for the latest news, industry updates and unique industry analysis.



ABOUT THE COVER Statoil's Heimdal Gas Center on the Norwegian Continental Shelf is an example of how operators are giving new purpose to maturing assets. Left, operator Det norske's Ivar Aasen platform jacket is shown after installation last year offshore Norway. The field is due onstream before year-end 2016. (Cover photo courtesy of Statoil; left photo courtesy of Det norske; cover design by Felicia Hammons)

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A nonhydraulic means to complete wells

Shaped charges can replace hydraulics in new system.

Nick Collier, Innovative Defense LLC

While hydraulic fracturing is recovering profitable quantities of oil and gas out of large volumes of formation, it is not without controversy and problems. The transportation, use and disposal of fracking water and the cost of machines, manpower and fuel are just a few of those issues.

Additionally, hydraulic fracturing is plagued by high cost and limited performance and is coming under greater scrutiny due to concerns about minor earthquakes and water contamination; already 16 states do not allow hydraulic fracturing.

Innovative Defense (ID) LLC has developed a new nonhydraulic means to complete wells that eliminates the issues mentioned above. This new method could reduce or eliminate the need for hydraulic fracturing and at about 20% of the cost. This patent-pending process is called concussive or shock fracturing.

Shock fracturing

In the early days of oil production large quantities of explosive were lowered into the well to the level of the oil-bearing formation and detonated. The shock from these large explosive quantities fractured the formation around the borehole, but of course it ruined the casing and the wellbore in the process. ID's Shock Frack system employs a more surgical application of much smaller quantities of explosive, strategically delivered and directionally controlled, into the gas- or oil-bearing formation.

A patent-pending select-fire multichambered down-hole gun and delivery system is the innovation that allows discreet quantities of high-explosive or other energetic materials to be delivered deep into a formation from the main borehole. Traditional perforating guns simultaneously fire a volley of conventional shaped charges from a common chamber. The small-diameter jets penetrate through the casing and into the formation in preparation for hydraulic fracturing. The ID select-fire gun system consists of one or more segments,

each consisting of multiple blast chambers containing one or more super-caliber hole-producing shaped charges. Since the shaped charge produces a super-caliber hole, follow-on charges can be aligned and propelled deep into the formation through the primary super-caliber hole made by the number one charge from each segment. The hollow cylindrical jet formed from the charge makes the hole

Hydraulic fracturing is a successful technology but faces many challenges.
(Source: Yarygin, shutterstock.com)



deeper, and the shock from the explosive couples to and fractures the formation in the vicinity.

Gun system, shaped charge delivery

The recent development and testing of the Super-Caliber Hole Producing shaped charge (SuperCal charge) has made it possible to deliver controlled quantities of explosive in the form of self-contained shaped-charge grenades deep into a formation. A super-caliber hole means a hole larger than the charge diameter (CD) making the hole. This allows repeated insertions of same-size charges into the existing hole, increasing its depth and shock-fracturing across all layers and in all directions. This is only possible using the super-caliber charge.

As a strong concussive shock travels through a formation at the sonic velocity of the rock structure, it fractures the microstructures separating oil- or gas-bearing voids, increasing porosity and thus the flow to the wellbore. Standard perforating charges produce only about a 15% CD hole in the casing and taper to a decreasing size in the formation. Repeated firings of SuperCal or standard charges could be accomplished with the select fire gun system described above.

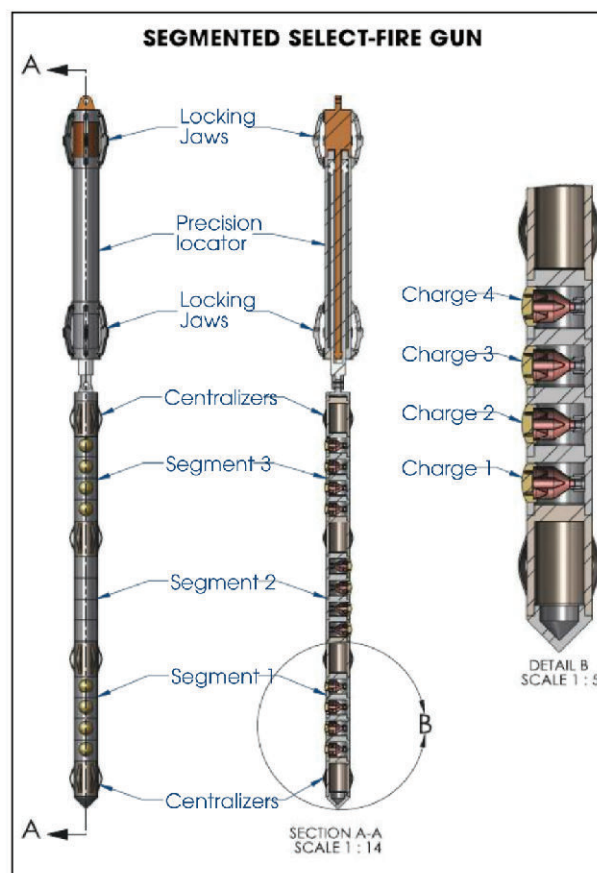
About shaped charges

Shaped charges use high explosive to collapse a hollow cone-shaped liner made of powdered metal, in the case of oil well use. The concentration of the explosive energy collapsing the liner on the longitudinal axis of the cone (the Munroe Effect) produces a rod-like stretching projectile (commonly called a jet) that has a velocity in the 5 km/sec to 10 km/sec (3 miles/sec to 6 miles/sec) range. Using this principle, the SuperCal charge design spreads the energy into a stretching hollow cylindrical jet that produces a super-caliber hole.

The process by which a shaped charge jet penetrates is by extremely rapid erosion of the target material. The pressure applied to the target by the jet is in the 6 million psi range, and no known materials can resist penetration under such forces.

How the system works

The segmented loaded select fire gun system is sent downhole to the location of interest by wireline or tubing-conveyed means; in the future it could be autonomous. The gun system is then centralized, and the precision locator is locked in the wellbore. The No. 1 charge from each gun segmented is fired from the gun, and an initial super-caliber hole is made in the casing and into the formation. The gun is then precisely lowered by the precision locator so that the second charge



Each segment of the select-fire gun system has multiple blast chambers containing one or more super-caliber hole-producing shaped charges. (Source: Innovative Defense LLC)

or set of charges are aligned with the initial super-caliber hole. At this point the No. 2 charge from each segment can be fired from the gun to increase the initial hole depth and get greater distance from the casing, or it can be propelled into the initial hole where it will increase the hole depth and also fracture-shock the formation in the vicinity. This process is repeated until all charges from each segment are expended.

Other benefits

There are thousands of abandoned wells across the country in which as much as 80% of what was originally there is remaining and is not recoverable using hydraulic fracturing. The SuperCal fracturing system might be able to access these reserves. Since oil prices are low and seem to be slow to increase, it makes sense to find a less expensive means of producing the product. The shock fracturing method offers a large reduction in the cost of stimulating new wells and rejuvenating older ones. **ENR**