

THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

Propellant-based Well Stimulation

Northrop Grumman has partnered with Precise Propellant Stimulation, LLC (PPS), the patentee (USPN#s 7565930, 7950457, 8186435) and developer of a propellant-based stimulation process, that pairs Northrop Grumman's proprietary solid propellant sticks with PPS's proprietary solid propellant stimulation tool. A propellant stick is placed in the stimulation tool which is placed down an oil, gas or geothermal well. The propellant is then ignited to generate a specified amount of gas which creates pressure that fractures the rock.

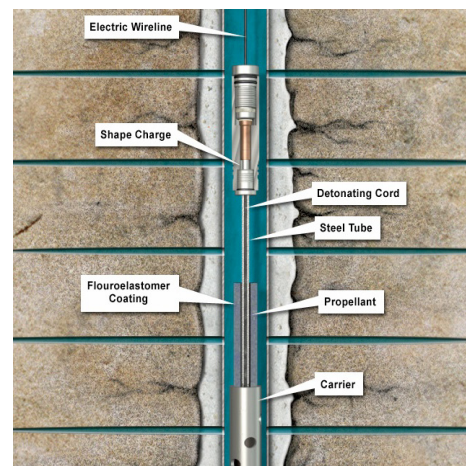
Applications

The propellant-based well stimulation process is used for initial stimulation, restimulation of existing wells, used in concert with hydrofracking (i.e. reduce breakdown pressures) and could be used to replace hydrofracking operations in certain situations:

- Oil, gas and geothermal production wells (initial stimulation)
- Existing and stripper wells (restimulation)
- Gas and water injection wells
- Vertical and horizontal wells

Product Features and Benefits

- Creates multiple fractures in near-wellbore region
- No specialized or modified tools needed
- Shorter service time to get the well on line
- Minimal onsite equipment and infrastructure
- Lower environmental impact and lower cost
- Propellant type, amount and burn profile can be tailored



Cross sectional view of the interval showing the PPS tooling design

Specifications

Technical Data

Propellant Stick NG-1

Flame temperature
(2000 psia): 3833.6°F (2112°C)
Energy output: 1010 cal/g
Gas output: 42 moles/kg
Density: 1.63 g/cm³
Thermal stability: 96 hours at 450°F (232°C)
Auto-ignition: 96 hours at ignition >550°F (>287°C)

Shipping

Classification: Class 1.4C, UNA499
EAR controlled: Subject to ECCN 1C992 & 1C018 licensing

Technical Data

Propellant Stick NG-2

Flame temperature
(2000 psia): 3275.6°F (1802°C)
Energy output: 897 cal/g
Gas output: 44 moles/kg
Density: 1.62 g/cm³
Thermal stability: 96 hours at 450°F (232°C)
Auto-ignition: 96 hours at ignition >550°F (>287°C)

Shipping

Classification: Class 1.4C, UNA499
EAR controlled: Subject to ECCN 1C992 & 1C018 licensing

Technical Data

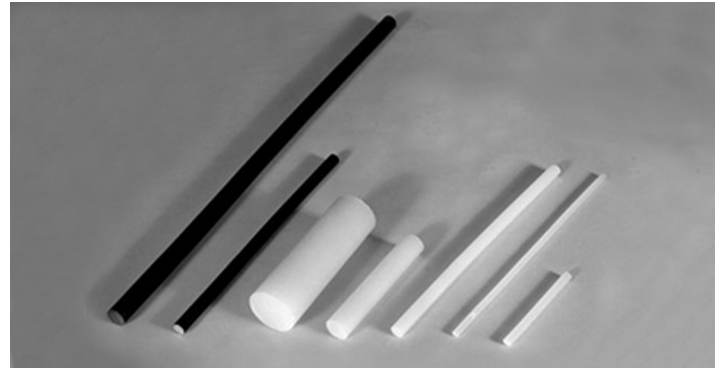
Tool

Tool sizes (length and diameter), amount of gas generated and burn time can vary depending on the well configuration and the interval to be stimulated. Contact Northrop Grumman for a recommendation and proposal on individual well parameters.

Test Data

Well stimulation experience: Oil, gas geothermal wells

demos: Over 600 domestically and internationally
Areas (U.S.): AL; AK; AR; CA; CO; KY; LA; MI; MS; NV; OK; TX; UT
Areas (Int'l): Nicaragua; Iceland; Ukraine
Offshore: Gulf of Mexico



Propellant sticks

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