

## **Laser Rock Drilling for Oil and Gas Wells**

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Application of advanced high power laser technology to oil and gas well drilling is attracting significant interest among research institutes, the petroleum industry, and universities. Laser or laser-aided oil and gas well drilling has many potential advantages over conventional rotary drilling, including high penetration rate, reduction or elimination of tripping, casing, and bit costs, enhanced well control, as well as perforating and side-tracking capabilities.

Studies on drilling petroleum reservoir rocks with lasers show that modern infrared lasers have the capability to spall, melt and vaporize natural earth materials. This paper will report results on sandstone, shale, and limestone lithologies exposed to radiation from a 1.6 kW pulsed Nd:YAG laser to determine the effect on rock removal efficiency of several parameters, including beam spot size, power, repetition rate, pulse width and exposure time. Tests clearly identified the spallation and melting zones for shale samples with increasing laser power. The lowest specific energy was obtained in the spallation zone just prior to the onset of mineral melt.

We also report results using a 6 kW CO<sub>2</sub> laser, operated in both continuous wave and superpulse mode, to drill reservoir rocks. The specific energy was determined, then used to assess the efficiency of rock removal. Results show that super-pulsed CO<sub>2</sub> laser beams can be efficiently used to drill deep, large diameter holes in petroleum rocks due to high peak power, 4 times higher than the average power, and its pulse nature.