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Investigation of Laser Drilling Method

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Abstract

Today, among politicians, the discussion of replacing modern drilling methods with rotary drilling has many supporters. For new methods, several methods have been suggested, among them, steam drilling, water pressure drilling, and laser drilling. Based on numerous tests on the use of laser technology in drilling, it has been proven that laser technology, in addition to increasing the speed of drilling, also reduces time, cost and environmental pollution. The experiments that have been carried out so far have all followed one main goal, that is, the maximum drilling of the rock with the lowest power required by the laser. In this article, logical data and strong arguments have been tried to be presented in this regard using existing devices and limited facilities.

Keywords: Laser engraving; New methods; Drilling speed; Drilling time

Introduction

At the beginning of the 20th century, the towline drilling method was added to drilling with a string of steel pipes and even replaced it in many cases. But both of these methods are very time-consuming, dangerous and expensive for drilling oil and gas wells, which are of the deep drilling type [1]. Research on the use of laser technology in drilling oil and gas wells began in 1997. First, the US Army was reported by Graves and O'Brien under the MIRACL project of a continuous wave (CW) laser system with a wavelength of ¬3.8 micrometers and a laser power of 600 to 1200 kW in 4.5 seconds about 2.5 inches for sandstone, drilling depth. In this experiment, the drilling speed increased by 10 to 100 times. A er that, an experiment called COIL was conducted under the supervision of the US Air Force. is laser operates in the CW wave, which has been successfully tracked at a range of 31 miles. Factors a ecting laser drilling include: laser power, wavelength, system working mechanism (continuous or shock waves), laser type and radiation pro le [2].

Advantages and disadvantages of using laser technology in drilling

With the introduction of the laser system to drilling in the oil industry, this eld can take a step towards progress and evolution. e advantages of using the laser system in drilling include the creation of a ceramic wall on the well wall due to the melting of rock, reducing the working days of the drilling rig and the duration of the drilling stoppage, creating the same diameter from the surface to the bottom of the well, reducing the possibility of Clogging of drilling pipes, a signi cant reduction in drilling costs, the possibility of using light pipes and replacing some heavy pipes with optical bers, reducing environmental pollution and increasing the drilling speed by 10 to 100 times. Kurdish [3]. Some experts are against replacing laser drilling with rotary drilling. Because some of the problems that arise during laser drilling cannot be largely ignored. Among these problems, the following can be mentioned:

a) e rotation of drilling mud during the drilling operation and its e ect on the energy transferred to the rock surface

b) Energy transfer from the laser source on the surface to the laser lens on the surface of the well [4].

Laser drilling steps

When the laser rays hit the stone surface, the stone is drilled through the following steps [3]:

a) Creating micro-fracture

b) Melting

c) Evaporation

When the laser rays hit the stone surface, the rays may show one of the following reactions [Figure-1] [5]:

a) Rays are re ected

b) Rays spread

c) Rays are absorbed

e conducted experiments show that the scattered and re ected rays have less e ect on the stone than the absorbed rays. In fact, the mechanism that causes rock crushing and nally drilling is the absorption mechanism of laser rays [6]. In rocks that have a high heat transfer coe cient, laser rays can evaporate accumulated crystalline waters along with minerals dissolved in the rock and cause expansion of the rock and create micro-fractures in the rock structure.

Nitrogen gas is used in experiments along with laser operation. One of the reasons for using nitrogen gas is to burn the gases released during rock drilling and to remove the resulting dust. is gas causes the

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Discussion and Test Method

In this experiment, three rock groups, sandstone, limestone and shale, which are the most encountered during excavation, have been used. ree samples of each stone with di erent depth, porosity and saturation have been used. From each of these three groups, one rock sample is saturated with water so that accurate comparisons can be made. In order to observe the changes before and a er the laser, all 9 samples were imaged using a Picker1200 CT scanner with a voltage of 130kw and a current of 80MA for 2 seconds. In this experiment, the laser with a radiation speed of about 10 Mm/S used 100% of its power, and in a period of 66 seconds, a diameter of 1 cm was drilled and a er that the samples were photographed again. [Figure 2].

A er the tests, the parameters of the amount of speci c energy (SE), drilling rate (ROP), comparison of drilling rate and speci c energy for saturated and unsaturated samples, the e ect of laser drilling on drilling costs and the impact of drilling It was investigated with laser on environmental management.

According to the following relationship, drilling speed has a direct relationship with the amount of laser power entering the surface (SP) and an inverse relationship with the amount of energy required for rock drilling (SE): [8]:

ROP=SP/SE (m/second)* (1)

Observations

Specific energy (SE)

Considering that the speci c energy depends on the rays that are absorbed, re ected and scattered, the results of Table-1 show that the amount of absorbed rays in sandstone is more than other stones. Of course, according to the results of the experiments, this article is reversed for saturated samples. According to the results obtained for saturated samples, it can be concluded that the highest drilling rate for and keeps more water in its building. erefore, during laser radiation on the surface of sandstone, the maximum amount of laser power is used to evaporate the water in the petri ed building and the energy transferred to the stone is reduced. is causes a decrease in the drilling rate in saturated samples compared to unsaturated samples. Of course, this article is an exception for shale; because with shale saturation, its drilling speed also increases so that the laser drilling rate of saturated shale is higher than the drilling rate of unsaturated sandstone [Table 1]

* SP: Power Per Unit Area,

SE: Amount of Energy Required To Remove A Unit Of Rock

Drilling speed (ROO [illegible]

B) Oil-based mud that is used for drilling wells, especially for Chilean formations, which use harmful chemicals for the environment.

By replacing the laser system in the oil and gas well drilling industry, it is possible to use air uid instead of oil-based mud in dust drilling and reduce environmental pollution. Also, in laser drilling, by replacing the electronic system with a mechanical one, much environmental pollution is prevented [9].

Laser drilling methods in the oil industry

Mechanization technology in the oil industry refers to the removal of materials and work parts and the use of optical power chips which refers to rock cutting in the oil industry, which is drilling. which are divided into two categories:

A) Grinding: which includes grinding, engaging in an action that causes the removal of materials by the action of rubbing and with the release of abrasive particles.