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MINERAL PROCESSING

OIL AND GAS EXPLORATION

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MINERAL PROCESSING

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INNOVATIVE METHODS IN ROCK DISINTEGRATION

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ABSTRACT

This paper presents a new deep drilling technology named TER-HM. It refers to the current state of the deep drilling, which describes the important elements such as drilling downforce speed drill string, refining drilling, measurement of pressure and temperature etc. We have also prepared a preliminary draft of a new system TER-HM, where we describe the principle of operation of this device. One of the key outcomes is the creation of a continuous ring of amorphous ventilated and congealing rocks around formed vertical segments, creating a continuous sheeting borehole without the need for plotting grit to the surface. As for other modes of drilling until now it was not possible. This new technology is established only hypothetically, but there are plans to introduce it into practice, since it is expected to be the leader in deep drilling. The energetic processes of disintegration of rocks were solved as system with photovoltaic power in case of the missing infrastructure, which we have solved the issue of logistical gases costs. We consider hydrogen fuel like the most suitable power which represents the development trend. Based on this, we described a control unit and also a deep drilling system using a photovoltaic system for the production of hydrogen and oxygen through the diffusion of water.

Keywords: Well-drilling, thermal digging, rock disintegration

INTRODUCTION

Use of fire to the disintegration of solid rock at the face of the mining works is a technology known from the Neolithic period. Ahead of the face, the brushwood was ignited and after the burn, the hot rock was spilled by a cold water. Thermal tension caused breach of the surface and speed up the work with gavel and handcuffs, or instruments resembling hooks, "made" of the antlers and bones [1], [2].

The stone was disrupted by a flame at a temperature up to 1500 °C. Individual minerals increase its volume and tensions arise between them. The most significant increase shows quartz, therefore this method was used on granite and other rocks containing a higher content of quartz. Even at present, this method is successfully used in the extraction of ornamental stone blocks [1], [10].

Instead of drilling, a thermal jet rig creates cuts of practically unlimited length and depth, depending on the construction of the burner rod (typically 6 m). The fuel (kerosene, diesel, gasoline) is enriched by compressed air or oxygen while burning. There are other

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systems using other fuels, but it is not the subject of our article. In general, less demanding oxygen-free systems to use, carry out a lower performance [15].

Well-drilling purposes

Deep drilling is the art which intervenes in other fields, whether directly or indirectly and thus becomes important for a wide range of technical activity. The main function of drilling consists in its mechanical action instrument for rock drilling:

• the exploration of mineral deposits,

• drilling and extraction of hydrocarbons / oil, natural gas /.

Deep well is a long vertical mine works, which the ratio (length / diameter) has a maximum size in. Drilling is usually in the vertical direction but also in the horizontal and sloping at different angles from the vertical. Deep well is done for the purpose of:

• exploratory: profit of geological and geotechnical information

• confirm the presence of hydrocarbons [6], [9].

Based on this breakdown, wells are generally divided into:

1. Geological exploration wells, which aim is to obtain geological and geotechnical information. A characteristic feature is, that it is useful only during the drilling, and in the end it loses the importance, so it must be discarded.

2. Operational and technical wells, which aim is to create holes to serve a specific purpose-mining. A characteristic feature is that they begin to serve its purpose after drilling.

Using of deep wells. The diversity of rock disintegration by different types of drilling tools does not create a single, general theory of rock drilling. Therefore, there were developed the theories for different types of drilling tools, for instance theory drilling roller bits and theory drilling of cutting tools and so on [3].

At any theoretical analysis of the drilling process, it is necessary to have particularly clear about the type, shape and condition of the drilling tool and the drilling process modes that will be used. Drilling mode is determined by the pressure, speed and drilling fluid. Each of these components is individually adjustable, independently of the other components. The aim of all theoretical analysis and operational tests is to find out which combination of regime components is preferred. The main component of the drilling is thrust.; It can be stable, oscillating, tapped and gusty.

Permanent downforce is exerted either by difficult or hydraulic or other feeding device. Its size is a function of time changed only slightly and slowly. In contrast, oscillating downforce is a result of permanent shocks downforce with a vibrating device, which increases the value of still downforce in one position and decreases it in inverted position; these changes happen very quickly, so they are very effective. A similar course has also hammer downforce, which equals the sum of permanent downforce with the firing pin effect; keystrokes will show a local increase in permanent downforce. The thrust impact is known from the thrust hole drilling and it is characterized by changes from zero to a maximum and back with significant breaks between keystrokes [3], [5].

The second very important component of the drilling is drilling fluid managing the revenues of the rock rubble disconnected from the hole, from the drilling tool to the surface. The drilling fluid may be broken down by type of circulation in direct or indirect, flow size (l/min) and the fluid type (liquid, foam, gas) [4].

The classical rotary drilling considering the basic technological steps:

Drilling

Drilling a borehole deep underground is the most important period of well life, to be implemented by "rotary system" using a rotary table or Top Drive System "rotating head". Both systems provide rotation and downforce through the drill string to the drill tool - drill bit. The process of deep boreholes drilling is realized by large robust rig that can be adapted not only for drilling on land "onshore" but also at sea "offshore".

Drilling for oil and gas is done mostly direct vertical wells (wells with diverted to 2-3 °) in contrast to the drilling of geothermal wells. While rotary drilling, we often meet not only vertical (vertical) but also crooked dodge and tufts wells [6].

Well-drilling technology are divided according to the method:

- Disintegration of rocks;
- Portable power tool to drill disintegrated rock;
- Revenue disconnected rocks from the bottom of the borehole to the surface.

Lining

Disturbance of the rock massif are suppressed by sheeting hole and its possible effects of cementation. Borehole is bracing protects against caving, and possible communication with the surface of the productive horizons. For the purpose of bracing is to put down the steel or plastic pipe, called casing through a borehole. Steel casing are manufactured as seamless or electrically welded tubes.

Casing column is in addition to casing made up also of the technical resources necessary for cementing the well, such as scrapers, centralizers, check valves, cementing head etc. Borehole is dressed by casing telescope, it's the set up casing column with diminishing diameter.

The most commonly used casing structure consists of:

- Steering column
- Introductory column
- Technical column
- Upstream column [5].

Cementation

Cementation of well serves to avoid the mutual connection of the transmission stacks at different depths, and the reinforcement together with the well casing. The casing column cementing must be airtight, isolate productive layers with each other and prevent them from communicating with the casing surface. Portland cement is used for preparing the compositions as basic material, it's used either alone or in conjunction with other components. Standard API Spec 10A, which deals with cements for cementation of wells recognizes 9 classes of drilling cements designated by letters A to J. The criteria for the class choice is the depth of cement used in the well, and physio - chemical conditions in the well. Cementation slurry required properties are obtained by adding suitable additives [6].

Primary cementation methods are:

- Cementation orifice
- Heel casing cementation,
- Cementation by heel drill pipe,
- Combined cementation

Well logging

It's a set of geophysical methods and measurements that allow the determination of:

- The physical properties of rocks and fluids,
- Clarify the technical condition of the well,
- Basic geological information about the well - geological profile of the borehole,Basic information on the deposit.

Creation of a borehole

Equipping deep wells is largely based on the same principle (based on bearing geological, technical and technological conditions), so that the borehole casing being equipped with a telescope Liner, which is at the bottom and fitted with perforated riser column, see. Pic. 1.

Pumping tests

The aim of pumping experiment is to verify and confirm the presence of hydrocarbons in the studied layer and rewards the potential opportunities and optimal sampling (extraction) occurring in the studied media probe. A permanent part of the pump is also attempting to stimulate the flow of the operation (acid, hydraulic fracturing, etc.) [6].

Gas experiment is carried out by tester during drilling, or after drilling, i.e. open or cased borehole [13] [14].

According to the method of use, testers know:

- Cable,
- Rod,
- Consistently placed in the column of drilling tools

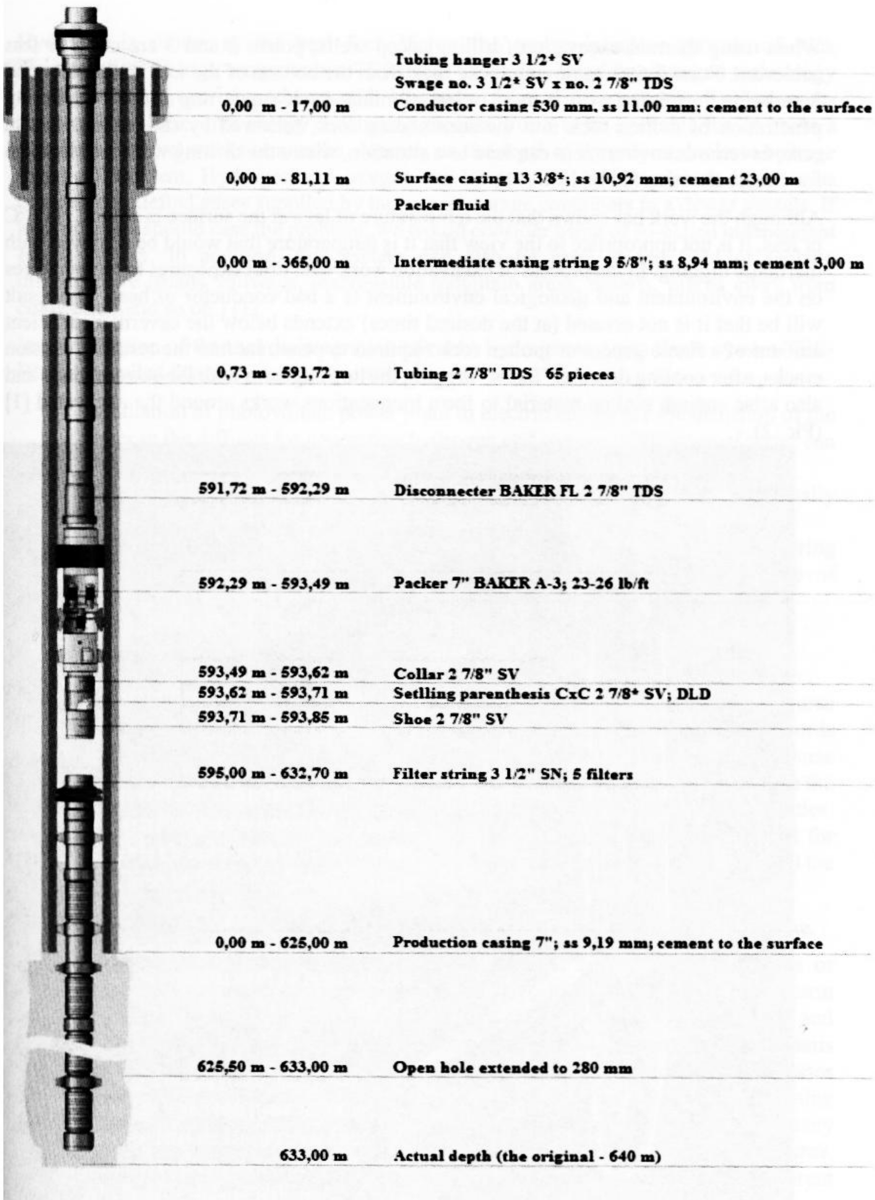
We will remove cementation and partly sheeting of the existing drilling rig principles by using the system, which will be described below. (Only in cases of cavernous environments may occur that drilling work will have to be divided using).

Thermal digging (TER-HM)

Well-drilling is a specific sector of mining activities and that's why we solve the problems affected a wide area of geotechnology. Therefore, there are common characteristics while a deep drilling, which are very obvious for all sectors of the mining activities.

The most important characteristic features of this particular example are: [12]

- rocks' disintegration
- loose rock removing (recover drill from under the rubble DNA isolating tool)
- mining works ensure



Pic. 1 Cased borehole probes [6]

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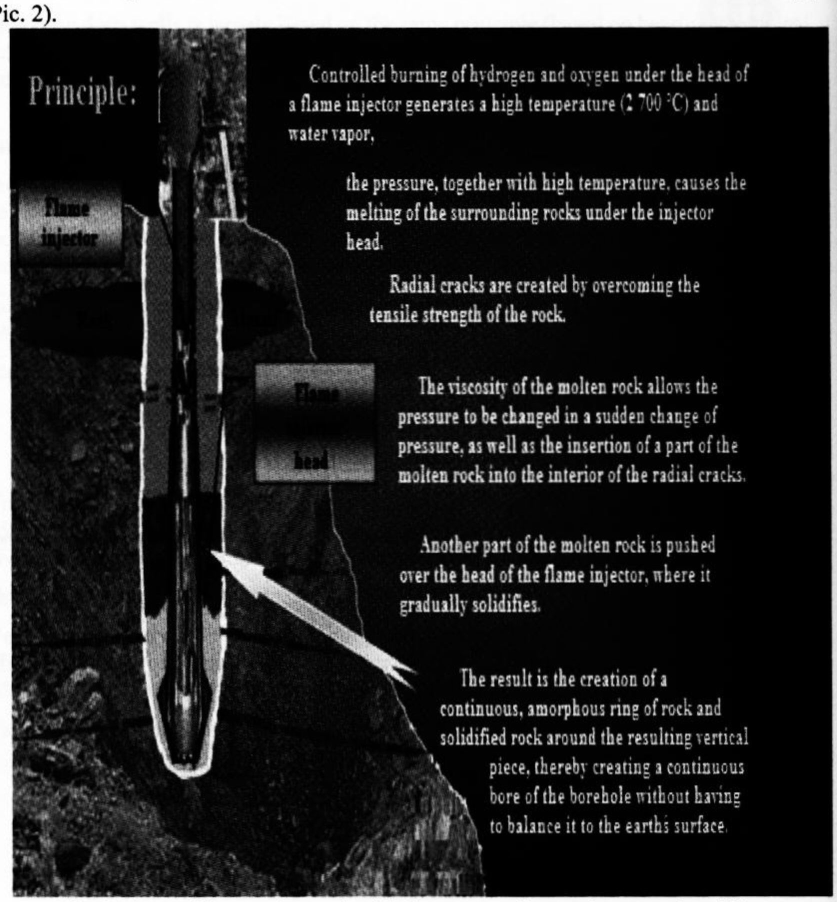
When using thermal excavation (drilling) deep wells, points 2 and 3 are more or less irrelevant. Point 2, it is removing loose rock from the bottom of the tool completely and 3, securing the mining work is more or less eliminated self-supporting and self-anchoring penetration of molten rock into the surrounding rock, followed by congealing. Just in case, cavernous environment can lead to a situation, where the drilling work will have go for classic sheeting [11], [15].

Although the work has shown that the temperature of lava at the surface is around 1000°C or less, it is not appropriate to the view that it is temperature that would be achieved with thermally digging. In the process of excavation work with brief exposures to temperatures on the environment and geological environment is a bad conductor of heat. The result will be that it is not created (at the desired times) extends below the cavern, a sufficient amount of a flame generator molten rock required to penetrate into the resulting tension cracks, after cooling down to "Skew" digging the housing bore with the surroundings and also arise enough molten material to form incrustations works around the excavated [1] (Pic. 2).



Pic. 2 Thermal interaction tool with the surrounding rock excavation, [1]

Hydrogen is shown as the best fuel due to the energy-intensive process of rock disintegration by high temperatures TER-HM, which is a trend in advanced technology to gain an edge over the other world. However, thermal disintegration by hydrogen-oxygen flame looks like energy consuming process. For it to be available for 24 hours a day during several weeks or months, depends on the depth of the project, looks to be huge logistical problem. Hydrogen and oxygen can be provided in batteries as a gas or as cryogenic liquefied gases supplied by tankers to storage containers in a dewar vessels. If logistic gases should case the problem, we would consider using of so-called independent Island system. In addition, this system can also be used in the field of lacking infrastructure (roads, railways, inaccessible mountain areas, deserts, places away from civilization and so on.) [1].

Implementation of thermal disintegration of rocks hydrogen-oxygen flame system TER-HM in so-called Island systems requires:

- installation of photovoltaic power plant to electric energy for the diffusion of the water in the diffuser for generating hydrogen and oxygen. (Diffusion of water can also use other renewable sources such as solar energy).
- The pressure safety container for storing liquid hydrogen, oxygen and optionally other industrial gases (liquid N 2).
- Supply of additional technical work and equipment - special pumps, measuring devices cylinders with the necessary infrastructure for temporary storage of energy gases ...
- Two-way connection of the whole system with control unit;

The control unit constantly acquires drilling parameters (excavation), controls the course of drilling, or gives instructions in drilling to master for changing the downforce, records changes caused by each command. Record of the control unit is documented in the course of excavating time with documented parameters. Control unit will gradually manage the process of excavating by itself in the future and person will only control the activities. The control unit provides information about the needs and real supplying the fuel for uncoupling. Real-time control will be maintained from the outset to the controller and the man will retrieve only control function [7].

The characteristics of the technical system - generator of hydrogen-oxygen flame.

The burning character is made not only by the physical and chemical processes of burning, but the quality of combustion is affected also by its designed features. The term generator means a set of fuel source and an oxidant, gas supply, regulatory and management elements of the system, the sensor parameters and above all design details nozzles - their mutual arrangement, length and material, which they are created of. Gases outflow must provide sufficient safety margin against the operating pressure. By adjusting the geometry and pressure at the nozzles, it is possible to change the shape and intensity of the flame. The spout nozzle is designed constant that affects all control elements. Another parameter to be considered when creating the generator is significantly different velocities of hydrogen and oxygen molecules [8].

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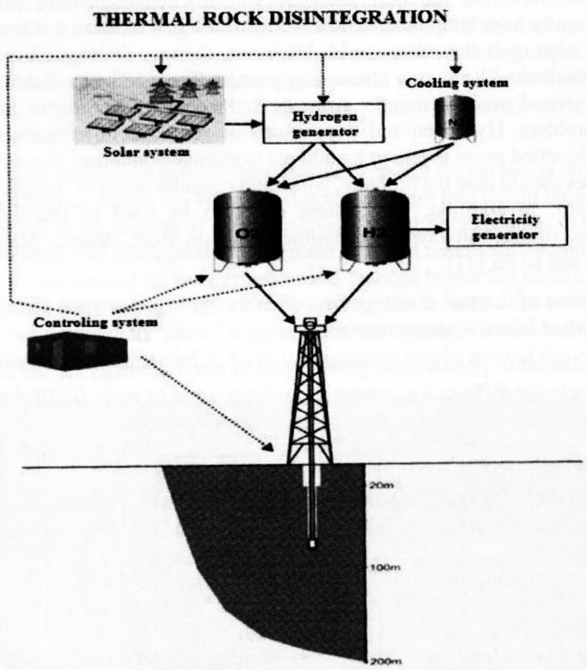

Pic. 3 Island system of thermal deep drilling using a photovoltaic system for the production of hydrogen and oxygen through the diffusion of water [1]

Hydrogen-oxygen flame generator effect to the surrounding rock

Initiating of flame generator producing a very high temperatures - above 2000 ° C forms a chamber resulting instant melting, to subliming immediately surrounding rock. Hydrogen-oxygen flame burning forms an aqueous vapor which creates the resulting cavern under the head of the generator pressure exerted on surrounding rock simultaneously with extremely high temperatures. In the surrounding rock, in addition to radial cracks are formed perpendicular to the advancing axis of the heat generator, the field gradient generated by the thermal stresses caused by the effect of the temperature gradient of the heat transfer from a heat source to a rock and their size is determined, at first, by the characteristics of the heat source (the temperature, the mode of action of rock) as well as thermal insulating properties of rocks (thermal expansion, heat capacity and thermal conductivity). A second type of thermal stresses arising are structural thermal stresses generated due to different values of the thermal characteristics of the rock components, due to the anisotropy of one mineral thermal expansion (e.g. silica), or voltage generated as a result of various changes in the chemical and crystallographic composition of the rock in enhancing the temperature. Structurally, the thermal stresses in the rock are induced, even if the temperature gradient caused by the action of the heat source was negligible [2,10].

Moskalev et al (1987) divided rocks according to the character of strength changes in case of high temperatures in two groups:

- Rocks that strength with increasing temperature is gradually reduced,
- Rock, that strength of with increasing temperature is gradually increased until the first maximum and then decreases

The first group includes rock, which occurs qualitative and quantitative changes in their structures when heated, accompanied by releasing the volatile components, melting, etc. They are for example. marble, apatite, dolomite, limestone.

Rocks of the second group have maximum values of strength within a temperature 473-573° C, these values are about 20-40% higher than at normal temperature. This increase in strength can be explained by the formation of dislocations in the minerals and inter-granular substance to be mixed with each other and do not come to the surface, resulting in increased strength. Upon further increase in temperature beyond the listed area temperature leads to a reduction of strength due to aggregation vacancies like micro germs that are developed by the action of structural thermal stresses. This second group of rock includes sandstone, gabbro, granite, quartzite iron [7,8].

Nowadays, the term magma means a silicate melt contained silicate crystals and metallic raw materials, water vapor and other volatiles. The ratio of components in the magma is flexible, and can contain up to 10% solids. Direct measurement of the lava temperature obtains a varying values in the range of 800 ° C to 1200 ° C, in most cases when the lava temperature at the surface is higher than in the depth. The higher lava temperature in the surface explains the oxidation reaction of gas in contact with atmospheric oxygen. For temperature measurements of various lavas, it shows that basic lavas have higher temperatures than acidic lava [9].

CONCLUSION

As indicated TER-HM system was originally developed for drilling (excavating) of the vertical segments to the vertical depths reaching several km. It is the ideal system for exploration and production of oil, gas and geothermal energy. The speed of the process compared to the conventional methods increases the depth of the work, because there is no drawing action of the drilling tool. Possibility robotics workstation TER-HM allows the automatic hoses and lines (which are placed inlet hoses, sensors, control elements and other elements for on-line management of the flame generator). Possible failure of the generator will be dealt with deploying a new generator that blows A fault zone and the system continues to work digging further. We are currently working for generator, which should excavate 1 000 meters borehole without correction or crash.

The TER-HM is being developed in parallel to create not vertical part - inclined or horizontal. Use: creation of large intact underground areas for (for example) storage (radioactive) waste and so on. The system will be modified and stamping large area underground transit line works.

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