

SUMMARIES

Miedzińska D., Niezgoda T.: Methods of CO₂ acquisition and costs reduction in shale rocks fracturing technology • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

The innovative method of shale gas recovery with the use of subcritical CO₂ is currently developed within the project titled “Development of guidelines for design of innovative technology of shale gas recovery with the use of liquid CO₂ on the base of numerical and experimental research – DIOX4SHELL”, supported by the National Centre for Research and Development (NCBR). The project is carried out by Polish company PGNiG and by academics from WAT, AGH and PW (Military University of Technology, AGH University of Science and Technology, and Warsaw University of Technology). Finding the best business model, in which costs of CO₂ production or acquisition are negligible is one of the most important factors influencing the economical effectiveness of the technology. The main part of known CO₂ acquisition methods is based on fuel purchase and its combustion, what is very expensive process. It results with the high CO₂ price, when purchasing from producer, about 300 zł/ton. This price is quite high, considering current low prices of natural gas. In the paper basic aspects of CO₂ acquisition from CO₂ producers, exhaust gases treatment plants or plasma gasification methods will be presented.

Keywords: fracturing, shale gas, carbon dioxide, economics

Macuda J., Macuda M.: Drilling large diameter intake wells with cutter bits in loose and weakly consolidated rocks • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

Most of the useful aquifers in Poland occur in the Quaternary and Tertiary horizons, which are deposited at a depth of tens to hundreds of meters. Owing to the need of providing large quantities of water for municipal and industrial purposes, the aquifers are more and more frequently opened with large diameter wells of various designs. Such wells are mostly drilled with the rotary method with reverse mud circulation with the use of various bits. The Quaternary and Tertiary strata abound in loose and weakly consolidated rocks therefore cutter bits are predominantly used. They allow for high rates of drilling and shorter time of drilling of the well. This significantly influences the negative influence of drilling mud on the near screen zone of the aquifer and better hydraulic properties of the well.

Drillability tests were performed with cutter bits of 0.86 and 0.67 m diameter for providing high rates of drilling of large diameter intake wells in loose and weakly consolidated rocks.

The research was made for measurement sections 0.5 to 1.0 m long, and each of them was drilled at constant rotational velocity and axial weight on bit.

Prior to the drillability tests the limitation of weight on bit and rotational velocity of bit imposed by the technical characteristic of Prakla B50 rig, strength of the string and cutter bit were established.

Various regression models were analyzed for the sake of finding a dependence between drilling rate and axial weight on bit and rotational velocity of bit for particular macroscopically homogeneous layers. The best results were obtained for the exponent model illustrating the influence of axial weight on bit and rotational velocity of bit on the drilling rate, which has been proved by the calculated regression coefficients and statistical parameters.

Keywords: cutter bit, drilling, reverse mud circulation, large diameter well, hydrogeological well, intake well

Kopey B.V., Bednarz S., Youy Shuanjui: Fatigue failure study of fiberglass sucker rods joints • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

Fiberglass sucker rods are fiberglass rods (body) of polymeric composite materials (PCM), which are connected with steel heads. In this paper, an analysis of the fatigue strength of joints of fiberglass sucker

rod under different bending stresses is performed and from this the key indicators of fatigue strength are derived. The main scope of fiberglass sucker rod is the use in aggressive environment because the plastic and glass fiber is not exposed to corrosion. Long-term strength and durability of operation – it's the most important characteristics used in the design and operation realized in sucker rod, made of polymer composite materials (PCM). The aging of polymers and fiberglass sucker rod fracture leads to an emergency in the operation of oil wells and need to execute the workover. Based on the found contact problem solving using computers strength characteristics of the compounds were analyzed, dependence of contact pressure on the value of shear compliances of shell material, orthotropy option, size of joint were obtained.

Keywords: fiberglass, sucker rod, steel head, bending stress, fatigue strength

Solecki T.: Monitoring of petroleum substances in the neighborhood of drinking water intake • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

This article concerns the monitoring of underground water quality in the vicinity of underground water intake, which is carried out continuously (quarterly) in six monitoring wells situated near the water intake. Groundwater occurring in this complex form a continuous and prosperous aquifer exploited with deep-water wells 19A and 19', intended to supply the population of part of Kraków with drinking and industrial water. Operated monitoring wells and holes are set in Czyżyny district in the protection zone of underground water intakes Mistrzejowice.

During the field research it were carried 41 quarterly measurements of petroleum substances at groundwater table. These tests were carried out using specialized equipment of Dutch company Eijkkamp Agri-search Equipment, which can measure thickness of petroleum substances at groundwater table in each monitoring well.

During the laboratory studies 41 quarterly measurements were performed. Determination and quantitative analysis of petroleum substances in groundwater samples were made. For laboratory testing methodology Fourier infrared spectroscopy was used.

Laboratory studies of oil products in water samples showed the variable contents in each series. The statistical analysis was also done using Shewhart's control card.

Keywords: drinking water intake, monitoring of water quality, petroleum substances

Metelska K., Cieślík T.: A review of currently available LNG facilities and means of transport used for supplying terminals in natural gas with a projection of LNG prices in the USA • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

LNG terminals allow for constant availability of fuel gas in insular countries (Japan) and in countries which do not have the option of transporting gas via inland pipelines due to their geopolitical location (South Korea). In many cases, possessing an LNG (liquefied natural gas) terminal increases energy independence, which translates first and foremost into avoiding energy blackmail (Lithuania).

This paper presents currently existing LNG terminals together with an overview of the most widely used technologies for gas liquefaction, storage and long-distance transporting by LNG carriers. A comparison of natural gas liquefaction plants and LNG terminals with respect to their location, age and capacity is also given. In the final part of the paper we analyse LNG carriers in relation to age, capacity and shipowner.

On the basis of data collected in the last 12 years, such as: price of LNG exported from USA, prices of imported and exported natural gas, consumption of gas, we have established the price of imported LNG using linear regression and power functions. In order to determine the price of LNG we have constructed mathematical models by means of the STATISTICA program. Our aim was to find the most accurate model. Three basic ex post methods have been used to compare regression models: ME (mean error), RMSE (root mean squared error), MAPE (mean absolute percentage error).

Keywords: LNG, LNG transport, LNG storage

Rychlicki S., Kosowski P., Wartak J., Solecki M.: **Social assessment of the impact of oil exploitation on lives of inhabitants and the environment** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

This article presents the results of surveys carried out in the framework of the MUSE project in order to gain knowledge and obtain assessment of the impact of oil exploitation on the lives of the inhabitants of certain regions and on the environment. The survey was conducted in Krosno, Jedlicz and Rymanów (SE Poland). In this area, since the nineteenth century, there are a lot of crude oil mines and many local people are employed at its exploitation. Current condition of the environment and the negative effects of pollution and its causes were assessed by the local community. Within the framework of the conducted study, particular attention was paid to assessing the impact of oil exploitation on the environment and human health. Respondents also pointed to environmental elements that have gone under the greatest transformation in connection with the exploitation of crude oil.

Keywords: oil exploitation, survey, social assessment, social acceptance

Solecki M., Stopa J., Wojnarowski P., Wartak J.: **The comparison of geological conditions of American unconventional oil fields and Krosno beds** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

In this paper the geological conditions of American unconventional oil fields has been described. Similarities and differences of geology of four formations (Bakken, Eagle Ford, Avalon & Bone Springs and Monterey) have been contraposed to Krosno Beds. Stratigraphy, lithology, petrophysical parameters and mineral composition have been compared. It has been shown, that there is some similarity of geological background of Monterey Formation and Krosno Beds, what may indicate the possibility of oil production after adaptation of american technologies to Polish conditions.

Keywords: unconventional oil, Krosno beds, Monterey Formation

Stopa J., Janiga D., Wojnarowski P., Czarnota R.: **Optimization of well placement and control to maximize CO₂ trapping during geologic sequestration** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

The CO₂ injection into geological formations such as saline aquifers can be effective method of sequestration enabling efficient immobilization of gas by surface and capillary forces. The main objective of presented method of optimization was to determine optimal well position and injection rates that maximize residual trapping. This would mitigate the risk of the CO₂ leakage outside of storage zone. A genetic algorithm and particle swarm optimization have been developed and coupled with reservoir simulator to optimally examine various placement and injection control strategies for vertical as well as horizontal well. Optimization was carried out in 3D heterogeneous real field model with water-CO₂-formation rock relationship. Numerical examples confirm that developed algorithm can find a promising optimal solution effectively within a partial number of simulation runs.

Keywords: CO₂ sequestration, optimization, numerical simulation

Kosowski P., Kuk M.: **Cost analysis of geological sequestration of CO₂** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

This article presents an analysis of the costs of geological sequestration of carbon dioxide. Special emphasis is put on the most important factors affecting the cost of this process. These are among others: the amount

of CO₂ emission, the kind of the emitter, the composition of exhaust gases, technology of separation, a distance between the source of emissions and the place of injection, the mode of transport and the cost of injection. For each of these factors and their combination a range of potential costs was presented. They were also ranked according to their impact on the economic efficiency of the entire process of geological sequestration of carbon dioxide.

Keywords: CO₂, geological sequestration, costs

Kosowski P., Mikołajczak E.: **Characteristics of industrial CO₂ emissions in Poland in 2014 in terms of its underground storage** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

This article contains a detailed analysis and characterization of the Polish base carbon emitters, which was created by the National Center for Emissions Management. This database contains a list of all registered in Poland CO₂ emitters with annual emissions of more than 1 tonne. On its base the analysis was carried out, divided into economy sectors, provinces, size of emitter and number of installations. Interpretation of the results allows to assess the potential and the need for underground sequestration of carbon dioxide in Poland.

Keywords: CO₂, industrial emission, sequestration, Poland

Solecki T., Stopa J.: **Petroleum substances in soil and groundwater in the urban areas** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

The result of human activity is polluting the soil and water. Based on the results of heavy metals studies it can be stated that the level of contamination of soil and water in urban areas is not high. This image is changing after taking into account other types of pollution. Besides some heavy metal contamination urban areas are contaminated with petroleum.

Contamination of oil derivatives has a significant impact on the soil and water environment. In addition, some petroleum substances, such as petrol, have high vapour pressure. This causes a displacement of soil air from the vadose zone through the hydrocarbon gases, which creates a risk of explosion, especially in urban areas.

This paper describes the pollution of ground-water oil derivatives in an urban area on the example of an oil filling station, operated for several years. In order to assess the condition of soil, 90 soil samples from different depths and 20 samples of groundwater were taken. Samples were taken for laboratory oil content tests. Using a computer program, a map of quality standards exceedances of soil and groundwater at the oil filling station and its vicinity was created. Results of laboratory tests of water samples are presented in tables and based on them, the classification of the underground water quality was made.

Results of this study indicate a significant pollution of soil and groundwater exceeding the applicable standards. Condition of the soil and the quality of underground water in the oil filling station indicate the necessity of reparation.

Keywords: petroleum substances, soil and groundwater pollution, classification of soil and groundwater quality

Strzyzek S., Wiśniowski R., Kremieniewski M., Rzepka M., Kotwica Ł., Złotkowski A.: **Analysis of technological parameters of cement slurries used for sealing casing in the Lublin Basin area** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

Both fresh and hardened cement slurries should meet respective standards. Recently the Faculty of Drilling, Oil and Gas AGH UST and Oil and Gas Institute – National Research Institute have recently realized works within the OPTIDRILLTEC project aimed at the modification of the existing and working out of new

recipes of slurries to be used for sealing wells on shale deposits. For this reason a crew of specialists realized scientific analyses with the use of high class control and measuring systems. These are, among others, pressure consistometers, filtration presses, viscometers, apparatus for measuring permeability and migration of gas, mercury porosimeter, ultrasound cement analyzer, strength testing machine. The investigations of cement slurries are aimed at working out recipes of slurries for sealing casing in wellbores drilled in shale gas formations.

Keywords: cement slurries, Lublin Basin

Wysocki S., Stryczek S., Gonet A., Gubała P., Gaczol M.: **Reconstruction fluid with new PT-86 polymer** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

While reconstructing partially exploited boreholes located in south-eastern part of Poland there were several issues. Standard procedures were not efficient enough to fulfil the requirements for fluid to work properly. This enforced investor to turn to the Faculty of Drilling, Oil and Gas AGH UST Krakow for assistance in developing special formula for working fluid. Major requirements set for reconstruction fluid were to: inhibit hydration of loam rocks, reduce corrosion of casing and tubing and decrease filtrate loss which maintained at a high level. Therefore, the Faculty of Drilling, Oil and Gas AGH UST Krakow developed and compared various reconstruction fluids' formulas to eliminate encountered complications. The article also concentrates on studying the samples collected from the borehole and presents conclusions based on laboratory tests. Analyses of the research results expose best working solution for eliminating the issues that came across during reconstruction of the borehole.

Keywords: reconstruction fluids, polymers

Czarnota R., Janiga D., Stopa J., Wojnarowski P.: **Laboratory measurement of wettability for Ciężkowice sandstone** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

The type of reservoir rock wettability is one of the most important factors affecting flow of formation fluids in rock pores. It impacts on the characteristics of capillary pressure curves and residual oil saturation, what result in final recovery factor. There are generally, four differ states of wettability for hydrocarbon fields. These are: water wet, oil wet, mixed and fractional. For determination of wettability both quantitative and qualitative methods are implemented. In presented work, the results of wettability laboratory measurement for Ciężkowice sandstone by Amott–Harvey has been shown. Obtained outcomes underline the influence of wettability phenomena on the recovery factor for Carpathian hydrocarbon fields, where Ciężkowice sandstone is the oil bearing formation. The proper understanding of the wettability of reservoir is essential for determining the most efficient way of oil production.

Keywords: Ciężkowice sandstone, rock wettability, oil fields

Wysocki S., Klima K., Podborska A.: **Studies on the impact of ionic degree of copolymer poly(AAm-co-AMPSA) to bentonite suspension parameters** • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

The article presents results of the laboratory studies on the impact of ionic degree of copolymer poly(AAm-co-AMPSA) to technological parameters of bentonite suspension. Rheological properties of bentonite suspension, lubricity, filtration and LST were examined.

Keywords: drilling fluids, polymers

Tătaru A., Ștefănescu D.P., Simescu A.M.: Utilization of Smart Field concept in mature gas field rehabilitation • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

Since the concept of Smart Field emerged, the operating companies work hard to enable such capabilities through various technology developments, both in the field and the office. Smart Fields help to manage, deliver, optimize and develop short and long term decisions and plans. The technology of “Smart Fields” is based on the measurement of process parameters in the reservoir and on the surface [4].

Implementing Smart Gas Field help us to maximize the value of production and increase profitability, while reducing operating costs and the use of industrial services. The integrated and automated data from sensors, simulated models and controllers provide reliable diagnostic tests, enable measurable improvements and implement a favorable environment to plan and schedule phases of production [5].

The main challenge for Romgaz was to combine and integrate older system into newer one. The problem was the installed old technology equipment, which was difficult to replace by the new one.

During the last years in the most majors fields has begun a process of rehabilitation. To extend the mature gas reservoir life we redeveloped and optimized the fields, improving productivity and reservoir performance. *To aim these goals, today, we need monitoring / surveillance programs for optimizing the production.* It is important to measure the parameters of process conditions as accurately as possible.

Keywords: *mature gas reservoir, Smart Fields, real-time monitoring, production optimisation, final recovery factor*

Klempa M., Rado R., Bujok P., Janečková N., Porzer M.: Utilization of high potential geothermal energy in the Czech Republic • AGH Drilling, Oil, Gas 2016 • Vol. 33 • No. 1

In the Czech Republic the electrical energy and heat from geothermal energy can be generated with the use of Engineering/Enhancing Geothermal System (EGS). In this case a downhole heat exchanger is performed to a depth at which the temperature of the rock mass is at least 150–160°C or more, preferably about 200°C. Taking into account the geological conditions in the Czech Republic, such temperatures can be observed at about 5000–6000 m of depth.

The site of a pilot project of geothermal electrical energy production was selected on the basis of the analysis of deep-seated geological structures in the Czech Republic, i.e. area of crust faults in the Ore Mountains Erzgebirge. The selected geological units consist of the Ore Mountains Fault and Central Bohemian Uplands, which are part of the Ohersky Rift Valley.

Two deep research wells are planned in that area, with detailed geological, geophysical and geothermal analyses, including laboratory analyses of sampled rocks (cores).

Keywords: *geothermal energy, enhancing geothermal system, deep geothermal energy, geothermal response test, wellbore design, drilling technology, down-the-hole drill (DTH) drilling technology, drilling tools*