

SUMMARIES

Uliasz M., Kremieniewski M.: Prevention of gas migration in the area of the Carpathian Foothills in the laboratory tests • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

In the area of the Carpathian Foothills, gas exhalations are a frequently observed phenomenon. It is connected with the presence of many shallow gas horizons in the autochthonous Miocene. In addition, gas migration effect is intensified due to the complicated geological structure in this region. During drilling boreholes, one of the most important requirements is to ensure adequate tightness in the annular space. In connection with the above, laboratory tests were carried out in the Oil and Gas Institute – National Research Institute, whose aim was to assess the impact of applied drilling fluids on the degree of sealing the annular space on the contact hardened cement slurry – rock formation, for specific geological and technical conditions. The result of the conducted research work was a modification of the composition of washing fluids in terms of improving the efficiency of their impact on the wall of borehole and removal of mud cake formed by the drilling muds, as well as modification of cement slurry formulations by application appropriate additives to prevent gas migration. During research work have been indicated potential causes of gas migration from the annular space in the selected holes drilled in the Carpathian Foothills and preventive actions aimed at reduction gas migration and exhalation.

Keywords: gas migration, gas exhalation, Carpathian Foothills, drilling fluids, drilling mud, cement slurry

Macuda J., Macuda M.: Drilling large diameter water wells in carbonate strata in the Lublin area • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

One of the most important sources of water for communal purposes in the Lublin area are the useful groundwater aquifers intaken with deep drilled wells. Such wells should be highly efficient and localized in a close vicinity of the local water supply network to lower the cost of transport. Large amounts of water can be produced by large diameter wells, where heavy duty pump aggregates can be installed.

High rates of penetration cannot be obtained if the profile abounds in hardly drillable carbonate. This elongates the time of drilling and increases negative impact of mud on the near well zone of the aquifer. It also lowers hydraulic parameters of the well. To improve the efficiency of the wells, drillability tests with clogged bits were performed in carbonate rocks to optimize the mechanical parameters of drilling. Measurement sections, each 0.3 to 0.5 m long, were selected for the tests. Each section was drilled at constant rotational speed and weight of bit values.

Prior to the drillability tests, the limits on the weight of bit and rotational speed of the bit were established, in line with the technological characteristic of rig Wirth B3A, strength of the string and of the clogged bit.

Keywords: well, water well, hydrogeological well, drilling technology, reverse circulation, drilling technology parameters, clogged bit, drillability test

Turkiewicz A., Kapusta P.: Assessment of the possibility of enzymatic decomposition of cellulose blockers • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The article discusses two series of the biodegradation tests of organic blockers used in drilling mud technology. Degradation process of the selected cellulose blockers in terms of quality was assessed by the colorimetric method. In all test solutions these tests revealed the presence of free glucose which is the final product of degradation of modified cellulose from which blockers were made. The beginning of the degradation process was noted already after 48 hours of the impact of enzymatic preparations on samples

of blockers. The progress of the degradation process after 30 and 40 days of incubation was assessed by gravimetric method by draining sludge and marking blocker dry matter after enzymatic impact, comparing the sludge matter in samples with the specified enzyme to control samples without the addition of the enzyme. The research described in the work may be useful in the oil industry as they contain data (from laboratory-scale tests) on potential treatments with the use of enzymatic preparations. Detailed data on the degree of degradation of individual enzymatic preparations is included in the tables.

Keywords: organic blockers, modified cellulose, enzyme, biodegradation, drilling mud

Gonet A., Stryczek S.: **Method used for safety pillar reconstruction on the example of the Dunajewski gallery in the “Wieliczka” Salt Mine** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Preserving such unique objects as the “Wieliczka” Salt Mine for the future generations is an obvious obligation. Water is the biggest threat to this object and many similar ones. At the last stage or even in the course of mine exploitation salt mines are flooded as this is the simplest method of their liquidation applied worldwide. However this method cannot be used in the “Wieliczka” Salt Mine, which was put on the UNESCO World Cultural and Natural Heritage list in 1978.

Geological and hydrogeological conditions in the Dunajewski gallery are presented in this paper. The Dunajewski gallery is localized directly east of the Mina gallery, where a catastrophic water flux was observed in 1992, threatening the mine with flooding and with considerable damage on the surface. Authors describe the pipeline injection method which was used in that situation. This was a fast and economic method thanks to which the Dunajewski gallery and the adjoining leaching gallery could be efficiently and tightly filled. Specialist recipes for sealing slurry had to be worked out. The slurry was prepared in an injection column elevated in the neighborhood of the Kościuszko shaft and then transported with special pipelines through the Kościuszko shaft and some workings to the Dunajewski gallery. In this way the off-side safety pillar in the area of the Dunajewski gallery was reconstructed.

Keywords: pillar reconstruction, “Wieliczka” Salt Mine

Dubiel S.J., Rzyczniak M., Solecki M.L.: **Reinterpretation of the results of the two-cycle reservoir test of the Mesozoic water-bearing deposits in the W-3 well in terms of assessing the changes in rock permeability in the zones tested with a drill stem tester** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The article presents the results of the reinterpretation of the results of the two-cycle DST of the Mesozoic strata in the W-3 well to assess the changes in permeability of reservoir rocks in the test zone. Two-dimensional diagrams of the first and second pressure restoration curves in the semi-logarithm coordinate system were taken into account. The determined linear regression equations of these sections give simultaneously the extrapolated value of the reservoir pressure and the directional coefficient. The “logarithmic approximation” method used in hydrogeology was used to determine the radius of the perimeter zone with altered permeability of the water-bearing rocks of the Mesozoic.

Keywords: Carpathian Foredeep, DST results, changes of rock permeability

Łukańko Ł., Macuda J.: **Emission of pollutants into the air during exploration of coalbed methane** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Coalbed methane is usually utilized by gas well drilled from the surface. In order to increase the coefficient of methane exploration from coal seams, in a horizontal section of the well, hydraulic fracturing operations

are applied. Drilling process and hydraulic fracturing operations involve emission of pollutants to the air from the fuel combustion process.

In the case of drilling operations fuel is used to generate electric power, which drives the drilling device and its components, while during hydraulic fracturing to drive high-pressure pump engines.

Keywords: emission, air pollution, fuel consumption, coalbed methane, drilling operations, hydraulic fracturing

Goc A., Wojtasiak P., Piotrowski J., Stec M.: **The influence of water on various clay rocks** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

One of the challenges of any laboratory dealing with drilling fluids is to develop a mud that is also environmentally friendly and, on the other hand, inhibits the clay layers to a maximum. The article presents the influence of water on various samples of clay rocks characterized by different geological age. The research was carried out using the Linear Swelling Meter. The geological age, the environment in which the clay rock was formed, the depth of burial – all these factors affect the swelling properties of individual clay rocks. Knowledge of the swelling properties of clay rocks allows the proper selection of drilling fluid system.

Keywords: swelling, clay rocks, clay, shale

Kułyńcz V., Pikłowska A., Kułynych O.: **Overview of the nanoparticles application for reservoir engineering and Enhanced Oil Recovery (EOR) methods** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The scientific aim of the paper is the characteristics of various types of nanoparticles, their physical and chemical parameters. In the article authors give examples of various nanoparticles used in reservoir engineering and EOR methods. The results of laboratory measurements of the impact of nanoparticles on the change of reservoir parameters and the increase of oil recovery of sandstones and carbonates are presented. In the article have been shown the possibilities of using nanotechnology, including the achievements of different authors. It presents a general literature review of modern research methodologies of nanoparticles in the global oil industry.

Keywords: nanoparticle, EOR

Dąbrowski K.M., Kuczyński S., Włodek T., Smulski R., Barbacki J.: **Characterization of natural gas by Raman spectroscopy and its application for in-situ measurements** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Gaseous hydrocarbons and nitrogen mixtures are characterized with an own designed portable Raman system equipped with a high pressure autoclave and fiber-optic probe. Backscattered radiation is collected through a sapphire window with a probe and transferred to the spectrometer. Samples are measured for a set of pressures in the range of 1–150 bar in ambient temperature. Measurement conditions are set to maintain an one-phase system. Spectra are collected in a wide range of wavenumber 350–3500 cm^{-1} . Initial composition of measured samples is measured by means of gas chromatography. Design computer algorithms automatically detects and characterizes Raman bands for given species and their peak areas. The influence of both pressure and concentration of a given element on given band position and area are demonstrated.

Keywords: natural gas, Raman spectroscopy

Tellez Ch., Singh K., Miska S., Ozbayoglu E., Ziaja M.: **Experimental and analytical study of the side cutting ability of drill bits** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Side cutting ability of a drill bit is an important factor to ensure successful directional/horizontal drilling. In this study, a mathematical model of a drill bit has been developed to investigate the side cutting ability of a drill bit. In addition to the theoretical model, the study is also supported by experimental work. Experiments have been conducted for both PDC and tri-cone rotary roller drill bits. Equilibrium equations for BHA in a curved wellbore were established. The expression of internal forces and moments along the drill-string, which are the state variables, are derived. Because of the simplicity and fast computation capability, transfer matrix method (TMM) was adopted to determine these variables. Experiments were conducted on an indoor Tulsa University Drilling Research Projects (TUDRP) full-scale drilling rig. Tests have been conducted using 6 inch and 8.5 inch PDC drill bits. In addition, 8.5 inch tri-cone bit were tested as well. Bent sub was installed above the drill bit to enhance the side force at the bit. During the experiments, weight on bit (WOB) and flow rate were kept constant. The torque was recorded by torque gage. It was observed that RPM has little influence on torque. As expected, the bit side cutting abilities, also referred to as bit steer-ability, were different for different bits. For quantitative comparisons, a dimensionless quantity has been introduced that measures the relative difference in torque with bent sub and without with respect to torque without bent sub. In all tests, the torque with bent subs was found to be greater than those without. Hence, the relative difference is always positive. The higher the relative difference, the poorer the side cutting ability. For drill bits with side cutting ability equal to that of face cutting, the dimensionless quantity becomes zero. In conclusion, the main outcome of this paper is a new method of measuring face and side cutting ability for PDC and tri-cone bits. A similar approach has been applied to the analysis of data from offset wells using a computer program to predict side forces and the corresponding torques. This in turn permitted us to calculate the relative difference in torque and assess the side cutting ability of the drill bits. A comprehensive study of the side cutting ability of a drill bits missing in the current literature. Considering the important role side cutting ability plays in directional drilling, a very innovative mathematical model has been proposed to study the same. Experimental tests have been conducted to verify the model. The model can be used to analyze directional data and obtain useful information from offset wells to enhance future drilling projects.

Keywords: drill bits, directional drilling, BHA mechanics

Formela M., Gonet K., Stryczek S., Wiśniowski R.: **Application of fluidal ashes as a component of cement slurry used in carbon dioxide injection wells - possibility analysis** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

One of the most important environmental issues bothering scientists nowadays are greenhouse gases, mainly carbon dioxide, and the possibility of limiting their emission and utilization. Many countries have been actively trying to limit the greenhouse gases emission, mainly carbon dioxide, and implement the Carbon Capture and Storage (CCS) technology for years.

One of the essential aspects of geological injection is constant monitoring of carbon dioxide, especially its pressure and temperature. Those parameters have an impact on viscosity, density and phase alterations during the flow. It is of vital importance to maintain the supercritical state of the fluid because it is the most efficient way of CO₂ storage.

The negative impact of CO₂ on the properties of the cement slurry may disturb the exploitation of the well and create considerable hazard for the geological storage of carbon dioxide. Therefore, the cement slurry should be appropriately selected and the role of CO₂ in the development of technological properties of fresh and hardened cement slurry should be determined.

The aim of this research is to select the most appropriate cement slurry composition exhibiting optimal properties with respect to the phase changes of carbon dioxide. The first part of the research consists in creating cement slurries of various compositions and investigating its thermal conductivity and sogginess

under in-situ conditions. The second part concerns a possibility of utilization of fluidal ashes from combustion of lignite as a component of cement slurry.

Keywords: cement slurry, CCS, fluidal ashes, carbon dioxide

Fąfara Z., Lewandowska-Śmierchalska J., Matuła R.: Oil pipeline leak detection using GPR method – simple case study • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Modelling experiment was used to investigate the abilities of using ground penetrating radar (GPR) to detect oil leaks in the underground pipeline system. Leaks not only waste precious natural resources but also create substantial damage to the transportation system within urban environments.

Surface geophysical methods are noninvasive tools used to characterize the changes in the physical properties of the subsurface material. This characterization, in consequence, is used to interpret the geological and hydrogeological conditions of the strata. GPR is a reflection-based technique which uses high frequency electromagnetic waves to acquire subsurface information. GPR responds to changes in electrical properties, which are a function of soil and rock material and moisture content. A simple experiment was conducted to determine the validity and effectiveness of GPR technology in detecting leakage in metal pipelines. Initially, a prototype model was designed to simulate a pipe leak. A 1.5 GHz antenna modeling mode was used to collect GPR data. The test was modelled using sandy soil material that is representative for pipelines construction. Also model simulations are being used to select an appropriate equipment configuration (frequency band, type of antenna and real-time imaging software) prior to data acquisition.

Keywords: pipelines, leak detection, GRP method, computer simulation, finite element modelling

Fąfara Z., Lewandowska-Śmierchalska J., Matuła R., Lewińska P.: Recent developments of non-direct methods of pipeline and leak detection • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Industrial pipelines are used as a low-cost method of transport of various types of substances. In the last decades the number of transmission and distribution pipelines increased considerably, leading to an increased number of failures and rising the need for better and more accurate non-destructive methods of their detection and prevention. Leakage in pipeline networks causes a loss of valuable resources in the form of oil and gas. Repairing the infrastructure requires significant additional financial resources. Therefore, any damage to the pipeline network must be detected and repaired as soon as possible.

Indirect methods for leak detection and localization uncover the presents of leaks from outside the pipeline by visual observation or by using appropriate equipment. Pipelines are often underground installations or run for many kilometers in areas where there are no roads, and access is extremely difficult or impossible. The underground occurrence of pipelines makes regular inspection difficult. It is also not possible to examine all pipeline sections simultaneously. Pipeline preventive maintenance or replacement program should be conducted based on detailed assessment of its technical and environmental conditions. Thus, safe and non-destructive techniques are needed, which would allow for pipeline periodical inspection without disturbing their operation.

Keywords: non-direct methods, pipelines, leaks detection, risk management

Macuda J., Klima K.: Selection of effective chemical compounds for drilled wells • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Drilled wells during their operation are subject to so-called “aging” processes, which is visible in the decrease of their efficiency and increase in depression. The process, especially in case of quaternary and tertiary waters, is most affected by the chemical colmatation of the filter and filter-adjacent zone with

chemical compounds precipitated from the flowing water. The literature analysis shows that ferrous sediments are the main mass of sediments clogging the quaternary and tertiary water intakes. They are usually in the form of soft reddish-colored sediments, and their essential element is Fe_2O_3 and FeO . Iron, siderite and quartz hydroxides were also found. The degree of colmatation in such wells can be significantly reduced by frequent renovations with chemical methods.

The article presents results of laboratory tests on dissolution of sediments clogging withdrawal well filters with sodium dithionite ($\text{Na}_2\text{S}_2\text{O}_4$) and sodium pyrosulphite ($\text{Na}_2\text{S}_2\text{O}_5$). Representative samples were taken from selected quaternary water intakes in northern Poland.

Keywords: hydrochemistry, water well, well screen, rehabilitation of wells, regeneration of wells, well clogging

Uliasz-Misiak B., Winid B., Chodań E.: The fresh waters of the Krakow region as the lower source for heat pumps • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Krakow is a city facing a big problem with air pollution, the use of energy accumulated in groundwater may contribute to reducing emissions of gases and dust to the atmosphere.

The article analyzes the possibilities of using groundwater made available with intakes located in Krakow. Estimated water temperatures were ranging from 7.9 to 9.7°C. The thermal power that can be obtained in groundwater varies for individual intakes and allows for obtaining thermal outputs from 0.395 to 1108.035 kW, according to calculations.

The analysis of groundwater chemistry in the Krakow region and their comparison with the recommendations of heat pump manufacturers indicates that the use of water as a lower heat source may in some cases cause technical problems.

Keywords: groundwater, heat pump, temperature, thermal power, Krakow

Dudek J., Janiga D., Wojnarowski P.: The model of development of the multihorizontal, hydrocarbon reservoir using advanced exploitation methods • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The decreasing number of discoveries of new large hydrocarbon reservoirs as well as the significant technical progress promote the use of enhanced oil recovery methods. One of the most popular is the sequestration of carbon dioxide in matured or depleted hydrocarbon reservoirs. It allows to achieve the synergistic effect of increased crude oil production and underground sequestration of injected gas. In this paper the model of development of the multi horizontal, oil & gas field using multilateral wells technology connected with simultaneously implementation of the EOR- CO_2 methods was presented. Based on the performed model, ten-year productions forecasts were made, which results unambiguously confirmed the significant efficiency of the applied technological solutions with indication of the interesting prospects of their implementation in similar reservoirs.

Keywords: multilateral wells, CO_2 sequestration, EOR methods

Kremieniewski M., Rzepka M., Stryczek S., Wiśniowski R.: Improving the efficiency of cleaning annular space with a new flushing fluid • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

One of the most important conditions to be met when cementing casing columns is obtaining appropriate tightness of the sealed interval, otherwise gas will have to be released from the annular space due to the dangerously high pressure in the upper part of the well. Gas migrating along the well in the annular space can penetrate directly the soil, groundwater or atmosphere. To counteract these unfavorable effects the

casing columns are sealed and the annular space filled with appropriate cement slurry. During injection, the slurry displaces mud from the annular space. However mud residue left out in the wellbore walls may cause that the slurry does not bond the rock sufficiently well and consequently gas may flow on the hardened cement slurry/rock/casing contact. This effect can be eliminated by thorough cleaning of the annular space from mud cake with flush fluid, followed by its complete displacement with buffer fluid and cement slurry. Hence it is crucial for the efficiency of cementing to precede this job with thorough cleaning of the annular space with appropriate flush fluids.

Laboratory experiments were undertaken to work out a new flush fluid with which the efficiency of removal of filtration cake from the wellbore walls and the cleaning of the annular space will be improved. Tests were performed for a group of agents, which appropriately selected as far as their quantity and quality is concerned, could create bases for a new type of fluid with very good flushing properties. The efficiency of mud cake removal was analyzed in a mud flow simulator. The analysis of the results revealed that the efficiency of removal of the mud cake on the rock surface can be improved by synergic operation of surfactants and surface active agent, when they are used in good concentrations. The influence of the injection volume and duration of contact of the flush fluid with the rock were taken into account as the main emphasis was on how to increase the efficiency of the designed fluid on the near well zone. The works on the new recipe of flush fluid and its efficiency were based on the measurement of adhesiveness of hardened cement slurry and the rock sample, from which mud cake was removed with the use of flush fluid. The analysis of the laboratory results shows that the efficiency of mud cake removal was considerably increased when the presented flush fluid was applied.

Keywords: *flush fluid, buffer fluid, cementing casing columns, flushing annular space, surface active agents, surfactants, annular space*

Mikołajczak E., Stopa J., Wojnarowski P., Janiga D., Czarnota R.: Intelligent control of CO₂-EOR process • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

One of the enhanced oil recovery methods, which enables to recover an additional 15–20% of oil resources is the CO₂-EOR method based on carbon dioxide injection into partially depleted reservoirs. Determination of the optimal process control facilitates effective use of natural resources. The idea of this paper is to develop an algorithm that optimizes the CO₂-EOR process. This algorithm is based on the combination of artificial intelligence, control theory and computer simulation of hydrocarbon reservoirs. The effect of the proposed solution is the CO₂-EOR process control, which is optimal in the case of the adopted objective function expressing the economic value of the project. The obtained results suggest that the use of artificial intelligence methods in the hydrocarbon production allows to improve the process efficiency by an additional 31% compared to the project carried out with the use of engineering knowledge.

Keywords: *CO₂-EOR, production optimization, intelligent control, artificial intelligence*

Macuda J., Gasiński J., Grad J., Szewczyk S.: Auxiliary gravity drain and infiltration wells supporting basic drainage system in the “Bełchatów” Lignite Mine • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The downhole parts of the “Bełchatów” Lignite Mine are dewatered through large diameter dewatering wells belonging to the primary drainage system. This system is supported by additional shallow wells performed in the overburden, in the forefield of extraction site or on the extraction site itself. They are used for limiting and removing residual water from extraction site, which corresponds to the height of excavator level. They are preceded by the analysis of dewatering of the mining benches based on the results of control drilling and observation of the water table in the existing piezometric wells. Shallow auxiliary wells are drilled with the “dry” rotary method to about 30 m of depth. Such wells considerably reduce the amount of water coming to the mine with rainwaters, and which were not captured by wells of the primary drainage

system. This is mainly caused by such factors as complex geological build, disturbed system of strata, presence of synclinal structures and closed lenses.

The technique and technology of drilling supporting shallow wells with the “dry” rotary method and their effect on dewatering of active extraction sites are discussed in this paper.

Keywords: “Belchatów” Lignite Mine, “Belchatów” lignite field, drainage, dewatering of opencast mine, mine gravity drain well, gravity infiltration well, dewatering well, residual water

Tătaru A., Ștefănescu D.P., Bolázs S.: Production decline curve analysis for mature gas reservoirs subject to rehabilitation • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Production decline under all its aspects, sometimes controllable, but more and more inconsistent with the growing demands of the natural gas market, has imposed a new approach on mature gas reservoirs which Romania owns, namely, their rehabilitation.

During exploitation, after recording a considerable production history and implicitly a appreciable depletion, it is necessary the evaluation of maintaining or changing the exploitation strategy. The approaches in this sense must be from the perspective of improving the value of mature gas fields.

Throughout the exploitation of a gas reservoir generally there are distinguished several stages, such as gradually increase of gas flow rates due to increasing gas wells introduced into production; maintaining of a quasi-constant production; an accentuated decline of gas flow rates of the reservoir respectively a attenuated decline of gas flow rates of the reservoir.

The first three stages are quite short reported to the whole exploitation process of the reservoir.

The production decline appears sooner or later depending on the manifestation form of the reservoir energy. For the accuracy of the baseline which is to be established, can be taken in discussion, as reference intervals, those periods from the production history, in which the points dispersion is minimal, and flow rates respectively the production are comparable with the current ones.

Taking into consideration the decline values obtained from decline curve analysis characteristically to every exploitation stage, we consider that to define the baseline production afferent to the next stage, it is optimal to accept the specific decline of the latest exploitation period.

It can be noted that throughout production history, although the exploitation of the gas reservoir was intensified, due to accessing new reserve volumes, the decline tendency is to maintain at a limited interval. This behavior indicates the fact that also in conditions of intensifying the exploitation in the future, the decline will maintain a value sensitively close to the values from the latest periods, in which rehabilitation was applied.

Keywords: production decline, mature gas reservoir, rehabilitation, production history, depletion, gas flow rates, baseline production, decline curve analysis, reserve volumes

Lupu D.-A., Foidas I., Sutoiu F.: Depleted gas reservoir management improvement by implementing specialized mobile teams • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The state of depletion of gas reservoirs generates many challenges for production management teams that focus their efforts to operate the fields in a rational and efficient manner in order to achieve attractive recovery factors.

An essential activity in terms of production management is related to the maintenance programs, particularly in the current paper, on those exploitation perimeters extended as a surfaces. This aspect, directly influences the maintenance activity in daily basis on the gas wells such us soaping and flowback programs for liquid unloading, visual inspection of wellhead integrity and pressure measurements.

It has been noticed throughout the production history that the wells located on extended exploitation perimeters as surfaces, some of them being placed in isolated areas, have low productivity and do not produce at their potential. The causes identified in this regard are as follows:

- The wells are liquid flooded or loaded and are not able to unload using their own energy being in an advanced stage of depletion.
- There are not enough representative production data recorded to monitor the real performance and intervene in the right time, in order to improve the well productivity.

The relatively large distances between the wells and the technological groups correlated with difficult access to the well location are the main arguments for the implementation of the specialized mobile teams which aims to monitor the wells performance, to ensure a safe exploitation process of the productive infrastructure, to improve the field management activity, respectively to increase the wells productivity.

Keywords: *reservoir management improvement, specialized mobile teams, optimizing the wells productivity, safe operation*

Wiśniowski R., Skrzypaszek K., Kiebzak P.: Drill string rotary speed influence on equivalent circulating density value • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Presented article displays a debate about very complex and still not fully understood issue of drill string rotary speed (DSRS) impact on pressure losses in wellbore annulus, thus Equivalent Circulating Density (ECD) value. With the aim of exploring the topic, series of numerical simulations were conducted and presented in following paper. Real, field data from two already accomplished wells was used to recreate actual wellbores conditions in Halliburton Landmark Drilling Software and to calculate ECD values. Dedicated to check and confirm the program's results accuracy, the outcomes were compared with pressure while drilling (PWD) equipment measurement results, collected during drilling operations. Collaterally, numerical simulations were made in order to analyze how drill string rotary speed shifts may affect overall ECD value, especially in deviated and horizontal wellbore sections. Simultaneously, both rate of penetration and flowrate were modeled to imitate poor and good cleaning conditions. Additionally with the object of confronting received results, in the article are included outcomes of other researchers conducted by T. Hemphill and K. Ravi (2011), I. Kjøsens, G. Løklingholm et al. (2003). Similarly to above mentioned papers, analysis and interpretation of collected data gave contrary conclusions. In other words DSRS can positively impact optimization of ECD value but in the same time cause growth of ECD parameter, depending on current wellbore conditions.

Keywords: *ECD optimization, drill string rotary speed, equivalent circulating density, wellbore pressure management*

Mikołajczak E., Kosowski P., Stopa J., Wartak J.: Analysis and selection of CO₂ sources for CCS-EOR projects in oil fields clusters in Poland • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Article contains a detailed analysis and a preliminary selection of potential CO₂ emitters that can supply gas for CCS-EOR projects in oil fields clusters in Poland. The idea of CO₂ injection into clusters arises from the fact that oil reservoirs in Poland are relatively small, but very often located close together. Reservoirs grouping significantly increases the potential storage capacity and improves economic indicators. In addition, CCS-EOR projects combine CO₂ storage (CCS) with an increase in production from mature oil fields (EOR). The analysis was performed using a database of carbon dioxide emitters in Poland created by the National Centre for Emissions Management. This database contains a list of all registered CO₂ producers with annual emissions exceeding 1 Mg. On this basis, potential CO₂ sources for previously selected four clusters of oil reservoirs were chosen.

Keywords: *CCS, EOR, CO₂, oil field, cluster, emitters selection*

Bujok P., Klempa M., Ryba J., Porzer M., Jakubčík M., Štastný L., Rado R.: **Special shut off device for liquidating blowout from the drill string** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Crude oil and natural gas belong to the most important raw minerals used by industry. Their world's consumption remains on a high level with an increasing tendency, similarly the demand for exploration-prospecting works.

The drilling works associated with reservoir prospecting and development are connected with the risk of reaching intervals containing highly pressurized formation fluids and with blowouts. When drilling the first well in a given area, the operator frequently does not have a full set of data about reservoir parameters of the drilled horizons. Investors want the drilling companies finish their works in the shortest possible time, therefore technologies which maximize the drilling advancement are employed. One of such techniques is drilling with minimally higher hydrostatic pressure of mud as compared to the reservoir pressure. If the drilling hits a porous interval of elevated reservoir pressure, reservoir fluid may inflow to the wellbore. If the hydrostatic pressure of fluid column in the wellbore is lower than reservoir pressure, the wellbore will be fed with reservoir water, which will consequently migrate towards the top of the well. This may result in a kick and then a blowout.

The inflow to the wellbore can be handled only by well trained crew and appropriate equipment. The crew has to recognize the flow, and depending on the condition of the well take suitable measures. Sometimes the lack of proper training, errors, hardware failures and improperly protected top of the well lead to a fully developed blowout from the well. Particularly dangerous are cases when the surface blowout prevention equipment or other elements of the well BOP facilities break down.

In such situations rescue teams with specialist equipment have to be involved.

Exemplary applications and technological potential of specialist blowout control equipment in uncontrolled kick of reservoir fluid through the string are presented in the paper. The designed tool and its functions allow for killing or reducing the outflow.

Keywords: blowout, blowout killing, damaged drillstring, oil and gas drilling blowout equipment

Gaczoł M., Wysocki S., Budzińska K.: **Modifications of the muds intended for HDD considering drilling through clay rocks – potassium chloride** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

The article describes issue of clay hydration phenomenon during Horizontal Directional Drilling. Reducing hydration, hence swelling, is a great concern in light of borehole wall stability maintenance. Muds commonly used for drilling by abovementioned technique are often blend of unknown ingredients. Thus, it should be carefully tested for addition of hydration inhibitors at the early stage of mud formula preparation.

The paper includes research formula and results of technological parameters of modified HDD mud. Moreover, there were conducted tests of QSE Pellets swelling and linear swelling of test samples collected from boreholes drilled by HDD technique.

Keywords: drilling mud, Horizontal Directional Drilling, shales and clays

Macuda J., Styrkowiec E., Rajpold W.: **Impact of wells reconstruction on their operational parameters** • AGH Drilling, Oil, Gas 2018 • Vol. 35 • No. 1

Use of deep water-bearing horizons on an industrial scale is an expensive undertaking, mainly in the first phase of the project which is the well construction stage. Also, emergencies occur during the well operation, with the most frequent including yield reduction caused by the poor technical condition of the well. These

frequently lead to the total decommissioning of the well, caused, for example, by backfill, filter damage or casing pipe damage. After conducting the proper diagnostics, a decision is most often made in such cases to reconstruct a well, and much less seldom to drill a new well hole.

Reconstruction of water intake wells usually encompasses replacement of the entire filter column with the well filter damaged as a result of ageing. As new technologies and materials become available on the market, it is possible to use new generation filters in the well construction, with better technical parameters (in terms of strength, hydraulics and corrosion resistance). In many cases, it allows for maintaining or achieving similar operational parameters in the reconstructed well. The determination of resources for a reconstructed well should, however, take into account modified filtration conditions in the aquifer's zone adjacent to the filter because of the zone siltation during previous use of the well.

The paper includes an evaluation of the impact of the reconstruction of two wells extracting water from the Lower Cretaceous level on improvement of their yields.

Keywords: *well, operational resources, determination of resources, well life, long-term operation*

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It is well known that water coning is a difficult-to-solve problem in heavy oil reservoirs with bottom water. A promising solution is offered by the downhole water sink (DWS) technology – a dual well completion technique for water coning control in reservoirs with bottom aquifer. In the field case addressed in this study, a DWS well was installed in a heavy oil reservoir underlined by thin water zone – notorious for severe water coning problem. Initially, the two well's completions had no separating packer; Later, the well was recompleted with packer and displayed much improved oil productivity and water coning control. However, after accidental shutdown of the bottom (water sink) completion and continuing production from the top (oil pay) completion the well was rapidly watered out and shut down.

In this study, the well's production history is analyzed to better understand dynamics of water coning control with packer-less DWS and the effect of temporary water sink shut-down. The analysis is performed with a radial grid-based simulation model using the reservoir properties and well production data. An adequate history match is achieved by tweaking reservoir properties within their uncertainty range – mostly the relative permeability and capillary pressure curves. The packer-less completion displays steady invasion of water to the top oil completion through the gravel pack with no separating packer. The analysis also confirms detrimental effect of sole temporary shutdown of the water sink (bottom) production that caused rapid buildup of water saturation in the oil pay zone around the well.

This work also evaluates possible restoration of oil productivity by putting the well back on production after a dormant period of time (when water cone might subside) and the contribution of the bottom water drive (aquifer strength) to the restored productivity. A 25-year production performance forecast is performed for three scenarios of well's operation after the water sink completion's shut-down for one month: (a) no shut-down and continuing production as DWS well; (b) one-month shut down and conversion to a conventional single-completed well; (c) one-month shut down and continuing production as DWS well. The results reveal that the watered-out well could be revived as an oil producer only by restoring its DWS operation [scenario (c)] as the conventional well operation [scenario (b)] would produce only water. Moreover, detrimental effect of temporary water-sink shut down would irreversibly reduce well's productivity by more than 10 percent. It is also shown that stronger aquifer stimulates DWS well productivity improvement of up to 20 percent in case of strong bottom water drive.

Keywords: *oil well production, water coning, downhole water sink*