SUMMARIES

Alibayeva K.A., Kuljabekov A.B.,Tungatorova M.S., Kaltayev A.: **Study of usage efficiency of multistage filters on mineral leaching** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

In this work the numerical study of the usage efficiency of the multistage filters setting technology on the process of mineral extraction by the in-situ leaching method is carried out on the basis of mathematical simulation. A comparison of the extraction degree at single and multistage filters is implemented. Obtained decisions for a multistage filters setting qualitatively conform to the experimental findings.

Keywords: *well, wellbore, porosity, permeability, Darcy law, Dupuit law, multi-stage filter setting*

Aminian K., Ameri S.: **Analysis of production data from hydraulically fractured horizontal wells in Marcellus Shale** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Unconventional reservoirs play an enormous role in hydrocarbon production in the United States. Marcellus Shale, a Devonian black shale found in the Appalachian Basin, has shown notable promise in the past few years. Shale is a complicated, naturally fractured reservoir with ultra-low matrix permeability. The gas is stored in the limited pore space of these rocks and a sizeable fraction of the gas in place may be adsorbed on the organic material. Shale gas reservoirs differ from conventional reservoirs in that massive stimulation treatments are requiredto achieve economic production. Horizontal wells are the most effective in providing access to the formation to perform multi-stage hydraulic fracturing treatments. The limited field experience with multiple hydraulic fractures in horizontal wells completed in Marcellus Shale indicates that significant increase in initial production can be achieved as the number of hydraulic fractures is increased. However, the production performance, particularly over longer time periods, is not well established.

The objective of this study was to investigate the long term production performance of multiply fractured horizontal wells completed in Marcellus Shale. Historical production data and stimulation treatment information have been collected and analyzed for a number of horizontal wells both in West Virginia and Pennsylvania. A commercial reservoir simulator which accounts both for dual porosity behavior and the adsorbed gas was utilized to history match the production performance. Based on the results of the history matching, the long term production performances of the multiply fractured horizontal wells were predicted.

The results were then utilized to investigate the production decline behavior of Marcellus Shale horizontal wells. A number of conventional as well as shale specific production decline models were considered in these investigations.

The results indicated the presence of different flow periods. The hydraulic fractures appear to dominate the early production performance which is characterized by linear flow. Gas desorption appears to impact on production decline behavior during the intermediate period. The late production is influenced by the reservoir boundaries and is controlled by natural fracture properties. A single decline model often cannot predict the entire production behavior and conventional decline analysis based on the early production data can lead to significant over-prediction of the future production rates or reserves. The results of this study can be utilized as guideline to investigate the feasibility horizontal wells with multiple hydraulic fractures and optimize the production from the shale formation.

Keywords: *unconventional gas, horizontal wells*

Bilstad T., Stenberg E.S., Jensen B., Larsen T., Toft M.: **Offshore drilled cuttings management** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The search for offshore fossil fuels generates large volumes of drilled cuttings which under certain conditions are defined hazardous, negating disposal at sea. Much of the cuttings end up in onshore landfills.

The types of fluids used in well drilling operations determine to which extent the cuttings are considered hazardous. The three main types of fluids are oil based mud (OBM), water based mud (WBM) and synthetic based mud (SBM). The purpose of adding fluids or mud in the drilling operations is to cool and lubricate the drill bit, to stabilize the well bore, to control subsurface pressure, formation pressure, well stability and corrosion, and to carry cuttings to the surface.
OBM is based on either diesel or mineral oil. One advantage of OBM is enhanced drilling performance, especially in technical challenging environments. A drawback, however, is the toxicity of OBM, prohibiting discharge of cuttings to the marine environment. Drilled cuttings are rocks produced during drilling operations, becoming coated with drilling fluids.
Historically, cuttings have been disposed to sea. However, recent environmental laws and regulations prohibit such practice. Re-injection of cuttings as a slurry into subsurface formations has also been discontinued due to leaks and re-entering of slurry into the bottom waters. Transport of cuttings to shore is therefore the choice. For logistics and cost reasons emphasis is put on offshore waste minimization and reuse/recycle.
Total fluid management (TFM) leads to environmental impact reduction (EIR). Minimization of drilling fluids and reuse of fluids lead to cost reduction. Volume of cuttings is reduced through directional drilling and by drilling smaller diameter holes. Synthetic based drilling fluids (SBM) are replacing OBM. Drilling wastes are further separated into a fluid and a solid phase. The solids may be used for road and other construction purposes, whereas the OBM is burned for energy recovery.
The purpose of the thermo-mechanical cuttings cleaner (TCC) is to convert hazardous oily cuttings into useful products. TCC facilities are only available onshore in Norway. However, offshore TCC units will in due time be introduced, negating the need for transport of cuttings to shore. Cuttings are allowed disposed to sea when no toxic fluids are attached. TCC separation is accomplished by generating temperatures of 240–300^{o}C sufficient for evaporation of oil and water from the mineral solids.

Keywords: *drilling, fluids, mud, cuttings, cleaning, TCC, reuse, disposal, regulations*

Dubiel S., Zubrzycki A., Maruta M.: **Decision system model for HC exploration on the basis of DST test results** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The paper presents the results of 57 Drill Stem Tests (DST) within the Upper Jurassic carbonate rocks forming the Carpathian Fordeep basement in the area between Bochnia and Ropczyce (south Poland) performed by the Polish Oil and Gas Company in the years 1993 to 1998. Designated prospective horizons were tested with DST for assessing productivity of strata. DST tests were performed mostly in open hole sections of boreholes (more rarely in cased holes) after prior borehole casing perforation operations. In approximately 75% cases the cycle drill stem tests (DST) was used for testing the Upper Jurassic carbonate rocks. On the basis of data and experiences obtained during exploration of the Upper Jurassic carbonate rocks the model of the work-flow decision diagram was elaborated. It may be used for the integrated HC field management and for possible modifications in the drilling and testing technology.

Keywords: *petroleum explorations, HC reservoir assessment, Carpathian Foredeep basement, Upper Jurassic carbonate reservoir rocks, DST tests results, model of the work-flow decision, HC field management*

Duse D.M., Duse C.S.: **The impact of using project based learning in Natural Gas Engineering** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

This paper sets out to present an application of learning by cooperation in a bachelor study program of Natural Gas Engineering. Starting from the idea that students' abilities to understand new things are enhanced when they are tied to significant problem solving tasks and students are helped to understand why, when and how these facts become relevant competencies, we have organized the didactic activities of the last study year of the bachelor level, specializing in Natural Gas Engineering, using the projects method. The goal was to see how students perceive the efficiency of learning by applying this method and if an increase in learning efficiency has been noticed. Having these goals in mind, the students were organized into groups, each group having the task of presenting a project with a certain theme. Inside the group, roles were cast and then the strategy for doing

the project was discussed. The research was done over a period of 3 semesters. In the first semester, traditional teaching was used, while the second and third semesters were dedicated to projects. In the traditional teaching part, students were encouraged to discover critical thinking methods. For this purpose, they were presented with the thinking hats method, the cube, the "I know – I want to know – I have learned" technique etc., but also methods to assist learning (mind map, cluster etc.). Doing the projects also involved presenting and defending them in front of the class, which has led to highlighting the pros and cons of the project. Also, students have received an evaluation questionnaire on evaluating key aspects during the presentation. Teamwork was evaluated by each student team member. The final evaluation of the students was comprised (in various proportions) by the contribution of the students during the semester (as a method of formative evaluation), as well as a final exam (summative evaluation). The general conclusion of applying this method highlights the fact that students have become aware of the pros and cons of their behavior, have gained new motivational support for learning and have managed to increase their performance in the field of Transporting Natural Gas.

Keywords: *Natural Gas Engineering, learning*

Fąfara Z.: **Magnitude of hydrocarbon sorption capacity of sandy soils analysis** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

This paper summarizes the author's previous studies on the sorption of hydrocarbons in sandy soils. Completed several independent series of measurements for various models of soil. There were used unleaded petrol and diesel fuel as petroleum products.A large amount of collected information allows you to draw some interesting conclusions, which may be the basis for generalizations. The detected regularity can afford to develop a several models that can be successfully used to describe the intensity of hydrocarbon sorption processes in soils. These processes have a significant impact on the hydrocarbon migration in the soil by reducing the pollution zone and extending the time of migration. Inaccurate description of the magnitude sorption capacity will lead to large differences between the actual scenario of hydrocarbon migration in soil and its numerical simulation.

Keywords: *loose soil, hydrocarbon migration, adsorption of hydrocarbons, sorption capacity of soil*

Fąfara Z., Stępień A.: **Evaluation of adsorption of petroleum products in the soil depending on its granulation** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Thanks realized in 2011 in a wide range of laboratory investigations of adsorption of selected petroleum products in different models of soil author has an extensive set of experimental data. They lead to a series of qualitative and quantitative analysis. They confirm the generally known fact that the intensity of the adsorption of hydrocarbons strongly depends on some features of the oil products (mainly viscosity) and soil (especially grain).It is possible to fit the regression equation using statistical methods, which permits to estimate the adsorption coefficient of different oil products on the basis of parameters describing the granulation of soil. Those obtained equations are characterized by a high degree of suitability to the experimental data and can be successfully used in numerical modeling of hydrocarbon migration in the soil.

Keywords: *loose soil, hydrocarbon migration, adsorption of hydrocarbons, models to evaluate the hydrocarbons coefficient*

Foidaş I., Ştefănescu D.-P., Vlasin I.: **Detection and estimation of overpressures in gas reservoirs while drilling** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

As part of rotary - hydraulic drilling method (the most common method for drilling the wells) the rock is displaced by the action of drilling bit, being removed from the bottom and brought to the surface, through the drilling fluid. Besides this function, the drilling fluid creates a backpressure against the borehole walls, overcoming the collapse of the poorly consolidated rocks as well as the fluids influx from the formations crossed by the well.

Keywords: *gas reservoirs, detection and estimation of overpressures*

Kaliski M., Krupa M., Sikora A.P., Szurlej A.: **Selected elements of unconventional natural gas economics on the example of North American Energy market experience** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

There is a several year experience concerning exploration and production of shale resources in the USA. First production wells started in 1996 (the history of hydraulic fracturing is even 40–50 years older), and last few years one can observe a huge impact on American economy and decreasing level of natural gas import. One can assume that the development will grow significantly and the USA will stay self-sufficient and can start exportation of hydrocarbons – especially LNG. The economy will decide about the share of the natural gas in energy mix – energy balance. In the paper there is a detailed discussion concerning economy of the shale exploration and production (i.e. the costs of drillings, services, geological conditions versus timings and schedule of production). Based on analyzed scope one can predict a stable progress in cost reduction (learning curves) linked with production of shale hydrocarbons.

Keywords: *shale gas, unconventional gas resources, natural gas production, gas prices, learning curves*

Klempa M., Porzer M., Bujok P., Pavluš J., Rado R.: **Petro-physical properties of geological formation in the aspect of possible CO_2 sequestration** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

CO_2 emissions and a future increasing trend can be, by some scientists, considered a serious menace for the sustainable development of mankind and the reduction is necessary for the environment protection. Carbon dioxide is one of the most important gases that causes greenhouse effect, which warms up the earth surface as a consequence of a different heat flow between the earth and the atmosphere.

Keywords: *carbon dioxide, enhanced oil recovery (EOR), porosity, permeability*

Knapik E., Stopa J.: **Application of multifunctional fluids to improve hydrocarbon production** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

In the course of the mature gas fields exploitation there are many technical problems including the corrosion damage, formation of hydrates and water cut. In many cases, an effective solution of these problems is the dosage of appropriately selected chemicals. Commercially available corrosion inhibitors, hydrate inhibitors, demulsifiers and foaming agents are injected in a form of single, multifunctional mixture through one liner which reduces injection costs.
The paper presents the results of laboratory tests, which aim was to investigate synergism and antagonism in multifunctional mixture containing different commercially available surfactants, corrosion and hydrate inhibitors. Correlations between final product composition and performances such as liquid unloading efficiency, corrosion protection and pour point were studied. The described approach allows to adapt the tertiary mixture composition (foaming agent + corrosion inhibitor + hydrates inhibitor) to the current production conditions. The polarization behavior of electrodes in brines with and without mixture of additives has been studied by a cyclic voltammetric method. The addition of increasing concentrations of each chemicals causes the reduction in the corrosion current density. The measurements using a modified method of the US Bureau of Mines show synergistic effect of surfactants and corrosion inhibitor on foamabilities. Multifunctional mixtures are stable under storage conditions and not cause any compatibility problems with reservoir fluids.

Keywords: *foam, gas wells dewatering, corrosion inhibitor, synergism*

Kondrat K.: **Study of methods of hydrocarbon recovery enhancement from the depleted oil fields** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The article deals with the optimization of existing development system and oil recovery factor enhancement through the involvement to the development of productive bed areas with significant remaining oil reserves by using

the hydrodynamic models of filtration processes of formation fluids in heterogeneous beds on the example of the sandstone deposit of the Boryslav field. The calculations for the different variants development in order to select the most rational one of the further development of a field were made. The task of the optimization was performed according to the criteria of the highest value of oil recovery factor.

Keywords: *field, well, oil, oil recovery, drilling*

Kopey B.V., Galiy S.I., Bednarz S.: **Effect of changes in operating power of gasmotocompressors 10 GKN on the diagnostic signs of connecting rod bearings defects** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The increasing of gasmotocompressors (GMC) reliability, operated on the booster compressor stations, underground gas storages with significant deterioration of the park units are the actual problems. The greatest attention should be paid timely detection of conrod bearings defects for the prevention of necks crankshaft scoring. Statistics increase of late crank bearings defects shows that scheduled repairs not ensure reliable operation of GMC. Improving the reliability of GMC through the detection in time the crank bearings defects is only possible using the methods and diagnostic tools for calculating the probability of failure-free operation, equipment failure rate during its operation. Increased probability of crank bearings defects detection is possible by the determination of dependence of levels of crank bearings vibration on gasmotocompressors 10 GKN operational capacity. For efficient conducting of connecting rod vibration condition monitoring on units with different power the software was developed and methods of using the obtained models depending on the power levels of vibration were elaborated.

Keywords: *gas compressor station, diagnostics, defects, vibration*

Kosowski P.: **Analysis of the current state and tendencies on the natural gas market and gas storage in Europe on the background of the situation in Poland** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The present state and tendenciesof the natural gas market and gas storage in Europe areaddressed in this paper and compared to the situation in Poland. The European countries are presented in view of their natural gas production, import and export vs. consumption (total and per capita) and the consumer structure. The changing consumption level is assessed as a function of the consumer's structure and quantity of consumption. This has a direct influence on the demand for natural gas storage. The author also characterizes the gas storage market in Europe, accounting for the existing and planned investments, with special emphasis on storage capacity, injection and withdrawal capacity, and also types of storages. The characteristic was based on, among others, the consumption level, home production and import in particular countries.

Keywords: *natural gas market, gas storage, gas consumption, gas prices*

Niezgoda T., Małek E., Miedzińska D.: **Carbon dioxide geosequestration method coupled with shale gas recovery** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Shale gas is natural gas produced from shale, a type of sedimentary rock. Shale gas has become an increasingly important source of natural gas in the United States over the past decade, and interest has spread to potential gas shales in Canada, Europe, Asia, and Australia. One analyst expects shale gas to supply as much as half the natural gas production in North America by 2020.

Carbon dioxide capture and storage (CCS) is a set of technologies for the capture of CO_2 from its anthropogenic point sources, its transport to a storage location, and its geosequestration. This is only one, though very important, option in a portfolio of actions to fight the increase of atmospheric CO_2 concentration and to mitigate climate change, while at the same time allowing for the continued use of fossil fuels. Deployment of CCS technologies is expected to be limited in the next 5–10 years, but to contribute significantly to the reduction of CO_2 emissions 20 years from now. Capture of CO_2 using existing separation techniques can be applied to large point sources, i.e. power plants or industrial plants; CO_2 can be easily transported over large distances using pipelines and ships; finally CO_2 can be permanently stored in suitable deep geological formations, namely deep saline aquifers, oil or gas reservoirs, and unmineable coal seams, or it can be fixed in carbonates.

The paper deals with the innovative method of carbon dioxide storage coupled with gas shale fracturing and methane recovery developed in the Military University of Technology. It allows to effectively mine the shale gas and to store carbon dioxide in shale rock. It must be noticed that CO_2 pollution is a very important problem in Poland, because of European Union CO_2 limits. Also carbon dioxide thermodynamic process of decompression numerical calculation, which simulates the injection of the cold liquid gas into the shale formation (high temperature and pressure conditions) and its influence on shale rock fracturing as well as initial experimental verification of the method was presented in the paper.

Keywords: *shale gas, geosequestration, carbon dioxide*

Niezgoda T., Miedzińska D., Małek E.: **Analysis of coal structure in the aspect of gas content** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The problem of methane existence in coal beds has been known for many years. It was and still is a danger to coalminers. The aim of the research presented in the paper is to show and assess the porosity structure (especially micro and nanoporosity) in accordance to the dimensions of carbon dioxide particle. The characteristic surface morphology of the sample and the disclosure of carbon porous structure was obtain using the scanning electron microscope (SEM).
The presented study of the coal microstructure is a part of the coal demethanation method with the use of liquid CO_2, that was proposed by Military University of Technology.
Based on the results of laboratory tests may be noted that the analyzed coal has a granular structure. It is also visible that that the structure is stratified, and there is a lot of cracks and free space between grains, which can accumulated methane in coal structure.
The nanoporosity of the coal grains was observed during SEM study. The sizes and shapes of pores are miscellaneous. However the dimension of 62–300 nm allow to draw a conclusion, that the nanopores can contain a few particles of CH_4 (4 Å), which can be released by the CO_2 particle (2.54 Å).
Finally, on the base of presented research it can be concluded that the method of coal demethanation with the use of CO_2 can be economically and ecologically effective, and can increase the miners safety.

Keywords: *carbon dioxide, methane, porosity of coal*

Oliinyk A., Łaciak M.: **Safety technical problems associated with the storage of liquefied natural gas (LNG)** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Liquefied natural gas (LNG) due to its extremely favorable properties is considered to be one of the most convenient sources of energy, both the transport, storage and distribution. However, these same properties, and factors which represent the LNG as convenient, such as: a very low temperature (–162^{o}C), a very large increase in the volume of the evaporation (about 600 times) and also create a potential threats The greatest potential threats are in areas where LNG is a very large quantities for a long period of time. The facts presented above show that there is potentially the greatest threat to the storage of LNG.
Leaks, clouds LNG vapor, explosions, low temperature, and "rollover" are the most dangerous potential hazards that occur during storage of LNG. Each of these risks can be avoided. This is achieved by the use of appropriate materials for tanks and equipment, as well as the proper and adequate execution of engineering design at each stage of technology.
Proper selection of vessel design and materials, and the use of appropriate methods of combining them decide on a safe and long life tanks.

Keywords: *LNG, storage problems*

Palmer C., Sito Z.: **Nitrogen and carbon dioxide fracturing fluids for the stimulation of unconventional shale plays** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

With the International Energy Agency (IEA) projecting that the global demand for natural gas to increase by 50% from 2010 to 2035, the exploration of unconventional gas reserves (e.g. shale gas, tight gas and coal bed methane)

will gain increasing importance as conventional gas reserves become more depleted. To enhance the production of unconventional gas and oil, water-based fracturing fluids are extensively used for the stimulation of North American shale plays because they are inexpensive and offer excellent proppant transport into the fracture when used with gelled polymers. However, in circumstances where water-based fracturing fluids are unsuitable due to concerns related to water sensitivity and clay swelling, alternative fracturing fluids are used such as nitrogen and carbon dioxide treatments. Nitrogen and carbon dioxide fracturing fluids are particularly advantageous in depleted and shallow formations because they offer a non-damaging effect around the fracture, rapid cleanup of flowback fluid, and reduced water requirements compared to conventional water-based fracturing fluids. Much research has been published about water-based fracture treatments, therefore, this review paper considers the use of nitrogen and carbon dioxide fracturing fluids used for the stimulation of unconventional shale plays, mainly in North America. By analysing selected literatures studies, this review paper summarises the utilization of the various types of nitrogen and carbon dioxide treatments (i.e. straight gas, foam, energized, cryogenic liquids) across various shale plays such as the Montney play, the Devonian play, and the Marcellus play. The paper further identifies the major benefits and challenges of nitrogen and carbon dioxide treatments documented by well operators, which will facilitate knowledge transfer about the applicability of nitrogen and carbon dioxide fracturing fluids.

Keywords: *nitrogen, carbon dioxide, fracturing fluids, shale gas*

Ştefănescu D.-P., Vlasin I.: **A new approach of mature gas fields rehabilitation from Transylvanian Basin (Romania)** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The mature gas fields rehabilitation represents a permanent concern of the Romgaz technical management, being considered one of the major priority of the development strategy of our company.
The most part of our gas fields located in the geological unit of Transylvanian Basin are characterized by an advanced stage of exploitation, with a long production history and high cumulatives, having a current recovery factors of more than 60–70%. This status gives them the name "mature fields", or "brownfields" concepts logically associated with another notion, called "rehabilitation", also very frequently used in the world oil and gas industry.
As the production decreasing became actually more obviously, due to the natural energetic decline of the reservoirs, the only viable solution to overcome this, consists in finding technical, commercial and operational best practices designed to develop incremental production and access additional reserves.
This issue has preoccupied also the Romgaz technical team to implement and develop in the same time a new management strategy of this type of reservoirs, setting up a special department for designing the rehabilitation projects for our mature gas fields.

Keywords: *mature gas fields rehabilitation, subsurface management of the reservoirs, incremental production, additional reserves, geological and physical model*

Stryczek S., Gonet A., Wiśniowski R., Złotkowski A., Ziaja J.: **Influence of fluidal ashes from lignite on technological properties of slurries based on G-class drilling cements** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

New generation fly ashes are a produced during coal combustion in fluidized bed furnaces with simultaneous sulphur removal from the gas. This process is held at temperature of about 850^{o}C. The generated ashes basically differ in their physicochemical properties from traditional silica ashes.
Fluidal ashes produced during lignite combustion consist of active puzzolana in the form of dehydrated clayey minerals and active components activating the process of hydration of, e.g. CaO, anhydrite II and $CaCO_3$ ashes. The paper presents the results of laboratory analyses of the influence of ashes coming from the combustion of lignite on technological properties of fresh and set sealing slurries based on drilling cement.

Keywords: *drilling cements, fluidal ashes from combustion of lignite, sealing slurries, cementing boreholes, technological parameters of fresh and set sealing slurries*

Şuţoiu F., Tătaru A., Simescu B.: **Rigless jobs in gas wells** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

At the same time with gas reservoirs energetic depletion there appears the perforation deterioration or blockage issue. Mostly, in the mature gas reservoirs, a big attention must be given to well interventions for maintaining or increasing the production.
Because of the workover operation risks and costs, the oil companies prefer as much as possible rigless jobs to accomplish well stimulation like reperforation or several coil tubing operations (acidizing, fracturing etc).
In our rehabilitation programs for many gas reservoirs, our company accomplished successfully more stimulation jobs. In this paper, we will present some case studies and results obtained after several rigless operations which assure long term production increases.

Keywords: *nature gas reservoies, workover operations*

Thiam M., Knez D.: **Behavior of hydraulic fracture propagation in naturally fractured reservoir** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The natural discontinuity or local separation in the plane, which separates the rock in two or many parts, can provide the permeability for fluid movement as water, oil and gas. In low porosity reservoirs, the natural fracture can store a large quantity of hydrocarbons that can be recovered at very high rates. It play a very important role in the minerals exploitation, especially in the sectors of mining and energy which gave an important boost to humanity through the industrial revolution and its associated benefits. So, it is essential to understand the behavior of natural fractures under the influence of other factors such as hydraulic fractures in reservoirs. This paper takes into consideration three models, analyze their results context and ultimately use of new computer program, developed in The Drilling and Geoengineering Department, to make all the necessary operations for each model and give us the results based on provided data.

Keywords: *hydraulic fracturing, hydrocarbons*

Toleukhanov A., Kaltayev A., Panfilov M.: **Storage of hydrogenous gas in geological formations: self-organisation methane gas** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

In the case of producing large amounts of hydrogenous gas, currently there are no problems related to basic techniques of hydrogen production and distribution, but the main technological problem will consists of storing it in order to regulate the difference between permanent or increasing gas production and seasonally modulated gas consumption. The most efficient and most inexpensive method of storing large amounts of hydrogen is to inject them in geological formations like aquifers, depleted gas reservoirs, or salt caverns (Zittel and Wurster 1996). The cost is of order $ 3.5 per 1 GJ (Taylor et al. 1986). Several underground storages of hydrogen (USH) or town gas exist in the word, as for instance, Teeside in the UK, in Texas, in Russia, Kiel in Germany, Lobodice in Czechoslovakia, Beynes – an ex-storage in France.
During several tens of years the storage of hydrogen was considered as something deja-vu, to be similar to that of natural gas, which is amplified by the chemical inactivity of hydrogen and its very low solvability in groundwater [Bulatov 1979; Carden and Paterson 1979; Lindblom 1985; Paterson 1983]. Nevertheless, quite unusual behaviour of UHS was discovered by in situ monitoring of the gas composition extracted during the cycle "production" which followed the cycle "injection". These observations (Smigai et al. 1990; Buzek et al. 1994) revealed high variations of gas composition in time and space. In particular, a significant reduction in the H_2 and CO_2 contents and a simultaneous increase in CH_4 contents were observed in the Lobodice town gas storage facility (Smigai et al. 1990). Similar phenomena were recorded in Beynes. After several months of injection and storage, at the beginning of the cycle "production" the twofold increase of the methane contents in the reservoir gas and the

twofold reduction of the CO_2 CO contents was observed. The contents of hydrogen decreased by 1.4. The explanation to these observations has been done in (Buzek et al. 1994) in terms of the in situ methane generators by methanogenic bacteria which catalyse the reaction between hydrogen and CO_2/CO, by producing methane and water. Further observations have revealed even more unusual effects within the storage facility, such as creating a spatial alternation of the areas saturated preferably by hydrogen or methane. This proved an in situ natural separation of chemical components in space.
Thus, we are dealing with a natural reactor which partially destroys CO_2 and H_2 and doubles the mass of methane. It is clear that the problem is important for industry as it concerns both the energy sector and ecology. The resulting economical efficiency of such a process can be estimated only after the physical and mathematical modeling of all possible scenarios of the reservoir behaviour. The development of such a model represents the main objective of this paper.

Keywords: *porous media, hydrogen, reactive transport, bacteria, neuston, chemotaxis, population dynamics, oscillations*

Twardowski K., Lewandowska-Śmierzchalska J., Przybyłowicz J.: **Present metrological standards in mathematical modeling procedures** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

In the years 1993–1994 International Organization for Standardization (ISO) introduced to the metrology the fundamental changes of basic character, involving – in addition to the traditional concept of measurement error – the use of new fundamental term of uncertainty of measurement. In consequence, this has led to currently undisputed axiom of metrology, that the measurement result has a form of a section on dimensional axis.
These rules of presenting measurable physical values should be reflected in the of practical procedures of mathematical modeling.
Presented work relates to this particular problem. It discusses the principles of mathematical modeling together with the assessment of the results. Particular attention was paid to the identification of possible systematic errors (i.e. the load of model) and to estimating the uncertainty of the statistical and deterministic modeling.

Keywords: *mathematical modeling, metrology, measurement error, measurement uncertainty*

Vasyuchkov Yu. F., Bykova M. Yu., Vasyuchkov M. Yu.: **Science principles for the concept – project of combined coal and gas and electrical blocks** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

To-day, the conventional technologies of coal mining are distinguished several shortages as negative influence on the environment and lower efficiency of coal potential energy use and higher labor capacity of underground works. In accordance with these shortages the natural gas became a play key role in many countries for power generation. During last twelve years the technologies of coal gasification for power generation are developing in the coal areas of the USA and other countries.
The novel concept of the local coal and gas and electrical complex (enterprise) had proposed in “Mineral”, Ltd and Moscow State Mining Institute. The technology was named through abbreviation as LCGEC. The concept is based on transformation of hard raw coal in a gas fuel through gasification procedure and recovery of coalbed methane and mix of these two gas streams for use the ones into a combine cycle unit for power generation. One from very important problems of LUGEC exploitation is high coalbed methane productivity through extracted wells. The problem is discussing in the report.
Implementation of the concept requires an attraction of large investments. For realization of the concept it is need to develop the concept – project of the complex. In the report the methods of main parameters and production capacity and commercial indexes of the LUGEC

Keywords: *coal, gas, local coal-gas-electricity complex*

Wang Z., Miska S., Yu M., Takach N.: **Effect of tripping velocity profiles on wellbore pressures and dynamic loading of drillstring** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Tripping events are expensive and time-consuming. Thus, minimizing tripping time through choosing optimized tripping velocity becomes urgent. Surge or swab pressures in the wellbore and dynamic loading of drillstring will be generated during tripping. Also, dynamic velocity, which is the velocity at the bottom of drillstring, is different from the input velocity at surface. The effect of tripping velocity profile, i.e., tripping velocity changes with time, on the hook load, downhole pressure changes and drillstring dynamic velocity should be fully studied to achieve the optimization.
In this study, the effects of tripping velocity profile on loading of drillstring, dynamic velocity and downhole pressure is investigated using numerical simulation. Bergeron's graphical method and Lubinski's approach are utilized to perform the simulations. Components of drillstring, wellbore depth, drillstring length and mud properties are also included in the simulations.
Through the current work, a driller's typical way of changing tripping velocity may not be the best one. Selection of tripping velocity profiles should be adapted to depth: higher velocity, triangular/parabolic profiles in shallow wells and lower velocity, trapezoidal profiles in deep wells. Also, based on simulations, the oscillation magnitude of dynamic velocity can be as high as twice that of velocity at surface.

Keywords: *trapping velocity, optimization*

Włodek T., Ławski Ł.: **Application of pipelines made with Thermoflex® technology for natural gas and carbon dioxide transportation** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

The main issue related to pipeline transportation of hydrocarbons (natural gas, oil) and chemical substances (e.g. carbon dioxide) is to get the best transportation efficiency, taking into account economic and technological aspects. The paper presents the possibility of using pipelines made with the Thermoflex® technology for the transportation of natural gas and carbon dioxide. Pipelines made with this technology can be used for transportation of natural gas from wellsites to natural gas mines installations. Thermoflex pipeline time of instalation is shorter compared to steel pipeline, this issue has great significance in the perspective of future exploitation of natural gas from unconventional reservoirs in Poland. Pipes made using this technology with new polymeric materials are characterized by much lower pressure drop along the pipeline compared to the steel pipelines, much higher maximum operating pressure range compared to polyethylene pipes, better thermal insulation compared to steel, high corrosion resistance and lower installation and operating costs. This paper presents the construction of the pipelines made using Thermoflex® technology, possibilities of applications and comparative examples of simulations of pressure drop and temperature for steel pipelines and made with Thermoflex® technology for the transport of natural gas and carbon dioxide.

Keywords: *thermoflex, natural gas transportation, pipelines, CO_2, carbon dioxide, CO_2 transportation, natural gas networks, new materials*

Ziemkiewicz P.F.: **Characterization of liquid waste streams from shale gas development** • AGH Drilling, Oil, Gas 2013 • Vol. 30 • No. 1

Hydraulic fracturing has been practiced for over thirty years to improve effective porosity and stimulate oil and gas production. In the Appalachian Basin it has been used with horizontal drilling since 2008 to extract methane and natural gas liquids from source rock such as the Marcellus Formation. Hydraulic fracturing generates large volumes of waste water known as flowback: about 3,800 m^3/well. Literature regarding the chemical composition of this waste stream is limited. This study examined injected hydraulic fracturing fluid from two wells and flowback from four hydraulically fractured wells. Wells were sampled at various times during the flowback cycle and

in sections of the basin known to produce either wet or dry gas, the former producing higher volumes of natural gas liquids. Concentrations were compared to available literature values and to drinking water standards as a basis for determining which parameters might compromise nearby, domestic wells in the event of an accidental release. Measured parameters included three classes: organic, inorganic ions and radioactive isotopes.
Concentrations of all three classes of contaminants tended to increase during the flowback cycle. Organic contaminants including BTEX were substantially higher in the wet gas well. Radioactive isotopes, particularly alpha, beta, radium 226 and radium 228 increased during flowback. All contaminants were found in much higher concentrations in flowback water than in injected hydraulic fracturing fluids suggesting that the bulk of contaminants originate in the Marcellus formation rather than in the injected hydraulic fracturing fluids. Primary and secondary drinking water standards for all classes of contaminants were generally exceeded in flowback water.
In addition to summarizing the chemical composition of flowback water, the presentation recommends practices for controlling the risk of environmental exposure.

Keywords: *liquid waste, shale gas*