SUMMARIES

Pavlenko A., Koshlak H., Vytyaz O., Rybicki C.: **Prospects for the development of hydrate storage and transportation technology of methane gas** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The gas hydrate technologies can be alternative to the traditional methods of the rational use of hydrocarbon gases. However the known constructions of apparatuses for the production of gas hydrates cannot satisfy the condition of their industrial use fully. Authors offer to carry out the high-quality contact of gas and water at formation of gas hydrate by jet apparatuses with a free falling jet. On their basis a technological chart is offered for realization of continuous cycle of production of gas hydrate.
The aim is to develop technical solutions and process parameters of continuous production of gas hydrates, which would satisfy the requirements of industrial application.

Keywords: *gas hydrate, jet apparatus, free falling jet, continuous cycle of production, coagulation, heat of gas hydration*

Kuczyński S., Skokowski D.H., Włodek T., Polański K.: **Compressed air energy storage as backup generation capacity combined with wind energy sector in Poland – implementation possibilities** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

Wind energy sector has been developing at a fast pace in many countries around the world in recent years. However, there is an issue with the unpredictability of electricity production provided by wind turbines that is caused by variability of weather. Therefore, there is need to compensate the intermittency of wind energy by means of backup power generation facilities. One of the solutions is compressed air energy storage technology (CAES). The paper discusses the CAES technology characteristics as well as economic aspects of CAES plant construction and operation. The latest achievements and developments in the field of CAES technology is presented. The paper inspects the existing CAES facilities and discusses the possibilities of implementing this technology in Poland.

Keywords: *CAES, wind power plant, renewable energy, backup capacity, energy storage*

Uliasz-Misiak B., Kosowski P., Lewandowska-Śmierzchalska J.: **Analysis of reservoir properties and parameters of oil fields suitable for the application of CO_2-EOR method** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The criteria worked out on the basis of the literature study were used for indicating oil fields, where carbon dioxide can be injected for the purpose of storing or to enhance the production of oil. The preliminary selection of oil fields, where the miscible CO_2-EOR method can be applied was based on the following criteria: depth of deposition, density of oil, reservoir temperature and oil saturation. From among 68 analyzed oil fields, 35 were used for the analyses: 3 fields in the Carpathians, 6 in the Carpathian Foredeep and the remaining 26 fields in the Polish Lowland. The statistical analysis methods were used for analyzing reservoir parameters of fields preselected for the CO_2-EOR method, i.e. depth of deposition of the roof of the horizon, average thickness, initial reservoir pressure and reservoir temperature. The reservoir properties of these fields were also analyzed, i.e. average permeability, average porosity and average saturation with oil.

Keywords: *oil field, reservoir properties, reservoir parameters, CO_2-EOR method*

Sapińska-Śliwa A., Kowalski T., Knez D., Śliwa T., Gonet A., Bieda A.: **Geological and drilling aspects of construction and exploitation geothermal systems HDR/EGS** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The article presents an overview of developing unconventional geothermal systems, such as Hot Dry Rock Systems (HDR), where is used the heat of dry rock and enhanced system with small water tributary called Enhanced Geothermal Systems (EGS). These systems provide utilization of geothermal energy in reservoirs (i.a. granites) where conventional methods are not possible to use. Operation HDR/EGS involves the use rock heating through warming medium, which flowing between the production and injection boreholes. In most cases medium introduced artifically by hydraulic fracturing. Currently, most of the projects HDR/EGS is in the implementation phase. Based on gathered materials an analysis of the construction and exploitation geothermal systems. Take into account geological and drilling aspects.

Keywords: *hot dry rocks, geothermal energy, fracturing of rocks, Enhanced Geothermal Systems*

Chruszcz-Lipska K., Knapik E., Rychlicki S., Stopa J.: **Assessment of the quality of surface water from selected area of active oil exploitation** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

In this work, the studies of various physico-chemical parameters of surface waters originated from the selected area of oil exploitation in the south of Poland are presented. The water samples were collected from streams and ponds or directly from surface tanks situated in the vicinity of operating wells. The observed values of different parameters like pH, odor, color, turbidity, electroconductivity, concentration of sulfate, chloride, nitrate, iron, calcium, magnesium, ammonium, alkanity, dissolved oxygen or petroleum contamination of samples were compared with standard values recommended by the WHO (World Health Organization) and the relevant Polish Regulation. Preliminary studies show that investigated surface waters are slightly affected by anthropogenic pollution. The main two sources of contamination of water from the study area are agriculture and mining industry.

Keywords: *surface water, oil exploitation, quality of water, chemistry of water, environment protection*

Dubiel S., Rybicki C., Zubrzycki A., Maruta M.: **Applicability of DST results to the evaluation of changes of geologic conditions of Rotliegend series in the Polish Lowland** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The presented theoretical analysis and industrial examples of interpretation of DST results for the Rotliegend series in the Polish Lowland were focused on the changes of gas productivity factor and commercial value of the analyzed horizon; permeability changes of the Rotliegend series in the wellbore area; facial changes of the Rotliegend.

Keywords: *the Rotliegend series, Drill Stem Tester (DST), Aeolian sandstones, natural gas accumulations, standard Halliburton drill stem tester, bottom hole pressure, rock permeability*

Fąfara Z., Ilkiv I., Solecki T.: **The modified Dräger probe to the geochemical research of the soil gases composition** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The Dräger probe in the measurement set to the geochemical research of the soil gases composition is inconvenient to use. It's heavy, which are required to operate at least two people. Cumbersome and time-consuming is to

place it into the soil by impact method, and often there is fail to reach the planned measurement depth. For this reason, there was designed and made the new modified Dräger probe. The new probe has significantly lower mass and outer diameter. In principle it should be possible to introduce it into the soil by pushing, which will greatly facilitate and accelerate conducting the geochemical research of the soil gases composition.In the autumn of 2014 has been tested the modified Dräger probe. The purpose of this study is to assess it suitability to conduct the geochemical research of the soil gases composition. In total there were performed 374 measurements of the soil gases composition at different depths in the 247 measurement points. In 99 cases (26.5%) there was failed to perform the measurement because the soil gases flow rate through the meter was too little. Pulling probe usually allowed to perform the research – in only 6 measurement points (2.4%), it was impossible. The average depth of the measurement point is equal to 0.78 m.

Keywords: *geochemical testing of soil gases composition, oil deposit*

Rybicki C., Solecki T., Winid B.: **Threats to the environment in the areas of abandoned extraction of hydrocarbon deposits** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The environmental problems in past mining areas, where the production process was ended, are connected with contaminations coming from past extraction processes and the risks relating to the abandonment of wells and deposits. The risk could be variable depending on such factors as the geological formation and hydrogeological conditions in the analyzed area, and the condition of abandoned wells. The main source of contamination could be improperly sealed abandoned wells and unplugged abandoned oil and gas wells. The environmental problems could be particularly concern on the area of old historical extraction sites. There are some hydrocarbon deposits, where production is ended and still it is possible to see places of wells and remains of an old oilfield infrastructure. Unplugged or improperly sealed wells can result in stray gas migration or contamination of soil, ground and surface and ground waters. The end of well exploitation may cause the risk associated to the restoration of formation pressure. This could be the reason of uncontrolled discharge of gaseous and liquid hydrocarbons into shallow depths. Returning to the extraction from some deposits could reduce the formation pressure and constrain uncontrollable leakages of hydrocarbons. This option seems to be environmentally friendly. Authors of the paper made efforts to evaluate the scale and the range of mentioned disadvantageous phenomena.

Keywords: *abandoned wells, environmental problems*

Wysocki S., Gaczoł M., Ciepielowska M.: **Removal of the filter cake created by the mud for hydrogeological drilling by the method of acidizing** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The article describes issue of a mud for hydrogeological wells and a method of removing sediment accumulated on the well filter and in the near-well zone after borehole drilling. Developed fluid formula is based on both primary criterion of selecting the best technological parameters of the mud and restrictive ecological standards. Because of the contact between the mud and the underground water (which is the main source of potable water), a need to select appropriate components such as biodegradable polymers (Guar-Gum, XC) and other organic compounds that are not causing harmful environmental effects has arisen. Furthermore, developed formula allows for relatively easy removal of mud remains from the well filter and near-well zone, increasing well efficiency. The paper includes research findings of sediment acidizing by the procedure called "soft acidizing". Any information about practical application of this procedure can hardly be found in specialized literature. Therefore, concentrations and variations of the acetic, hydrochloric and citric acids were subject of research and analysis.

Keywords: *acidizing, filter cake, drilling fluids*

Vasyuchkov Yu.F., Fedorova M.A.: **Synthetic gas production during underground gasification of coal seams** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

Last time technical developed countries find alternative gas sources for own energy duty. This source may save natural gas resources in these countries or make sure other countries having an energy deficit. One from named resources is synthetic gas which may be manufactured from a natural coal. Several countries tried to receive this gas from coal seams by way underground gasification process. But results aren't good before today. A reason is deficiency information about thermal and chemical regularities which control the process underground coal gasification. This article allow reader deeper to understand thermal process in a fire health of the coal seam channel and to learn mathematical description of a temperature distribution into the seam on modern procedure.

Keywords: *synthetic gas, coal seams*

Barbacki J.: **Application for quantifying the lithology of a rock formation using geophysical well logs and constrained optimization methods** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

Correct determining the lithology of a rock formation is one of the main goals of geophysical interpretation. The application for analysis of borehole geophysical measurements encoded in Log ASCII Standard format files was created. Appropriate choice of geophysical parameters allows to determine the percentage volume of elements in the rock formation, as well as the porosity and the water saturation of the formation. For the precisest solution a conjugate gradient method with Monte Carlo starting points was used.

Keywords: *lithology, porosity, water saturation, optimization, LAS*

Ştefănescu D.P., Falk I., Iturbe Y.: **Integrating new data acquisition to develop tight gas reservoir of a mature field through multilayer fracture stimulations** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

Laslau Mare field is situated in the central part of the Transylvania Basin, in Romania. This is a mature gas field, composed by multi-layered sandstone reservoirs, grouped in six production packages. The permeability of the reservoirs is decreasing with depth, resulting in tight gas formations in the two deepest reservoirs.
One of these tight reservoirs presents a high interest for reserves development in order to accelerate the recovery factor of the field. Compared to the other production packages, which have higher recovery factors (~80%), this package has a current RF of only 65%, with more attractive remaining recoverable gas volumes.
The reservoir model was built based on 3D seismic and old log data. After history matching and simulation, a remaining gas in place map was created, in order to visualize the areas of interest for future drilling or workover operations.
One new infill well was drilled in 2014, in an area with higher remaining gas in place. Special logging and sidewall coring were executed in this well, in order to get a better characterization of the reservoir properties and to build a geomechanical model for hydraulic frac design.
The subject package still has a decent reservoir pressure which keeps an acceptable value of the productivity index of the producer wells. The reservoir pressure recorded after the drilling helped to update the static reservoir pressure in the area; the new points were incorporated in the dynamic model in order to get more control in the pressure history match. New population of static properties such as: porosity, net to gross and permeability have been included in the dynamic model to generate the forecast production profile for the infill well and neighbor wells.

The infill is a dual completion well which means the deeper zone produces through the tubing and the shallower zone through the annulus being separated by a packer. These two zones have two different dynamic models. The production forecasts has been done also based on decline curve analysis DCA, using historical production of the neighbor wells as a reference and the decline rate of the area, in each reservoir. In that order of ideas the infill has two gas production forecasts coming from each methodology, to compare with the real gas production, which allows us evaluating the results in the well.
Based on the new data, the frac stages were defined and simulated in the deeper tight reservoir, in order to select the best target layers. The initial plan was to do multistage frac stimulation, but the idea was discarded after evaluating the operational feasibility. Ten frac stages have been evaluated creating a local refinement grid around the well and designing a fracture simulation scenario. The results pointed out one stage as being the best in terms of cumulative production and it was chosen as the only final target for frac. A PLT log was run in the infill well for the purpose of identifying the risk of water layers and the production contribution of the perforation intervals. This was matched very well with the simulation results.
The results and experience gained from this new well are helping with the further planning of the production development strategy of this production package in order to increase the final recovery factor.

Keywords: *tight gas reservoir, mature field, mechanical Earth model, fracture multistage simulation, fracture LGR model, special logging as formation microimager, pressure express, dipole sonic and PLT*

Tătaru A., Ştefănescu D.P., Balázs S.: **Implementation of project management concept, in depleted gas reservoir exploitation** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

In the past the gas industry focused its interest and major investments mainly on the early life of the reservoir and on the development and constant maintenance of production. But times change and currently for depleted gas reservoirs defined as reservoirs in an advanced stage of decline, energy and production should be considered as potential additional energy sources.
The ideal time to start managing a reservoir is at its discovery, but Romgaz has a new approach regarding project management implemenatation for depleted gas fields.
The strategy presumed, a multidisciplinary team of geophysicists, geologists, reservoir engineers, production engineers and economists.
These multidisciplinary teams evaluated existing information and build up a plan for new data acquisitions, the data was integrated, processed, interpreted and correlated in a study with following objectives:

- Construct 3D geological model to estimate resources.
- Use reservoir engineering to estimate remaining reserves and expected ultimate recovery.
- Use results of the study to identify new development opportunities on the field and forecast production scenarios.

Success for this challenge depended on:

- working as a team;
- openness, flexibility, communication, and coordination;
- persistence.

Keywords: *project management, depleted gas reservoir, multidisciplinary team, team work*

Gonet K., Blicharski J., Rybicki C.: **The analysis of CO_2 injection in depleted gas reservoirs during the sequestration process** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

One of increasingly used methods for reducing carbon dioxide emission to atmosphere is CCS technology (Carbon Capture and Storage). The last element of sequestration technological chain, after capturing and transporting,

is CO_2 storage which is currently considered in: natural environment, oceans and geological structures – of which depleted gas reservoirs have high sequestrating potential mainly by virtue of proven record of geological recognition and high recovery factor, hence, great storage capacity. This paper is connected with first stage of CO_2 storage in depleted gas reservoir i.e. flow of injected fluid inside the well.
Conducted analysis was concerned about CO_2 flow conditions inside the injection well in various stages of CO_2 storage process, and furthermore, relation between reservoir pressure, injection rate, well diameter. Moreover, the thermodynamic conditions and its impact on changeability of PVT parameters and hence phase changes were also investigated.

Keywords: *CO_2 injection, depleted gas reservoirs, sequestration*

Wiśniowski R., Knez D., Hytroś Ł.: **Drillability and Mechanical Specific Energy analysis on the example of drilling in the Pomeranian Basin** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The advancements in drilling have always depended on the cost of drilling of new wellbores, therefore mathematical models of the drilling process were elaborated to minimize the cost. The first simple models based on a few fundamental parameters, were then developed into complex, computer-based models employing many variables.
Models made for cutter bits are used for PDC tools. They contain formulae accounting for drilling parameters and wearing of the bit. The paper addresses works which prove that in some particular situations the influence of the tools wear on the drop of rate of penetration can be neglected, thanks to which simple formulae are obtained, based on the fundamental parameters and which are easily applicable in the field conditions.
The MSE is an amount of energy used for drilling a given volume of rock. This approach is useful and practicable because allows for detecting possible inefficiencies in a relatively short time (as compared to other parameters).
Attempts are made to compare the drillability indications Z_{SP} with MSE plots, thanks to which new conclusions and observations can be drawn as far as the analysis and interpretation of drillability plots is concerned.

Keywords: *drillability, drilling technology, ROP, MSE*

Kulynych V.: **Optimal demulsification method selection on deposit Lubiatów** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

According to world statistics on the oil production about 25–35 % of the volumes are appearing in the form of an emulsion. Oil emulsions cause the great impediment in the operating time as a result of increasing the viscosity even to 200 times towards oil. For a commercial product, it is necessary to prepare oil for processing, which involves the separation of a stable emulsion. In the industry various methods of dividing are applicable, among others: mechanical, chemical, electric. The article describes the types of emulsion, the reasons for its creation. The methods of demulsification of crude oil were characterized, the construction of demulsifiers, and their influence on the processes of exploitation of oil. The aim of the author's laboratory tests was demulsifiers selection to the crude oil produced in the deposit Lubiatów on Polish Lowlands.

Keywords: *emulsion, demulsification, demulsifier*

Nair R.R., Saltveit K.J., Protasova E., Bilstad T.: **Improved oil production by membranes** • AGH Drilling, Oil, Gas 2015 • Vol. 32 • No. 1

The objective of this presentation is to show connections of activities leading to improved oil recovery (IOR) when prospecting for oil and gas. Increased wettability of injected water into the reservoirs is caused by specific

ions. Technical limitations for production of designer water from seawater by membrane separation are highlighted. Desirable characteristics of designer water are low NaCl concentrations and high divalent ion concentrations for improving wettability of Crude Oil, Brine and Rock (CBR). Experimental setup incorporated nanofiltration (NF) membranes for ion separation. Retentate from NF contains the main constituents of Designer Water. A property of NF is to retain divalent ions. Performance of the membranes was evaluated in terms of flux and rejection under varying feed compositions, pressures and recovery rates.
The research comprised a technical-economical study for salt separation. Results were evaluated in terms of desalination efficiencies and energy requirements. A sensitivity test, spiking Na_2SO_4 in the feed seawater, showed a decrease in retention of Cl^- with increasing SO_4^{2-} concentrations. A reduced permeate flux resulted, however, with increasing Na_2SO_4 concentrations.

Keywords: *designer water, NF membranes, IOR, seawater*