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微生物基因检测技术在鄂尔多斯盆地 神府南气田勘探中的应用

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摘要: 针对鄂尔多斯盆地构造复杂, 储层分布差异大, 气藏富集规律不明等问题, 本文采用微生物基因检测技术的荧光定量PCR法测量研究区样品中油气指示基因的丰度, 同时利用高通量基因测序法检测样品中的烃类微生物种群类型, 分析认为, 本区主要有东北部、西部、南部三个烃类异常带, 展布特征与沉积认识吻合, 且西部、南部有亲缘关系, 东北部与二者无亲缘关系, 可能与致密气、煤层气不同层系烃的逸散有关。实钻表明, 本技术对于鄂尔多斯盆地致密气和煤层气混源区的含油气性评价方面具有较好的适用性, 为油气有利区带筛选提供参考依据。

关键词: 鄂尔多斯盆地 黄土塬地貌区 微生物基因检测 荧光定量检测 高通量基因测序

Application of Microbial Gene Detection Technology in Exploration of Shenfu South Gas Field in Ordos Basin

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Abstract: Given the complex structure, large differences in reservoir distribution, and unclear gas reservoir enrichment patterns in the Ordos Basin, this article employs the fluorescence quantitative PCR method of microbial gene detection technology to measure the abundance of oil and gas indicator genes in the samples of the study area. Additionally, high-throughput gene sequencing is used to detect the types of hydrocarbon microbial populations in the samples. Analysis indicates three major hydrocarbon anomaly zones in the northeastern, western, and southern parts of this area. The distribution characteristics are consistent with sedimentary understanding, and there is a close relationship between the western and southern zones. The northeast zone is unrelated to the other two, possibly due to the escape of hydrocarbons from different layers of tight gas and coalbed methane. Actual drilling shows that this technology has good applicability in the evaluation of oil and gas in the mixed-source area of tight gas and coalbed methane in the Ordos Basin, providing a reference for the screening of favorable oil and gas zones.

Keywords: Ordos Basin; Loess Plateau Landform Area; microbial genetic testing; gene fluorescence quantitative detection; high-throughput genome sequencing

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高煤阶煤层气井压降扩展规律研究及应用

——以沁水盆地樊庄区块为例

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摘要: 文章以沁水盆地樊庄区块直井为研究对象, 综合考虑因排采降压差异导致的储层渗透率动态变化这一特征, 通过搭建应力-压缩性-渗透性三者之间的关系, 构建了适用于高煤阶煤储层的气-水流动模型, 同时分别对单相产水阶段、两相采气阶段的压降扩展规律进行了量化分析, 理清了樊庄区块煤层气井压降扩展规律, 从而优化了现场单井排采制度。结果表明: 在采气阶段存在最佳提气速度, 其次确定了影响煤储层压降扩展的6个主控因素, 拟合得到了采气阶段-最佳提气速度预测公式, 为樊庄区块及类似地区煤层气井的排采管控提供了指导依据。

关键词: 沁水盆地 高煤阶煤储层 渗透率变化差异 压降量化指标 最佳提气速度

Research on Pressure Drop Expansion Law and Application of High-Rank Coalbed Methane Wells

—A Case Study of Fanzhuang Block in Qinshui Basin

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Abstract: The paper focuses on the vertical wells in the Fanzhuang Block of Qinshui Basin. By comprehensively considering the dynamic changes in permeability caused by variations in drainage pressure, a gas-water flow model suitable for high-rank coal seams is constructed by establishing the relationship between stress, compressibility, and permeability. Meanwhile, the pressure drop expansion law during both the single-phase water production stage and the two-phase gas-water production stage is quantitatively analyzed, clarifying the pressure drop expansion patterns of the coalbed methane wells in Fanzhuang block, and optimizing the field drainage system for single wells. The results indicate that there is an optimal gas extraction rate during the gas extraction stage. Additionally, six main control factors affecting the pressure drop expansion in coal reservoirs are determined, and a prediction formula for the optimal gas extraction rate during the gas extraction stage is developed, guiding the drainage management and control of coalbed methane wells in Fanzhuang Block and similar areas.

Keywords: Qinshui Basin; high-rank coal reservoir; permeability dynamic variation; quantitative pressure drop indicator; optimal gas extraction rate

煤层气水平井随钻仪器工程方案研究与应用

——以沁水盆地安泽区块为例

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摘要: 文章以沁南安泽区块为例, 对工程地质因素、地质导向参数、防塌钻进等内容进行研究, 从随钻仪器方面助力煤层气安全高效钻井。安泽区块3#煤层具有夹矸层多、煤岩碎裂结构发育等特点, 以工程技术结合地质要求开展导向方案与措施的优化, 制定出适合该区域的随钻仪器作业模板。本文采用近钻头方位伽马地质导向技术进行现场应用, 对A13井实钻作业轨迹进行校正与控制。现场施工顺利, 实际水平煤层段累计进尺882 m, 钻遇率94.89%, 安泽区块随钻仪器作业模板切实可行。

关键词: 煤层气水平井; 近钻头方位伽马; 地质导向; 沁南安泽

Research and Application of Engineering Scheme of Instrument while Drilling in Coalbed Methane Horizontal Wells —A Case Study in Anze Block of Qinshui Basin

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Abstract: This paper takes the Anze Block in Southern Qinshui Basin as an example to study engineering geological factors, geo-steering parameters, anti-collapse drilling, etc. The aim is to enhance the safety and efficiency of coalbed methane drilling through the use of instruments while drilling. The No. 3 coal seam in Anze Block has the characteristics of multiple interlayers with gangue and the development of a coal-rock fragmentation structure. By combining engineering technology with geological requirements, the optimization of guidance plans and measures is carried out, and a suitable instrument while drilling operational template is developed for this area. In this paper, near-bit azimuth gamma geo-steering technology is applied in the field to correct and control the real drilling track of the A13 Well. The on-site construction proceeded smoothly, with a cumulative drilling footage of 882m in the horizontal coal seam section and a drilling rate of 94.89%. This proves that the instrument while drilling the operational template in Anze Block is feasible.

Keywords: Coalbed methane horizontal well; near-bit gamma; geo-steering; Anze in Southern Qinshui Basin

煤层气低压采气管线气、液两相流演化分析

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摘要: 在煤层气田开发的中后期, 为保持抽采速率, 控制递减率, 管网运行压力逐年降低。结合贝克流型分界法进行流型划分并对流型演化的影响因素进行分析, 在煤层气采气管线中两相流发展演化的过程中通常为雾状流、环状流、层状流、波浪流、段塞流依次出现, 影响流型发展的因素包含降温、合并、捕获、叠加、重力作用及特殊管段等。同时因相对流速变化或截流效应, 高持液率的相态也会向低持液率的相态转化。对气液两相流的演化过程进行研究有助于系统分析积液产生的原因并采取科学的治理对策。为提高冬季管线运行效率, 降低煤层气开发的操作成本, 在进一步研究中需要深入分析两相流演化的各类影响因素, 探索采取干预措施, 为管线优化设计提供依据。

关键词: 气液两相流 持液率 截流效应

Analysis of Gas-liquid Two-Phase Flow Evolution in Low-Pressure Coalbed Methane Pipeline

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Abstract: In the mid-to-late stages of coalbed methane field development, to maintain extraction rates and control decline rates, pipeline network operating pressures are gradually reduced each year. Combining Beck's flow pattern boundary method, the flow patterns in coalbed methane production pipelines are categorized and the influencing factors of their evolution are analyzed. In the development and evolution of two-phase flow in coalbed methane pipelines, mist flow, annular flow, laminar flow, wave flow, and slug flow appear successively. Factors affecting pattern development include cooling, merging, capturing, superposition, gravity, and special pipe sections. Additionally, due to changes in relative velocity or the cutoff effect, the phase with high liquid holdup will also transform into the phase with low liquid holdup. Studying the evolution process of gas-liquid two-phase flow helps in systematically analyzing the causes of liquid accumulation and in taking scientific countermeasures. To improve pipeline operating efficiency in winter and reduce coalbed methane development operating costs, further research is necessary to deeply analyze various influencing factors of two-phase flow evolution and explore intervention measures, providing a basis for optimized pipeline design.

Keywords: Gas-liquid two-phase flow; liquid holdup; cutoff effect

管道伸缩补偿器在煤层气长输管道 塌陷区的适用性研究

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摘要: 文章通过分析目前常见补偿器的适用工况和优缺点, 提出了针对跨越塌陷区等复杂地形的管道伸缩补偿器。管道伸缩补偿器能够在煤层气管道所在区域发生地质灾害(如沉降、塌陷导致管道悬空, 洪水冲刷导致飘管等)时为管道提供一定量的伸缩补偿, 以消除或减小因管道变形带来的应力变化。通过以常见的长输管道为例, 计算出使用管道伸缩补偿器前后的最大悬空跨度为和最大的挠度对比情况。计算对比结果表明: 在可能的地质沉降区, 在管道内接入管道伸缩补偿器后, 允许边坡长度可达64m, 且边坡支撑面与管道的距离可达到1.52m, 能够满足实际地质灾害发生时对管道产生形变应力的挠性补偿, 避免管道断裂的发生。

关键词: 塌陷区 煤层气管道 管道伸缩补偿器

Applicability Study of Pipeline Expansion Compensator in Long-distance Pipeline Subsidence Area

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Abstract: In this paper, by analyzing the applicable working conditions and advantages and disadvantages of common compensators at present, the pipeline expansion compensator for crossing complex terrain such as subsidence area is proposed. The pipeline expansion compensator can provide a certain amount of expansion compensation for the pipeline when geological disasters (such as subsidence and collapse of the pipeline caused by hanging, flood erosion caused by floating pipe, etc.) occur in the region of the long-distance pipeline, so as to eliminate or reduce the stress changes caused by pipeline deformation. Taking common long-distance pipelines as an example, the maximum hanging span before and after using the pipeline expansion compensator is calculated and the maximum deflection is compared. The calculation and comparison results show that in the possible geological subsidence area, the allowable slope length can reach 64m and the distance between the slope support surface and the pipeline can reach 1.52m after the pipeline expansion compensator is inserted into the pipeline, which can meet the flexible compensation of deformation stress of the pipeline when the actual geological disaster occurs and avoid the occurrence of pipeline fracture.

Keywords: Subsidence area; coalbed methane pipeline; pipeline expansion compensator

煤层气低温低伤害自悬浮支撑剂 性能评价与现场应用

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摘要: 为了实现煤层气储层高效开发, 需要开展储层改造, 水力压裂则是最重要的改造手段。面对深部煤储层加砂困难易砂堵、支撑缝长较短、改造范围较小等问题, 常规“活性水+石英砂”的砂液组合已无法满足压裂改造需要, 因此从支撑剂角度入手, 提出一种自悬浮压裂液体体系, 以提升压裂改造效果。本文对该体系的悬浮性能、流变性能、破胶性能、压裂液破胶液残渣含量、岩心伤害情况开展室内实验评价, 结合裂缝导流能力模拟、裂缝监测结果和实际产气量验证了自悬浮支撑剂与石英砂的组合加砂模式可以提高压裂改造效果, 大幅提升煤层气井的产气量, 可进一步应用于现场。

关键词: 煤层气 水力压裂 自悬浮支撑剂 性能评价

Performance Evaluation and Field Application of Low-Temperature, Low-Damage and Self-Suspending Proppant for Coalbed Methane

LIU Yuhan, WANG Xuan, ZHANG Yang, HAN Mingzhe, MA Wenfeng, ZHANG Guangbo
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Abstract: To achieve efficient development of coalbed methane reservoirs, reservoir reconstruction is necessary, with hydraulic fracturing being the most crucial method. Due to issues such as difficult sand addition, easy sand plugging, short support joint length, and limited reconstruction range, the conventional sand liquid combination of “active water + quartz sand” can no longer meet the needs of fracturing reconstruction. Therefore, a self-suspending fracturing liquid system is proposed from the perspective of proppant to improve the effectiveness of fracturing reconstruction. In this paper, laboratory experiments are carried out to evaluate the suspension performance, rheology performance, glue-breaking performance, fracture fluid residue content and core damage of the system. Combined with fracture conductivity simulation, fracture monitoring results and actual gas production, it is verified that the sand addition mode with a combination of self-suspending proppant and quartz sand could improve the fracturing effects and significantly increase gas production of coalbed methane wells. This approach can be further applied in field operations.

Keywords: Coalbed methane; hydraulic fracturing; self-suspending proppant; performance evaluation

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提高煤层气直井动液面解释 精度方法研究与应用

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摘要: 煤层气井动液面解释精度对于煤层气井精细化排采管控至关重要, 本文对比了接箍法、音标法及声速法等测液面方法的优缺点, 分析了影响动液面解释精度的主控因素为井筒温度和气泡段, 从而提出了一种提高动液面解释精度的新方法。此方法综合考虑了影响动液面解释精度的各个要素, 能够依据所解释液面较为准确地反映煤层气井的井底流压, 克服了前期其它方法所存在的一系列问题, 为煤层气井精细化排采管控提供保障。

关键词: 煤层气直井 动液面 声速 解释精度

Research and Application of Improving the Interpretation Accuracy of Coalbed Methane Vertical Well Dynamic Fluid Levels

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Abstract: The interpretation accuracy of dynamic fluid levels in coalbed methane wells is crucial for the precise drainage management of coalbed methane wells. The paper compares the advantages and disadvantages of the coupling method, phonographic method, and sound velocity method for measuring liquid level. The main factors influencing the interpretation accuracy of dynamic fluid levels are wellbore temperature and bubble cross-sectional area. A new method is proposed to improve the interpretation accuracy of dynamic fluid levels, which comprehensively considers various factors affecting the interpretation accuracy. This method can reflect the bottom-hole flow pressure of coalbed methane wells more accurately according to the interpreted fluid levels, addressing a series of issues present in previous methods. This provides a guarantee for the precise drainage and production management of coalbed methane wells.

Keywords: Coalbed methane vertical well; dynamic fluid level; sound velocity; interpretation accuracy

延川南有效支撑压裂煤层气井 出砂治理对策研究

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摘要: 随着延川南煤层气田开发方式的转变, 特别是以“大排量、大液量、大砂量”为核心的有效支撑压裂工艺及配套快速排液制度的形成, 煤层气井在排采过程中的出现了较为严重的出砂问题。为了解决出砂问题, 对出砂原因进行了分析, 从地层、井筒两方面开展了出砂治理对策研究, 形成了纤维防砂、抽油泵分级排液、水力射流泵排液三种防砂工艺并进行了现场试验, 结果表明, 三种防砂工艺初步解决了有效支撑压裂煤层气井的出砂问题。

关键词: 开发方式 出砂原因 防砂工艺 现场试验

Sand Production Countermeasures of Coalbed Methane Wells Using Effective Support Fracturing in South Yanchuan Gas Field

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Abstract: As development technologies change in South Yanchuan Gas Field, particularly with the introduction of effective support fracturing technology characterized by large displacement, large liquid volume and large sand volume, coupled with the high-efficiency drainage system. This paper analyzes the causes of sand production. It studies the countermeasures for sand control from both the formation and wellbore perspectives and introduces three sand control technologies, including fiber fracturing sand control technology, oil pump dynamic adjustment sand control technology and hydraulic jet pump sand control technology. Field experiments show that these three technologies effectively addressed the sand production problem in coalbed methane wells using effective support fracturing.

Keywords: Development technologies; causes of sand production; sand control technology; field experiments

1 区块概况

延川南煤层气田是国内最早投入商业开发的深部煤层气田, 构造上处于鄂尔多斯盆地东南缘, 晋

西挠褶带、渭北隆起和陕北斜坡过渡地区, 主力开发层系山西组2号煤、接替层系太原组10号煤, 2、10号煤层间距40~50m, 埋深640~1600m, 断层同时断开两套煤层, 产状基本一致, 对煤层气保

煤层气井不停产洗泵技术在贵州地区的应用及改进

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摘要: 文章通过对近9年煤层气井不停产洗泵技术在贵州地区的应用及理论和实践改进的研究, 总结分析了在贵州地区77口煤层气直井或定向斜井运用煤层气井不停产洗泵技术289次的情况, 其很好的解决了粉末状固相物质导致的泵故障问题, 大幅降低了检泵频率, 将检泵周期极大延长, 很好的保证了煤层气井排采的连续性和稳定性, 避免了粉末状固相物质导致检泵给井产生的产气下降等伤害, 同时节约了大量生产成本, 多维度提高了煤层气勘探开发效益。

关键词: 煤层气井不停产洗泵技术 清理 粉末状固相物质 延长 检泵周期

Application and Improvement of Non-stop Pump Cleaning Technology for Coalbed Methane Wells in Guizhou

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Abstract: Based on the application of non-stop pump cleaning technology in coalbed methane wells in Guizhou over the past nine years as well as the research on theoretical and practical improvements, this paper summarizes and analyzes the situation in which the non-stop pump cleaning technology applied for 289 times across 77 vertical or directional coalbed wells in Guizhou. This technology effectively solves the pump failure issues caused by powdered solid substances and significantly reduces the frequency of pump inspections and greatly extends the inspection cycles, ensuring the continuity and stability of coalbed methane well drainage. This approach prevents the decline in gas production caused by pump inspections due to powdered solid substances, saves substantial production costs, and improves the efficiency of coalbed methane exploration and development from multiple dimensions.

Keywords: Non-stop pump cleaning technology for coalbed methane wells; cleaning; powdered solid substances; extension; pump inspection cycle

利用煤矿瓦斯通过旋转式蓄热氧化装置 在煤炭生产过程中应用

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摘要: 煤泥是煤矿开采生产过程中排出的煤粉, 其形成是在选煤厂洗选加工过程中的副产品, 其特点容易结块影响运输, 且对空气污染有一定的危害。利用旋转式蓄热氧化装置通过对煤矿瓦斯抽采泵站中的低浓度瓦斯的利用, 与乏风或空气掺混后产生高温烟气, 通过热风换热装置进行煤泥烘干, 处理后的煤泥水分含量可以从25%~28%降到12%左右, 对煤矿瓦斯利用和煤矿生产具有客观的积极意义, 同时提高了能源的综合利用。

关键词: 低浓度风排瓦斯 旋转式蓄热氧化 智能掺混

Application of Coal Mine Methane in Coal Production Process Through a Rotary Regenerative Oxidation Device

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Abstract: Coal slime is pulverized coal discharged in the process of coal mining, and its formation is a by-product in the washing and processing process of coal preparation plants. It is easy to agglomerate affecting transportation, and has certain harm to air pollution. The rotary regenerative oxidation device utilizes low-concentration gas from the coal mine methane drainage pumping station, which is mixed with ventilation air methane (VAM) or air to produce high-temperature flue gas. This high-temperature gas is then used to dry the slime through a hot air heat exchange device. The moisture content of the treated slime can be reduced from 25%~28% to about 12%. This process has objective positive significance for the utilization of coal mine methane and the production of coal mines, and it also improves the comprehensive utilization of energy.

Keywords: Low-concentration ventilation air methane; rotary regenerative oxidation; intelligent mixing

1 低浓度煤矿风排瓦斯利用技术

1.1 低浓度旋转式蓄热氧化技术简介

将煤矿抽采泵站抽采浓度为0.25%~1.2%的

低浓度瓦斯进行利用, 把煤矿的低浓度瓦斯和乏风中排放的超低浓度甲烷混合后进行高效蓄热氧化燃烧, 产生的高温余热用于煤矿以及周边的冬季供暖、制冷和发电, 可替代煤矿原有的产能装置, 如