

CHINA COALBED METHANE

(Bimonthly)

Vol.21 No.6 December. 2024

6

2024

主管单位：国家矿山安全监察局

主办单位：煤炭信息研究院

中联煤层气有限责任公司

编辑出版：《中国煤层气》编辑部

主 编：郑景奇

副 主 编：刘文革 张迎春

印 刷：北京华联印刷有限公司

定 价：18 元

发 行：《中国煤层气》编辑部

(100029 北京市朝阳区

芍药居 35 号)

国际标准连续出版物号：ISSN 1672-3074

国内统一连续出版物号：CN 11-5011/TD

广告发布登记：京朝市监广登字 20190010 号

电 话：(010) 84657948 (投稿)

(010) 84657905 (征订)

传 真：(010) 84657941

http: //www. iiem. ac. cn

Email: cbmc@ iiem. ac. cn

中国煤层气

ZHONGGUO MEICENGQI

2004 年创刊 (双月刊)

第 21 卷第 6 期 2024 年 12 月

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晋城矿区采空区地面井井身结构 优化分析及工程应用

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摘要: 实际生产中发现井身结构的稳定性对采空井抽采及后期增产改造等工艺环节至关重要, 针对晋城矿区采空井二开段容易钻遇裂隙带及割缝套管容易倾斜等实际问题, 提出了二开段终孔位置的计算方法; 提出了一种悬挂式井身结构优化设计及施工工艺, 现场实践表明优化后的井身结构不仅保证了井身结构的稳定性, 而且大幅度降低了后期通洗井等增产改造修井作业难度, 修井前试验 1 井相比试验 2 井平均日产气量增加约 6%; 修井后平均日产气量增加约 44%。

关键词: 晋城矿区 采空区地面井 终孔位置计算 悬挂式井身结构

Optimization Analysis and Engineering Application of Wellbore Structure for Surface Wells in Goaf Areas of Jincheng Mining Area

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Abstract: Field production reveals that the stability of the wellbore structure is very important to the process of gas drainage and later stimulation for goaf wells. To address practical issues such as frequent encountering fracture zones during the second borehole section and inclination in the slotted casings of the goaf wells in Jincheng Mining Area, an accurate calculation method for the final hole position of the second borehole section is proposed. Additionally, an optimized design of hanging-type wellbore structure and construction technology is proposed. Field practice shows that the optimized wellbore structure not only ensures the stability of the well structure but also significantly reduces the difficulty of subsequent well workover operations for production enhancement, such as well opening and hydraulic punching. Compared to the No. 2 Test Well, the average daily gas production of the No. 1 Test Well increased by about 6% before well workover, and by about 44% after well workover.

Keywords: Jincheng Mining area; surface wells in goaf areas; final hole position calculation; hanging-type wellbore structure

基金项目 山西省重点研发计划项目 (202202080301010); 山西省揭榜招标项目 (20201101001);
山西省科技重大专项项目 (20201102001)

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不同压裂规模对煤层气井产气量影响研究

——以韩城矿区某井田为例

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摘要: 煤层气储存环境复杂, 大多需要通过先钻井后压裂的方式对储层结构进行改造后抽放, 目前国内所采用的压裂工艺以水力喷砂射孔压裂为主。文章以韩城矿区某井田为例, 使用灰色理论关联分析方法进行各个地质-工程等参数与产量的关联度计算, 并对计算结果进行排序, 明确影响煤层气井产量的主控因素。对比分析不同压裂规模对煤层气井的造缝能力、裂缝支撑效果及气井产量影响情况。结果表明: 贯穿砂岩沟通煤层增采煤层气, 必须以井间裂缝沟通、段间裂缝覆盖、层间裂缝贯穿为原则, 优化设计液量、加砂强度, 从而达到经济合理增采煤层气的目的。

关键词: 煤层气 灰色关联 压裂规模 多段控砂压裂

Impact of Fracturing Scales on Gas Production in Coalbed Methane Wells —A Case Study from a Wellfield in Hancheng Mine Area

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Abstract: The storage environment of coalbed methane is complex, requiring reservoir structure modification through drilling followed by hydraulic fracturing before gas extraction. The current domestic hydraulic fracturing technology mainly uses water jet sandblasting fracturing. Taking the example of a wellfield in Hancheng Mining Area, this paper employs the grey relational analysis method to calculate the correlation between various geological engineering parameters and gas production. The calculated results are ranked to identify the main controlling factors influencing the production of coalbed methane wells. Furthermore, the paper compares and analyzes the impact of different fracturing scales on fracture generation capacity, fracture support effect, and production of coalbed methane wells. The results show that enhancing coalbed methane production by connecting sandstone beds with the coal seams should follow principles of inter-well fracture communication, intra-segment fracture coverage, and inter-layer fracture penetration. Optimizing fracturing fluid volume and sand injection intensity can achieve the goal of economically and reasonably improving coalbed methane production.

Keywords: Coalbed methane; grey relational analysis; fracturing scale; multi-stage sand control fracturing

煤层气井动压调节技术应用性研究

——以沁水盆地南部 PH 区煤层气井为例

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摘要: 以沁水盆地南部 PH 区块为例, 基于平面径向渗流理论、煤层气解吸吸附理论以及压降叠加原理, 建立了煤储层压力与采收率变化率耦合关系, 同时跟踪 36 井次动压调节技术的现场应用, 开展该技术的气藏及生产特征匹配性分析。研究表明: 在煤层气井产量上升期需充分排水, 尽量扩大单井压降漏斗半径, 可作为获取单井更高累产的基础; 在煤层气井产量递减期应用此技术, 可正向促进排水采气, 目前应用在递减期 36 口井的平均增产率达 125%。

关键词: 动压调节 提产稳产 采收率

Application Research of Dynamic Pressure Regulation Technology in Coalbed Methane Wells

—A Case Study of Coalbed Methane Wells in PH Block of Southern Qinshui Basin

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Abstract: Taking PH Block in southern Qinshui Basin as an example, based on the theories of plane radial seepage and coalbed methane desorption and adsorption, and the principle of pressure drop superposition, the coupling relationship between coal reservoir pressure and recovery rate change is established. Meanwhile, the field application of dynamic pressure regulation technology in 36 wells is tracked, and the matching analysis of the gas reservoir and production characteristics of this technology is carried out. The results show that it is necessary to fully drain the water during the production rising-up period of the coalbed methane well and maximize the radius of the single well pressure drop, which can be the basis for achieving a higher cumulative production of a single well. However, the application of the technology in the production decline period of coalbed methane wells can positively promote water drainage and gas production. At present, the average production increase rate of the 36 Wells applied in the decline period is 125%.

Keywords: Dynamic pressure regulation; production increase and stabilization; recovery rate

基金项目 中国海洋石油集团有限公司重大科研专项“煤层气增储上产技术研究”(CNOOC-KJ135ZDXM40ZL01)。

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梧桐窝子煤矿区煤层气地质特征及 成藏控气因素分析

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摘要: 为了揭示梧桐窝子煤矿区煤层气控气影响因素, 以研究区参数井的实验数据为基础, 通过煤岩组分、煤层含气性、煤层孔渗特征、储层温压特征、水文特征等分析, 开展了梧桐窝子煤矿区煤层气控气因素特征分析。结果表明: 含气性总体具有“低含气量、低含气饱和度、甲烷组分低、兰氏体积高、兰氏压力低”的特征; 储层低孔低渗, 气藏处于欠压状态; 煤层气地质特征的综合对比, 认为煤层气成藏主要受构造、沉积、水文三要素的影响。

关键词: 梧桐窝子煤矿区 煤层气 地质特征 控气因素

Geological Characteristics and Gas Controlling Factors of Coalbed Methane in Wutongwozi Coal Mining Area

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Abstract: To reveal the controlling factors influencing coalbed methane accumulation in the Wutongwozi Coal Mining Area, the study analyzes the gas control factors in the Wutongwozi Coal Mine area through the analysis of the coal rock composition, coal seam gas content, coal seam pore-permeability characteristics, reservoir temperature-pressure conditions, and hydrogeological features based on the experimental data from parameter wells in the research area. The results show that the overall gas content has the following characteristics: low gas content, low gas saturation, low methane composition, high Langmuir volume, and low Langmuir pressure. The reservoir is characterized by low porosity and low permeability, and the gas reservoir remains under pressure state. A comprehensive comparison of the coalbed methane geological features suggests that the coalbed methane reservoir is mainly influenced by three dominant factors including structure, sedimentation, and hydrogeology.

Keywords: Wutongwozi Coal Mining Area; coalbed methane; geological characteristics; gas controlling factors

1 概况

梧桐窝子煤矿区 (以下简称研究区) 位于淮

噶尔盆地东南 (图 1), 区内地势南东高北西低, 构造相对简单, 总体呈“两凹一隆”样式; 地层分层界限明显, 仅石树沟群组地层厚度变化较大、

郑庄区块水平井产气产水特征分析及 提产技术对策研究

张 玮

(中石油华北油田山西煤层气勘探开发分公司, 山西 048000)

摘要: 沁水煤层气田郑庄区块由于储层体制条件的多样性, L型水平井存在排采管控模式与复杂的产气产水不匹配的特征。本文分析了不同研究区的产气产水特征, 并且针对低产原因展开分析及治理对策研究。研究表明, 通过不同区块制定差异化排采管控模式、排采工艺设备适应性分析调整、出砂严重单井通过氮气洗井等措施可有效提高 L型水平井排采时率、保障产量运行平稳。

关键词: 煤层气 L型水平井 特征 措施

Analysis of Gas and Water Production Characteristics and Research on Production Enhancement Technical Measures for Horizontal Wells in Zhengzhuang Block

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(Shanxi Coalbed Methane Exploration and Development Branch, PetroChina Huabei
Oilfield Company, Shanxi 048000)

Abstract: Due to the diverse reservoir system conditions in the Zhengzhuang Block of the Qinshui Coalbed Field, L-shaped horizontal wells exhibit a mismatch between the drainage management mode and the complex gas and water production. This paper analyzes gas and water production characteristics in different study areas, investigates the causes of low production, and proposes corresponding countermeasures. The research findings demonstrate that by developing differentiated drainage and production management modes for different blocks, analyzing and adjusting the adaptability of production process equipment, and applying measures such as nitrogen well flushing for individual wells with severe sand production, the drainage rate of L-shaped horizontal wells can be effectively improved, ensuring smooth production.

Keywords: Coalbed methane; L-shaped horizontal well; characteristics; measures

乌鲁木齐河东矿区煤层气潜力 煤层含气性分析

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3. 中国矿业大学煤矿瓦斯与火灾防治教育部重点实验室, 江苏 221116)

摘要: 乌鲁木齐河东矿区地处准噶尔盆地南缘, 是新疆地区煤层气勘探开发工作比较成熟的区块。但是, 由于构造情况复杂、煤体结构变化大、煤层多等客观情况, 造成对煤层气潜力煤层的含气性认识不明确, 影响煤层气规模性勘探开发。基于研究区的煤层气藏赋存特征, 对主要煤层的含气规律进行探索, 以期助力该区煤层气工作的高效开展。

关键词: 乌鲁木齐河东矿区 潜力煤层 煤层气 含气规律

Gas Content Analysis of Potential Coalbed Methane Seams in Hedong Mining Area of Urumqi

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Abstract: The Hedong Mining Area of Urumqi, located on the southern edge of the Junggar Basin, represents a relatively well-developed zone for coalbed methane exploration and exploitation within Xinjiang. However, due to the complex structural conditions, significant variations in coal body structure, and the presence of multiple coal seams, the understanding of gas-bearing properties in potential coalbed methane seams remains unclear, which hinders the large-scale exploration and development of coalbed methane. Based on the characteristics of coalbed methane reservoirs in the study area, this research investigates the gas-bearing patterns of primary coal seams, aiming to facilitate the efficient development of coalbed methane in the region.

Keywords: Hedong Mining Area of Urumqi; potential coal seams; coalbed methane; gas-bearing patterns

沁南煤层气 Z 区块水平井低产原因分析

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摘要: 沁水盆地煤层气资源丰富, 具备工业开发的價值, Z 区块 15 煤水平井主要采取水平井开发的方式, 文章以 Z 区块低产水平井为例, 深入分析了区块内水平井开发效果存在的差异性, 从该区块的地质条件、工程施工、排采控制等方面开展了产量主控因素原因分析, 研究表明, 储层渗透率是影响 Z 区块多数井低产的主控因素, 钻井压裂及排采因素是影响少部分井低产的主要原因。

关键词: 水平井 低产原因 排水采气 煤层气渗透率

Analysis of Low Production Causes in Horizontal Wells of Z Block in Southern Qinshui Coalbed Methane Field

ZHANG Wei

(China United Coalbed Methane Co., Ltd., Shanxi 030000)

Abstract: Qinshui Basin has abundant coalbed methane resources with industrial development value. The horizontal wells of No. 15 coal seam in Z Block are primarily developed using horizontal well technology. Taking the low-production horizontal wells in Z Block as an example, this article conducts an in-depth analysis of the differences in development performance among horizontal wells in the Block. It examines the key production-controlling factors from geological conditions, engineering operations, and drainage control perspectives. The results indicate that reservoir permeability is the primary factor affecting the low production of most wells in Z Block, while drilling and fracturing, and drainage factors are the main reasons for the low production of a smaller number of wells.

Keywords: Horizontal well; low production causes; water drainage and gas production; coalbed methane permeability

1 工程因素

本区 15 号煤顶板发育 K₂ 石灰岩含水层, 在钻井的过程中多口井出现漏失, 高产液层层间干扰严重, 造成后续排采阶段产水量增多, 流压降幅

缓慢, 煤层气解吸受限, 甚至部分井出现只产水不产气的现象。因此, 高产液水平井产水量大, 煤层气解吸范围有限是造成部分井低产的主要原因。

复杂山地通信技术在煤层气井站的研究与应用

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摘要: 山西煤层气生产井站数量多分布广, 人工采集数据工作量繁重, 网络覆盖范围受限, 生产管理难度大。根据目前生产实际需求以及调研数据, 开展对新一代无线网络传输技术 TD-LTE 通信技术的研究和工程实施, 大规模网络升级, 基于 LTE 系统完善的安全体系架构, 大带宽, 低时延, 覆盖面积广的技术特点构建一套适配煤层气特点的无线通信系统。从而提升煤层气井站通信覆盖率、传输速率、通信稳定性及通信系统的安全性, 满足覆盖区域内生产数据采集、控制指令下达、监控视频等业务需求。

关键词: 煤层气 TD-LTE 气井 数据采集 远程监控

Research and Application of Communication Technology in Complex Mountainous Areas for Coalbed Methane Well Stations

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Abstract: Coalbed methane stations in Shanxi Province are characterized by large quantities and wide geographical distribution. Manual data collection involves heavy workloads, and complex terrain and limited network coverage increase the difficulty of production management. According to the current actual production needs and survey data, the paper carries out research on TD-LTE communication technology, a next-generation wireless network transmission technology, and its engineering implementation. A large-scale network upgrade is implemented, leveraging the LTE system's robust security architecture, high bandwidth, low latency, and extensive coverage capabilities to establish a tailored wireless communication system for coalbed methane production. The proposed system enhances communication coverage, transmission rate, communication stability and security of the communication system of coalbed methane well stations, which can meet the business requirements of production data collection, control command delivery, and video surveillance within the covered area.

Keywords: Coalbed methane; TD-LTE; gas well; data collection; remote monitoring

矿井瓦斯梯级利用关键挑战与解决策略研究

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摘要: 在总结现有梯级利用技术和应用效果的基础上, 文章通过调研总结近年来山西省矿井瓦斯气梯级利用项目经验, 针对矿井瓦斯气领域存在技术应用、经济效益以及政策及标准执行等面临的关键挑战与风险提出解决策略, 旨在优化瓦斯气的综合利用, 提高资源的利用效率, 为矿井瓦斯气管理提供科学决策依据。

关键词: 矿井瓦斯气 梯级利用技术 关键挑战 解决策略 资源效率 决策依据

Research on Key Challenges and Solution Strategies for Cascaded Utilization of Coal Mine Methane

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Abstract: Based on summarizing the existing cascade utilization technology and application effect, this paper summarizes the coal mine methane cascade utilization projects in Shanxi Province in recent years through investigation and summary, the paper put forward solutions to address the key challenges and risks faced in the field of coal mine gas, such as technology application, economic benefits, and policies and standards implementation, etc. These strategies aim to optimize the comprehensive utilization of coal mine methane, improve the utilization efficiency of resources, and provide a scientific decision-making basis for coal mine methane management.

Keywords: Coal mine methane; cascade utilization technology; key challenges; solution strategy; resource efficiency; decision-making basis

1 关键问题和创新突破

近年来, 山西重点煤矿区包括晋城、西山、汾西、潞安等矿区, 积极投产研发煤矿瓦斯梯级利用示范项目, 瓦斯利用率稳步提升, 利用技术不断成熟。表 1 所列矿井瓦斯气梯级利用项目, 代表山西省在变压吸附提纯、燃烧发电、直燃、蓄热氧化等

不同原理技术开展了甲烷体积分数 0.3% 以上矿井瓦斯的“全浓度”范围梯级利用工程示范, 其中神堂嘴煤层气项目在瓦斯气提纯方面具有代表性, 屯兰瓦斯发电和芦家峪瓦斯发电代表瓦斯气内燃机燃烧发电的成熟技术, 阜生煤业矿井则实现对爆炸浓度范围瓦斯气直接燃烧应用。重点从工艺技术、项目建设、经济指标等方面进行分析总结, 分析对

外置旋转阀的 RTO 在潞安集团古城煤矿 瓦斯利用项目上的应用

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摘要: 旋转阀式 RTO 的应用是潞安集团古城煤矿瓦斯利用项目的一个重要的技术特点, 对比早期类似项目使用的两床式 RTO 的气体分配阀采用提升阀, 存在故障率、泄漏率高的问题。为了解决旋转阀式 RTO 在潞安集团古城煤矿瓦斯利用项目的应用, 克服以上问题, 本公司设计和制造了大量外置式旋转阀, 经过实际的安装调试和一段时间的运行来看, 实际效果达到了预期目的。

关键词: 旋转阀式 RTO 古城煤矿瓦斯利用项目 外置式旋转阀

Application of RTO with External Mounted Rotary Valve in Coal Mine Methane Utilization Project at Gucheng Coal Mine of Lu'an Group

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Abstract: The application of the rotary valve regenerative thermal oxidizer (RTO) is an important technical feature of the coal mine methane utilization project at Gucheng Coal Mine of Lu'an Group. Compared with the coal mine methane distribution valve of the two-bed RTO used in similar projects in the early days, which adopts a lift valve, there are problems of high failure rate and leakage rate. To solve the application of rotary valve RTO in the coal mine methane utilization project at Gucheng Coal Mine of Lu'an Group and overcome the above issues, a large air volume external rotary valve is designed and manufactured. After actual installation, commissioning, and a period of operation, the practice confirms that the system achieved the expected goal.

Keywords: Rotary valve RTO; coal mine methane utilization project at Gucheng Coal Mine; external rotary valve

1 潞安集团古城煤矿瓦斯氧化发电项目

1.1 旋转阀式蓄热氧化装置工艺原理

瓦斯氧化发电将瓦斯浓度在 0.1% ~ 0.3% 的乏风或者空气与浓度 8% 以下的低浓度瓦斯安全采

集运输后进行掺混, 形成 1.0% ~ 1.2% 浓度的掺混气由设备主风机推进旋转式蓄热氧化装置进口风管道, 掺混气经由旋转阀进入蓄热氧化装置的蓄热室, 在蓄热室中进行无火焰氧化, 蓄热室中的高温气体会分为两部分, 一部分经旋转式蓄热氧化炉中