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煤炭甲烷自愿减排项目方法学研究

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摘要: 煤矿瓦斯既是煤矿安全生产的最大危害之一, 也是我国最主要的人为甲烷排放源之一, 具有增温潜势高的特点。推进煤矿瓦斯利用可以避免甲烷直接排放, 具有保障煤矿安全生产、增加清洁能源供应、控制和减少温室气体排放等方面的多重效益。煤炭甲烷自愿减排方法学是全国温室气体自愿减排交易市场在甲烷领域、也是煤炭行业第一个CCER方法学。本文阐述了煤炭甲烷自愿减排方法学制订背景, 分析了煤炭甲烷自愿减排方法学项目边界、计算方法、监测监管等研究内容, 并阐述了煤炭甲烷控排的机遇。

关键词: 低浓度瓦斯 风排瓦斯 甲烷减排 方法学

Research on CCER Methodology for Coal Mine Methane Project

LIU Wenge, HAN Jiaye, ZHAO Yingchun, WU Zhilei, WANG Hongbo

(Information Institute of the Ministry of Emergency Management, Beijing 100029)

Abstract: Coal mine methane is not only one of the biggest hazards threaten to safety production in coal mine, but also one of the main source of anthropogenic methane emission in China, of which global warming potential is high. It could be realized by promoting coal mine methane utilization to avoid methane emission directly, ensure coal mine safety production, increase clean energy supply, control and reduce greenhouse gas emission. The CCER methodology for coal mine methane project is the first CCER methodology of the carbon trading market in the field of methane and coal industry. This paper describes the background of the formulation, analyzed the project boundaries, calculation methods, monitoring and supervision of CCER methodology for coal mine methane project, and expounds the opportunities of coal methane emission control and reduction.

Keywords: Low concentration coal mine methane; ventilation air methane; methane emission reduction; methodology

1 煤炭甲烷减排的意义

煤炭甲烷的排放主要来自煤炭开采过程、矿后活动和废弃煤矿排放。煤矿地下开采过程中的甲烷排放是我国煤炭甲烷最主要的排放来源。煤矿瓦斯

的主要成分是甲烷, 是一种清洁能源, 煤矿瓦斯抽采量近年来保持130亿 m^3 左右, 利用量50亿 m^3 左右; 煤炭甲烷有效利用有利于保障煤矿安全生产, 煤矿百万吨死亡率由2010年的0.798, 降至2022年的0.044(图1), 作为温室气体, 其百年

基于提高煤层气处理中心场站 运行效率降低能耗的研究

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2. 中国石油华北油田公司数智技术公司, 河北 062552)

摘要: 随着能源需求的不断增长和环保意识的日益提高, 节能降耗成为工业领域的重要关注点。本文针对山西煤层气处理中心能耗高的问题, 深入探讨了高能耗问题的原因和节能降耗的途径。通过对流程运行的剖析以及节能技术的研究, 阐述了一系列可行的节能措施, 旨在为提高煤层气场站运行效率和实现可持续发展提供有益的参考。

关键词: 煤层气 场站 压缩机 能耗 优化措施

Research on Enhancing Operational Efficiency and Reducing Energy Consumption in Coalbed Methane Processing Center

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(1. Shanxi Coalbed Methane Exploration and Development Branch, PetroChina Huabei Oilfield Company, Shanxi 048200; 2. Digital Intelligence Technology Company, PetroChina Huabei Oilfield Company, Hebei 062552)

Abstract: With the continuous growth in energy demands and increasing environmental awareness, energy conservation and consumption reduction have become focusing in the industrial sector. This paper addresses the issue of high energy consumption at the Shanxi Coalbed Methane Processing Center by analyzing the causes of excessive energy use and exploring energy-saving approaches. Through detailed analysis of operational processes and investigation of energy-saving technologies, it proposes a series of feasible optimization measures, aiming to enhance the operational efficiency at coalbed methane processing stations and support sustainable development.

Keywords: Coalbed methane; processing station; compressor; energy consumption; optimization measures

在当前的能源发展形势下, 山西煤层气勘探开发分公司处理中心面临着较为严峻的能耗现状。“十四五”期间, 公司产量快速上升, 这本应是令

人欣喜的发展成果, 但与之相伴的是机组耗电量的逐年攀升。在各项用电设备中, 压缩机的用电占比竟然高达93%。这意味着, 压缩机的能耗问题已

基于事故树分析法对煤矿瓦斯 爆炸事故的定性定量分析

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摘要: 本文运用事故树分析法, 针对煤矿瓦斯爆炸事故展开了定性定量分析。构建了煤矿瓦斯爆炸事故树模型, 通过对各基本事件、中间事件的梳理与逻辑关联设定, 深入剖析事故发生的潜在原因链条。在定性分析中, 确定了各基本事件的结构重要度排序, 明晰关键影响因素; 于定量分析时, 结合相关概率数据进一步探讨顶上事件发生的概率情况, 以及各基本事件对整体事故概率的贡献程度。研究成果可为煤矿瓦斯爆炸事故的防控提供科学、有效的参考依据, 助力提升矿井安全生产水平。

关键词: 事故树分析法 定性分析 定量分析

Qualitative and Quantitative Analysis of Gas Explosion Accidents Based on FTA

WANG Qingguo

(Hongyang No. 3 Coal Mine, Shenyang Jiaomei Industry Group Co., Ltd., Liaoning 111300)

Abstract: This paper conducts qualitative and quantitative analyses of gas explosion accidents in coal mine corresponding by using the Fault Tree Analysis (FTA) method. A corresponding Fault Tree model is developed, to sort out the basic events and intermediate events as well as setting their logical correlations, and further analyze the potential causal chains of accident occurrence. In the qualitative analysis, the structural importance ranking of each basic event is determined to clarify the key influencing factors. During the quantitative analysis, combined with relevant probability data, the probability of the top event occurring and the contribution degree of each basic event to the overall accident probability are further explored. The research results can provide scientific and effective reference bases for the prevention and control of gas explosion accidents in coal mine and help to improve the work safety level in coal mines.

Keywords: Fault tree analysis (FTA); coal; qualitative analysis; quantitative analysis

1 事故树分析法概述

1.1 事故树分析方法概述

事故树分析 (Fault Tree Analysis, FTA) 是用

逻辑分析和演绎推理来梳理事故的发生是因果脉络。通过这种方式, 它能够深度揭示事故的潜在原因, 帮助人们挖掘那些隐藏在表面之下、可能引发事故的因素。

煤层气开采中压裂改造技术对比分析研究

韩勇

(山西潞安金源煤层气开发有限责任公司, 山西 046200)

摘要: 煤层气的高效开发对于优化能源结构、提升能源利用效率具有重要意义。然而, 由于煤岩孔隙度小、渗透率低的特点, 煤层气开采面临较大挑战, 压裂改造技术成为提升煤层渗透性和气体流动性的关键手段。本文以沁水煤田某区块为研究对象, 通过对比分析“氮气伴注+石英砂+木质砂”和“氮气泡沫+石英砂”两种不同的压裂方式, 研究其对煤层气排采效果的影响。研究表明, 两种压裂方式的产气能力相近, 但“氮气泡沫+石英砂”压裂方式的产水能力更强, 且具有较高的投入产出比。

关键词: 煤层气开采 压裂改造 临界解析 产气能力 产水能力

Comparative Analysis of Fracturing Technologies in Coalbed Methane Extraction

HAN Yong

(Shanxi Lu'an Jinyuan Coalbed Methane Development Corporation Limited, Shanxi 046200)

Abstract: Efficient development of coalbed methane plays a crucial role in optimizing the energy structure and improving energy utilization efficiency. However, due to the low porosity and permeability of coal formations, coalbed methane extraction faces significant challenges, making fracturing technology a key method for enhancing permeability and gas flow. This study examines a specific block in the Qinshui Basin and compares two different fracturing methods: nitrogen-assisted injection with quartz sand and wood sand, and nitrogen foam with quartz sand, analyzing their impact on coalbed methane drainage and production performance. The results indicate that both fracturing methods have similar gas production capacities, but the nitrogen foam with quartz sand technique demonstrates a higher water production capacity and a more favorable input-output ratio.

Keywords: Coalbed methane extraction; fracturing modification; critical desorption; gas production capacity; water production capacity

1 目标煤层概况

目标煤层所处的大地构造位置为华北断块区吕

梁—太行断块沁水块拗东部次级构造单元沾尚—武乡—阳城的NNE向凹褶带中段, 晋获断裂带西侧, 主体部分叠加长治新裂隙。井田位于长治新裂隙的

鄂尔多斯盆地深层煤层气水平井钻井液技术

胡祖彪 骆胜伟 王清臣 张延兵 韩成福 张勤

(中国石油川庆钻探长庆钻井总公司, 陕西 710010)

摘要: 鄂尔多斯盆地深层蕴藏着丰富的煤层气资源。为此, 长庆油田针对埋藏深度介于2500至4000m的本溪组的8号煤层以及山西组的5号煤层的深层煤层气资源, 开展了前瞻性的钻探与开采试验。在钻探过程中, 遇到了诸多挑战, 特别是在水平段煤层垮塌及其上覆岩层中存在多层薄弱区域, 导致井壁稳定性差; 坍塌的煤矸石难以有效携带, 井眼清洁度不足。文章针对钻探过程中遇到的这些难题, 分析了本溪组煤岩和煤矸石的成分, 研究了岩石的理化性质和力学特性。通过精心筛选微纳米封堵剂、页岩抑制剂等关键处理剂, 研制了纳米二氧化硅封堵剂, 成功开发出一套适用于深层煤层气安全钻探的多级配强封堵钻井液体系。

关键词: 鄂尔多斯盆地 深层煤层气 水平井 纳米二氧化硅 钻井液

Drilling Fluid Technology for Horizontal Wells in Deep Coalbed Methane of Ordos Basin

HU Zubiao, LUO Shengwei, WANG Qingchen, ZHANG Yanbing, HAN Chengfu, ZHANG Qin
(PetroChina CCDC Changqing Drilling Corporation, Shaanxi 710010)

Abstract: The Ordos Basin contains abundant deep coalbed methane resources. To explore the deep coalbed methane resources in the No. 8 Coal Seam of the Benxi Formation and the No. 5 Coal Seam of the Shanxi Formation with burial depths ranging from 2500 to 4000 meters, Changqing Oilfield carried out forward-looking exploration and production tests. During the drilling process, significant challenges were encountered, particularly the collapse of coal seams in the horizontal section and the presence of multiple weak layers in the overlying strata, resulting in poor borehole stability, and the collapsed coal gangue is difficult to carry effectively, leading to insufficient wellbore cleanliness. To address these difficulties, this paper analyzes the components of coal rocks and coal gangue in the Benxi Formation and studies the physicochemical properties and mechanical characteristics of the rocks. By carefully selecting key treatment agents such as micro-nano plugging agents and shale inhibitors, a nano-silica dioxide plugging agent is developed, and a multi-level strong plugging drilling fluid system suitable for safe deep coal methane drilling is successfully developed.

Keywords: Ordos Basin; deep coalbed methane; horizontal well; nano-silica dioxide; drilling fluid

基金项目 川庆钻探工程有限公司顶层设计科研项目“深层8#煤层气水平井钻井液技术研究”(CQ2024B-6-Z1-3)

作者简介 胡祖彪, 高级工程师, 主要从事钻井液技术研究与管理工。

新型井口防护装置在煤层气 修井作业中的应用研究

陈小云

(中联煤层气有限责任公司晋太分公司, 山西 046000)

摘要: 在煤层气开采过程中, 由于其特殊的地质条件和工程技术要求, 检泵修井作业成为了保障煤层气井稳定运行的关键环节之一。本文针对当前煤层气行业中无杆泵举升工艺广泛应用背景下存在的修井作业中的小物件掉落问题进行了深入探讨, 并基于此提出了一种新型井口防护装置的设计思路与现场应用分析。通过对该装置的技术原理、性能指标、操作方法等方面的详细阐述, 旨在为相关领域提供一种有效解决此类安全隐患的新途径。

关键词: 煤层气 无杆泵举升工艺 井口防护 新型装置

Application of a Novel Wellhead Protection Device in Coalbed Methane Workover Operations

CHEN Xiaoyun

(Jintai Branch of China United Coalbed Methane Co., Ltd., Shanxi 046000)

Abstract: In the process of coalbed methane extraction, due to its special geological conditions and engineering technical requirements, pump inspection and workover operations have become a key link to ensure the stable operation of coalbed methane wells. This article delves into the issue of small-object drop incidents that exist in the background of widespread application of rodless pump lifting technology in the coalbed methane industry, and proposes the design concept and field application analysis of a novel wellhead protection device based on this. This article provides a detailed explanation of the technical principles, performance indicators, operational methods, and other aspects of the device, aiming to provide an innovative solution to effectively solve such safety hazards in related fields.

Keywords: Coalbed methane; rodless pump lifting technology; wellhead protection; novel devices

无杆泵举升技术是现代煤层气田开发中常用的一种人工举升方式, 它通过安装在井下的特殊设备——无杆泵来实现流体(主要是水)向地面输送的目的。相比传统有杆泵系统, 无杆泵具有结构简单紧凑、占地面积小、维护成本低等优点。此

外, 由于没有机械运动部件直接暴露于外部环境中, 因此能够更好地适应恶劣工况。

在修井作业过程中, 特别是在频繁进行上提管柱作业时, 如果缺乏有效的井口保护措施, 则容易导致扶正器销子、井口螺栓、螺帽、液压钳牙片及

沁水盆地 A 区块水平井开发模式 适应性评价

曹明亮^{1,2} 吴洛菲¹ 张兵¹ 邓志宇^{1,2}

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摘要: 为研究沁水盆地 A 区块水平井开发模式的适应性, 分析了水平井开发方式的优势, 确定了适应研究区水平井部署的原则。分析认为: (1) 水平井大大提高了渗流通道的连通性及泄压面积, 相对于直井, 水平井开发更有优势。(2) 资源条件是保证水平井产量的基础, 煤层厚度、构造情况、煤体结构、最大水平主应力方向是影响水平井部署的重要因素。(3) 研究区北部斜坡带、东北部斜坡带及北部向斜部分区域适合水平井部署, 水平井尽量部署为西南走向, 水平井轨迹应尽量靠近煤层上部。

关键词: 地质特征 有利区 水平井 适应性评价

Adaptability Evaluation of Horizontal Well Development Mode in Block A of Qinshui Basin

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Abstract: To study the adaptability of the horizontal well development modes in Block A of Qinshui Basin, this paper analyzes the advantages of the horizontal well development mode, and determines the adapting principles for the deployment of horizontal wells in the study area. The analysis shows that: 1) Horizontal wells significantly improve the connectivity and pressure relief area of seepage channels, demonstrating greater advantages over vertical wells. 2) Resource conditions are the basis for ensuring the production of horizontal wells. Coal seam thickness, structural conditions, coal body structure, and the direction of maximum horizontal principal stress are important factors influencing the well deployment. 3) The northern slope zone, the northeast slope zone and the northern inclined part of the study area are suitable for the deployment of horizontal wells. Horizontal wells should be preferably deployed in the southwest direction, and the well trajectory should be as close as possible to the upper part of the coal seam.

Keywords: Geological feature; favorable area; horizontal well; adaptability evaluation

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螺杆泵在煤层气井排采管控中的应用与实践

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摘要: 螺杆泵装置因占地面积小, 设备维护简单, 在煤层气开采中得到了应用, 其运行过程受煤层气井井况、井身结构、排水采气阶段差异、排采过程管控中认识差异等因素, 导致螺杆泵排采不连续, 泵效变低、变差, 甚至烧泵现象。本文通过研究煤层气井排水采气阶段螺杆泵的管控差异, 总结故障诊断方法, 对症下药, 制定管控方法, 以适应其特点, 保障了螺杆泵的排采连续性。

关键词: 煤层气井 螺杆泵排采过程管控 排采阶段 电流诊断法

Application and Practice of Screw Pumps in Drainage and Production Control of Coalbed Methane Wells

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Abstract: Due to its small footprint and simple equipment maintenance, screw pump devices have been applied in coalbed methane exploitation. However, their operation process is affected by various factors such as well conditions, well structure, differences in water drainage and gas production stages, and inconsistent understanding of drainage and production process control, resulting in the discontinuity of screw pump drainage, low pump efficiency, and even pump burning. In this paper, the control differences of screw pumps in the water drainage and gas production stage of coalbed methane wells are studied, the fault diagnosis methods are summarized, the causes are identified based on symptoms, and the control methods are formulated to adapt to the characteristics of screw pumps and ensure the continuity of drainage and production.

Keywords: Coalbed methane wells; drainage and production process control of screw pump; drainage and production stage; current diagnosis method

近几年来螺杆泵采油技术在石油开发中起到了重要作用, 螺杆泵不仅在重油和含砂井中应用, 而且在稀油井、大排量井和排水采气中也应用广泛。

目前最大下泵深度已达到 3000m, 最大排量达到 1000m³/d。地面驱动螺杆泵采油系统对于普通油藏及水驱油藏后期高含水开采阶段也表现出很好的

隆华煤矿瓦斯氧化供热项目的应用探讨

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摘要: 隆华煤矿供热需求明确, 之前的供热装置运营成本较高。瓦斯作为煤矿生产的伴生物, 是一种清洁能源。煤矿瓦斯氧化供热项目, 利用了直接排空的瓦斯, 回收了能源的同时, 实现了综合利用的目的, 具有客观的经济效益和环保效益。隆华煤矿瓦斯氧化供热项目进入试运行期以来, 替代了之前的燃气锅炉, 实现了预期目标。本文介绍了隆华煤矿瓦斯氧化供热项目及其中的一些措施特点。

关键词: 隆华煤矿 瓦斯氧化供热项目 伴热 保温 浓度控制

Discussion on the Application of Gas Oxidation Heating Project in Longhua Coal Mine

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Abstract: The heating demand of Longhua Coal Mine is clear, and the operating cost of the previous heating device was relatively high. Gas, as a byproduct of coal mining production, is a clean energy source. The coal mine gas oxidation heating project utilizes directly discharged gas, recovers energy, and achieves comprehensive utilization, with objective economic and environmental benefits. Since the trial operation of the Longhua Coal Mine Gas Oxidation Heating Project, it has replaced the previous gas boiler and achieved the expected goals. This article introduces the Longhua Coal Mine Gas Oxidation Heating Project and some of its measures and characteristics.

Keywords: Longhua Coal Mine; Gas Oxidation Heating Project; Heat Tracing; Insulation; Concentration Control

1 项目背景

和顺隆华煤业有限责任公司位于山西省和顺县, 地处太行山中段西侧, 属中山侵蚀地貌, 地形切割较强烈, 基岩成片裸露, 沟谷和梁坡处间或有黄土覆盖。区内地势总体表现为南高而北低, 最高

处位于井田南部边界处山梁, 海拔1665m, 最低处位于井田东北边界处沟谷中, 海拔1297m, 最大相对高差为368m。和顺县地处高寒山区, 气温比同纬度太原盆地区域偏低较多, 属暖温带大陆性季风气候。多年平均气温7.5℃, 其中1月分最低, 平均-8.4℃, 7月份最高为19.9℃, 极端最低气温

水平井重复压裂造缝机制及其工艺方法

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摘要: 针对国内水平井重复压裂主体技术不明确、现场应用较少, 本文在梳理国内外重复压裂工艺方法基础上, 系统阐述了老缝复压、补孔造新缝两类造缝机制、五种成缝模式; 并结合体积压裂工艺认识与现场实践, 详细分析了原井筒复压、新井筒重建两类七项工艺技术特点, 包括桥塞分段多级暂堵转向压裂、井筒暂堵桥射联作压裂、大口径油管水力喷射压裂、跨隔封隔器拖动压裂及套中固套、膨胀管、管外封隔器重建新井筒分段压裂, 为水平井重复压裂技术发展指明了攻关方向。

关键词: 水平井重复压裂 提高采收率 井下电视 分段压裂 井筒重建

Fracture Initiation Mechanism and Technical Methods of Re-fracturing in Horizontal Wells

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Abstract: Given the lack of clarity in the core technologies and limited field application of horizontal well re-fracturing in China, this paper reviews domestic and international re-fracturing techniques, and systematically explains two main fracturing initiation mechanisms, re-pressurizing existing fractures and creating new fractures through perforation, as well as five types of fracture formation modes. Combined with the insights from SRV fracturing and field practice, the paper analyses the characteristics of the re-fracturing techniques in the original wellbores sand reconstructed wellbores, including temporary plugging multistage diverting fracturing, temporary wellbore plugging combined with bridge perforation fracturing, hydra-jetting fracturing through large-diameter coiled tubing, dragging fracturing with straddle packer, and segmented fracturing in new wellbore reconstruction with cemented casing, solid expandable tubular and external casing packers. This research provides a clear direction for future development and breakthroughs in the development and application of re-fracturing technology in horizontal wells.

Keywords: Horizontal well re-fracturing; EOR; downhole video; multistage fracturing; wellbore reconstruction