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保护煤储层的煤层气井固井技术*

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摘要:国内的煤层气井主要采用注水泥射孔方式完井,研究固井设计和施工的一些关键问题对于避免潜在的生产作业和开采效益风险具有重要意义。简要回顾了国内煤层气井固井施工和研究状况,分析了煤层气井固井的质量要求和保护储层需求,结合室内和现场试验提出了适用于煤层气井固井的水泥浆性能和施工设计方法。研究认为煤层气井固井中最重要的封隔要求是对煤储层顶板的封隔,首要的作业安全问题是防止漏失。综合考虑固井作业和保护储层需要认为:适宜的水泥浆密度范围为 1.20～1.60 g/cm³,并应采用黏稠水泥浆在 0.5～0.8 m/s的低返速下固井施工。现场应用的固井质量合格率达到 100%,证明该研究结论适用于煤层气井固井。

关键词: 煤层气; 固井; 漏失; 保护煤储层; 低速顶替; 壁面剪应力

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就国内现有的固井技术能力和经营管理模式而言,尽管大多数煤层气井的固井质量评价结果都合格,从固井实践中也总结出了一些有益的成功经验,但对一些重要问题仍缺乏深入系统的研究,特别是如何合理确定水泥浆性能参数以及在一定水泥浆性能条件下的施工参数方面缺乏统一认识,固井工艺设计和施工存在一定的盲目性,容易造成潜在的生产作业和开采效益风险。

1　煤层气固井施工和研究状况

国内的煤层气固井从 20世纪 70年代开始,在现场施工方面,华北石油地质局[1]在沈阳北部和长春外围地区采用密度 1.65 g/cm³ 的水泥浆固煤层气井,发现不仅水泥浆密度选择对固井质量有影响,而且流变性的影响也很重要,提出了水泥浆屈服值与塑性黏度比值应为 0.21～0.48,并指出低速顶替对保证煤层气固井质量具有重要作用。东北煤田地质局在辽宁东部铁法煤田[2]固井时,总结和遵循了与常规油气井相同的技术要求,包括钻进过程发现漏失层应先期堵漏、固井水泥浆应上返到地面、了解地层裂隙和煤层割理发育状况、控制固井水泥浆的密度及排量、提高套管质量。华北油田[3,4]在山西晋城将水泥浆密度由 1.84～1.91 g/cm³ 改为 1.45～1.65 g/cm³,固井质量达到优质。中原油田[5]在淮南和山西晋城使用密度 1.91 g/cm³ 的速凝水泥浆固井 40余口,实现了固井优良率 74.2%,合格率 100%。

在煤储层保护的研究方面,有学者通过对重庆松藻矿区的煤试样[6]室内试验研究认为:煤的渗透率随周围压力的变化规律十分复杂,由于影响因素很多而难以精确描述。根据其研究结论,固井时应保持一个较小的作用在煤层上的孔隙压力与体积应力比值,避免漏失和压裂煤层造成固相伤害。中国石油勘探开发研究院廊坊分院[7]通过对河北大城、陕西吴堡和山西晋城煤层岩心的室内试验也证实了过高的压力将引起煤储层渗透率产生不可恢复的降低。大港油田[8]在山西河东、寿阳和沁水盆地煤层气井有关钻井液的研究以及其他一些研究均提出了一些与常规油气井相同的煤储层伤害观点,即固相堵塞、吸附堵塞及水锁。

2　煤层气井的固井需求分析

2.1　水泥胶结质量

煤层气井与常规油气井在开采方式上的重要差

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异是排水降压开采,这一特征体现了水泥胶结的重要作用是防止上部地层的流体进入井筒,而不是煤层气逸散;煤层气井中不存在一般意义的底水锥进问题。因此,一般情况下对煤储层部位的水泥胶结可以不做特殊要求,而为了防止上部地层流体进入井筒,对顶板和底板的封隔要求是最高的。从实际施工结果来看,由于水泥浆本身的特点,当顶板和底板胶结质量得到保障时,储层部位的胶结一般会较好。但若发生微小渗漏时(这是在近井地带存在水泥浆固相污染),也会表现出煤储层部位胶结不良而顶板和底板胶结良好,见图 1。晋城地区和大宁—吉县地区的煤层气井固井均证实了这一结论。

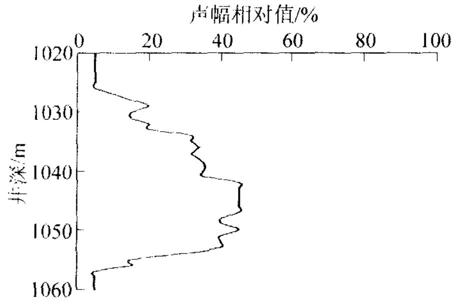

图 1 吉试 1井太原组煤层 CBL测井曲线

顶板以上地层的水泥环胶结质量虽然不影响煤层气开采,但出于对煤层气井寿命的考虑,水泥浆最好返至地面。这是因为煤层埋深一般较浅,上部地层本身的蠕变易引起管柱失稳,当水泥胶结不良时,疏松地层中的流体活动也容易造成环空水泥环强度崩溃,进而引起管柱破坏。

综合考虑以上因素,煤层气井固井质量需求的重要性顺序依次为:顶板和底板、煤储层、顶板以上疏松地层。顶板和底板、煤储层均胶结良好时可以认为固井质量优质;顶板和底板胶结良好而煤储层部位胶结不好时,可以认为固井质量合格;顶板以上疏松地层的胶结关系到煤层气井寿命,但不同的质量要求意味着不同的费用消耗,故可以根据具体情况在地质、工程设计中专门规定是否纳入质量考核范畴以及明确应达到的胶结质量测井指标。

2.2 保护煤储层

从技术和施工角度来看,单纯确保水泥胶结质量并不困难,但要考虑保护煤储层时,情况就变得比较复杂了。国内外的研究早已证实了煤层岩心存在应力敏感[9]和液相伤害问题,但如何落实到工艺设计中却有一定难度。

工程作业对煤储层的伤害主要是高压引起的渗透率下降、固相侵入引起流体产出通道堵塞、液相侵入引起的界面润湿性改变。试验数据[7]显示了随着煤层岩心围压的增加,其渗透率呈下降趋势。当围压达到 6 MPa时,渗透率降低 55%～83%,但卸压后渗透率只能得到 8%～32%的恢复。从这个角度看,固井时的过平衡压力对煤储层的伤害不可低估。石油大学岩石力学实验室对晋城 5#煤试样的研究结果表明,在轴向应力达到围压(8 MPa)前后,煤层岩心的体积应变明显不同,证明围压可以引起裂缝和节理闭合,见图 2。

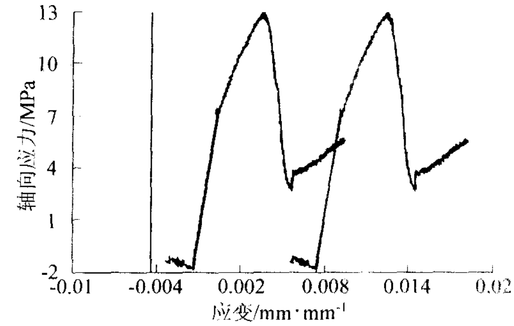

图 2 煤岩轴向应力—应变曲线(平行原岩心轴线)

从煤层气井的排水过程来看,产出水中含有大量细微煤颗粒,这意味着排水过程中煤储层骨架收缩,渗透率增大。从这个角度来看,大部分伤害均可得到相当程度的恢复。因此,优先需要注意的储层伤害问题是避免超高压引起的煤储层渗透率下降和水泥浆大量漏失引起的固相堵塞。

虽然从防止应力伤害的角度看,固井时的环空液柱压力越接近煤储层孔隙压力越好,但结合考虑煤层气井排水过程对伤害的解除情况,可以认为轻微过平衡压力产生的应力伤害和固相堵塞可以得到有效恢复。

对于液相伤害问题,目前技术条件下能够做的工作只是尽量降低水泥浆的 API滤失量。现有的水泥浆外加剂可以很容易的把 API滤失量降低到 50 mL以下,甚至更低。

2.3 固井作业需求

固井的需求主要是简化作业程序和保证施工安全。从安全的角度来看,对于煤储层的封隔首先是避免漏失,大多数人认为气窜问题对煤储层是不存在的。对大宁—吉县地区的施工数据分析表明,吉试 1井太原组 8#煤层深度为 1050.2～1052.8 m、1053.7～1059.4 m,从 CBL曲线上可以观察到太原组煤层声幅值偏高,表明存在轻微漏失,见图 1。结合环空液柱压力分析,可以确定太原组 8#煤层的漏失压力梯度为 17.25 kPa/m。以后的施工注意了这

一问题,及时调整环空液柱压力梯度不超过 17.25 kPa/m,见表 1,煤储层段的声幅值胶结均小于10%,达到了优质。

表 1 8#煤储层固井时承受的压力梯度 kPa/m

井号	吉试 1	吉试 2	吉试 3	吉试 4	吉试 5	吉试 6
压力系数	1.759	1.707	1.706	1.673	1.725	1.674
压力梯度	17.25	16.75	16.74	16.41	16.93	16.42

在固井作业程序方面,当采用低密度水泥浆施工时,对于一定的注入体积,水泥浆密度越低,水泥干灰体积越大,干灰混拌的工作量和运输所需的罐车数量相应增多。这使得长途运输成本增加很多。因此,从作业者的角度来看,采用高密度水泥以节约成本,这与保护煤储层所需的低密度需求是矛盾的。宜在满足质量和保护储层要求的前提下,尽量简化作业程序。

3 水泥浆性能

3.1 密度

煤层岩心强度和煤储层地应力特征决定了水泥浆密度范围和环空液柱压力系统的设计。按照常规要求,水泥浆密度应大于井眼坍塌压力、小于煤层渗漏压力。在此基础上,结合水泥浆强度要求,尽量采用较低的水泥浆密度。

综合考虑固井作业和保护储层需求,按照紧密堆积理论设计的水泥浆配方是较好的折衷选择。设计出的水泥浆与早期的低密度水泥浆相比早期强度大幅度地提高,水泥石渗透率极小。在目前的技术条件下,适宜的水泥浆密度范围为 1.20～1.60 g/cm^3 (图 3),对孔隙压力系数接近 1.0的煤储层而言,过平衡压力系数为 0.20～0.60。一种在现场实际应用的水泥浆配方为 G级水泥 +15%空心微珠 +1.5%降失水剂 +1.0%早强剂 +5%微硅,其性能参数:密度 1.55 g/cm^3;失水量 42 mL;稠化时间 130 min; 24 h抗压强度 17.2 MPa;自由水 0。由此可以看出,30 ℃低温下 24 h的抗压强度达到了 17.2 MPa,超过常规低密度水泥浆。

3.2 API滤失量

控制 API滤失量的目的一是保持作业过程中的水泥浆性能相对稳定;二是减少液相伤害,在固井中减小渗漏。这种渗漏可能在地面观察不到,但会造成煤层部位及以上井段胶结不良,并对煤层气开采造成重大影响。

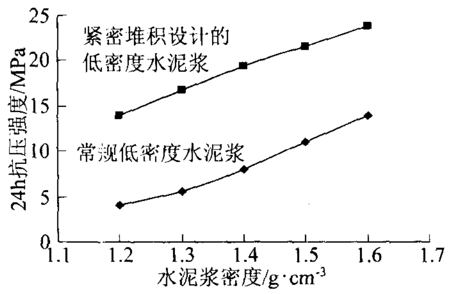

图 3 2种低密度水泥浆的抗压强度比较

固井水泥浆降失水剂从化学组成上主要有 2类:聚乙烯醇复合物(PVA)、AMPS - AM共聚物。二者在性能上有重要差异。不论井下温度高低,聚乙烯醇复合物降失水剂加量必需超过一个最低值,否则无法控制失水,而 AMPS - AM共聚物则随加量增加和温度降低,失水量逐渐减小。虽然二者都能够将 API失水控制在 50 mL以内,见图 4,但综合考虑性能和价格因素,AMPS - AM共聚物更适于煤层气井固井。

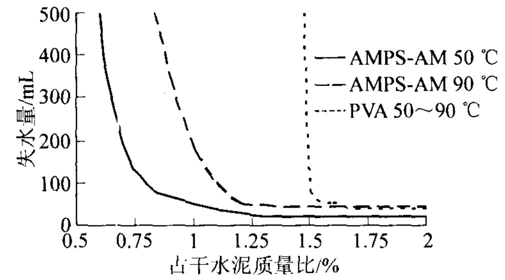

图 4 AMPS - AM共聚物与 PVA降失水效果比较

3.3 流变性能

煤层气井固井对水泥浆的性能要求与常规油气井的重要区别是紊流顶替技术很难适应固井作业需要[1,3]。因此,水泥浆流变性能应以黏稠为特征,对于宾汉流体最好是保持较高的屈服值,对于幂率流体则以具有较大的稠度系数为好。

文献[1]中水泥浆流变参数计算方法仅适用于水泥浆为宾汉流体的情况,因此建议采用下述公式确定水泥浆流变参数[10]

$$\tau_w = \frac{\Delta P}{4L}(D - d) \quad (1)$$

式中, τ_w 为水泥浆在环空流动的壁面剪应力, Pa; ΔP为水泥浆在环空流动的摩擦阻力, Pa; L 为流体流动作用的井眼长度, m; D 为井眼直径, m; d为套管外径, m。

公式 (1)适用于任何类型的流体。水泥浆稠度

越大 ,在低流速下产生的壁面剪应力就越大。当壁面剪应力为 15 Pa时可以保证胶结合格 ,当壁面剪应力为 30 Pa时可以保证胶结优质。

4 固井施工设计

煤层气井固井作业参数主要包括:前置液类型和用量、水泥浆体系和注替排量。

根据煤层割理发育的特点 ,前置液中应含有堵漏材料 ,较为经济的办法是在钻井液中加入适量钻井液稀释剂。该方法的优点在许多研究中早已指出 ,主要是钻井液滤饼更容易被冲洗掉 ,并可有效防止后续流体中的大量固相进入储层。

水泥浆体系设计应在注意保护储层的同时 ,兼顾到经济适用性。在水泥石抗压强度满足要求的条件下 ,采用密度尽量低的水泥浆。兼顾到顶板上部地层封固的需要 ,目前的按照紧密堆积理论设计的低密度水泥浆是一个较好的选择。但由于这种水泥浆含有的大量细微颗粒会有部分进入煤储层引起固相堵塞污染 ,故应考虑选择具有良好封堵性能的前置液作为先导流体。如果考虑到压裂作业的需要 ,也可以采用更高密度的尾浆施工。

考虑到顶替的需要 ,施工应采用单车注单泵替 (为准确计量 ,也可以直接用水泥车顶替)的方式进行 ,按照目前的设备能力 ,注入排量 0. 3～0. 6 m^3/min,替浆排量 0. 8～1. 2 m^3/min,可以保持环空返速为 0. 5～0. 8 m/s。

5 施工实例

5. 1 地质、工程特点

大宁一吉县地区的目的层位为山西组 5#煤储层和太原组 8#煤储层 ,埋深 900～1200 m,主要采用∅139. 7 mm套管注水泥完井。钻井风险是上部地层井漏和井塌 ,并造成井径不规则 ,井径扩大异常 (表 2)。吉试 1井原设计采用密度 1. 05～1. 08 g/cm^3的盐水钻井液 ,由于井下垮塌严重 ,完钻时密度已经提高到 1. 25 g/cm^3;吉试 6井在钻进期间存在垮塌 ,钻井液密度由 1. 10 g/cm^3提高到 1. 15 g/cm^3。吉试 1、3井最大井径扩大率分别达到 183%和 144%。吉试 4井钻进期间和固井期间发生过漏失 ,吉试 6井在固井顶替后期发生漏失。

表 2 吉试 1～6井钻井复杂和井径统计

井号	复杂情况	最大井径/mm	最小井径/mm	平均井径/mm	平均扩大率/%	最大扩大率/%
吉试 1井	井塌	610	216	253. 0	17. 2	182. 5
吉试 2井		279	216	234. 8	8. 8	29. 2
吉试 3井	井塌	526	222	248. 4	15. 1	143. 6
吉试 4井	钻井和固井井漏	312	208	226. 0	4. 7	44. 5
吉试 5井		249	216	227. 7	5. 5	15. 3
吉试 6井	钻井井塌、固井井漏	305	220	226. 0	4. 7	41. 3

5. 2 施工措施

根据大宁一吉县地区特点 ,保护煤储层的固井技术要求施工过程中防止煤储层发生漏失、裂隙充填、孔隙压缩 ,同时确保顶板和顶板以上 200 m以内胶结质量良好。根据这一质量要求 ,固井设计和施工采取了以下措施。

(1)总体上降低环空液柱压力 ,防止煤层双孔结构在压力下破坏 ,保护储层 ;

(2)煤储层顶板以上 200 m至井底用常规密度水泥浆封固 ,保证后期压裂作业的需要 ;

(3)煤储层顶板以上 200 m至地面用低密度水泥浆封固 ,防止上石盒子组地层发生漏失 ;

(4)煤层的漏失一般为渗透性漏失 ,故考虑到技术的经济适用性 ,采用提高水泥浆稠度的办法防漏 ,并有助于提高“大肚子 ”井段顶替效率 ;

(5)控制水泥浆 API失水不超过 50 mL,减少固相对煤裂隙的充填 ,同时减少漏失风险 ;

(6)采用套管居中技术并合理确定顶替参数 ,保证““大肚子 ”井段顶替良好。

设计的基本水泥浆配方为嘉华 G级水泥 + (2. 0～3. 5) % TD - S降失水剂 +现场水。施工前根据井下实际情况加入少许消泡剂和早强剂。加入 5% ～9%微硅和 6% ～10%空心微珠 ,可将密度调节到需要的数值。在 35～38 ℃条件下 ,水泥浆性能满足施工需要 (表 3)。通过精心设计和组织施工 ,固井质量合格率达到 100% (表 4)。

表 3 大宁—吉县地区固井水泥浆性能

水泥浆体系	密度 /g·cm⁻³	初始稠度 /Bc	稠化时间 /min	API失水 /mL	24 h抗压强度 /MPa
常规水泥浆	1.87～1.97	22.8～32.6	65～162	5～44.8	12.87～20
低密度水泥浆	1.62～1.65	7.2～22	105～200	12～40	8～10.11

表 4 大宁—吉县地区固井质量统计

井号	封固井段 /m	优质封固段 /%	封固合格段 /%	总封固合格井段 /%
吉试 1井	1125～117	58.5	25.5	84.0
吉试 2井	1169～20	86.7	4.7	91.4
吉试 3井	1360～20	51.0	46.9	97.9
吉试 4井	1192～144	60.5	39.5	100
吉试 5井	1000～0	89.7	5.3	95.0
吉试 6井	1097～100	97.8	0.5	98.3

6 结论

(1)煤层气井固井质量需求的重要性顺序依次为:顶板和底板、煤储层、顶板以上疏松地层。顶板和底板、煤储层均胶结良好时可以认为固井质量优质;顶板和底板胶结良好而煤储层部位胶结不好时,可以认为固井质量合格。

(2)工程作业对煤储层的伤害主要是高压引起的渗透率下降、固相侵入引起流体产出通道堵塞、液相侵入引起的界面润湿性改变,但煤层气井的排水过程可使大部分伤害均可以得到相当程度的恢复。由于目前不能定量确定伤害的解除程度,固井时的环空液柱压力越接近煤储层孔隙压力越好,并应尽量降低水泥浆的 API滤失量。

(3)煤层气井固井首要问题是避免漏失,宜采用紧密堆积设计的低密度水泥浆,并在满足质量和保护储层要求的前提下,尽量简化作业程序。目前的技术条件下,适宜的水泥浆密度范围为 1.20～1.60 g/cm^3。

(4)聚乙烯醇复合物和 AMPS - AM共聚物都能够将 API失水控制在 50 mL以内,综合考虑性能和价格因素,AMPS - AM共聚物更适于煤层气井固井。

(5)水泥浆流变性能应以黏稠为特征,配合按照紧密堆积理论设计的低密度水泥浆的固井工艺需要,前置液中应含有堵漏材料。

(6)在大宁—吉县地区的固井实践证明该研究结论适用于煤层气井固井。按照目前的设备能力,适宜低返速固井的注入排量 0.3～0.6 m^3/min,替浆排量 0.8～1.2 m^3/min,可以保持环空返速为 0.5～0.8 m/s。

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Research of lithology identification method while drilling with PDC bit LI Gong-quan, CAO Dai-yong, CHEN Gong-yang, QIN Jun. ODPT, 2006, 28(2): 25-27

Abstract: While drilling with PDC Bit, Some problems are come out when using the methods of traditional recorder well. Lithology identification is crucial. The data collected by mud-logging equipment, for examples, ROP, WOB, torque et al., reflects the different sides of rock's property in subsurface. The relation among them is complex and BP neural network is adopted in three layers. The section of Zhang 2104 well in Zhangdian oil field is used as predictive model and the depth is between 2500 and 2700 meters. In order to test the precision of the model, the section of Zhang 2104 well (2000-2200 m) and zhang 2201 well (2600-2800 m) are predicted. The precision predicted to Zhang 2104 is 93.6% and zhang2201 well is 89.2%, as the pure rock is almost 100%. The error remains the identification to the rock filled with nearby 50% clay. The result presents that this method is practical.

Key words: PDC bit; BP neural network; lithology Identification

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New method for evaluating borehole stability in brittle shale. WANG Jian-hua, YAN Jie-nian, SU Shan-lin. ODPT, 2006, 28(2): 28-30

Abstract: In the present, the typical experience can't solve all the problems of borehole instability. Especially in brittle shale formation, there are not optical methods to solve in the lab. So setting up methods for brittle shale is very urgent. To solve the borehole instability in brittle shale because of micro-fractures, this paper set up a new evaluation method of hard brittle shale—the simulation and sealing about microfracture. The method could simulate little fracture from 1 μm to 50 μm, and the experiments of seal have been done. The relationship among velocity, peripheral pressure and fracture width was studied. Sealing efficiency of the silicate drilling fluid was reached to 90%. The result of experiments indicates that the method is possible, and has some guidance for improving the sealing capacity of drilling fluids.

Key words: hard brittle shale; borehole instability; micro-fracture; evaluation methods

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New design approach on combination of liquid-gas flow rates of gas based fluid. WANG Li-guo, YANG Hu, YAN Jie-nian, LIU Chun-qiang. ODPT, 2006, 28(2): 31-34

Abstract: During Underbalanced Drilling (UBD), the highest bottom hole pressure during normal drilling condition affects the degree of formation damage, the lowest bottom hole pressure during pipe connection controls severity of the wellbore damage. And bottom hole pressure is controlled by the combination of the liquid and gas flow rates on the ground. In order to minimize both the formation damage and wellbore damage problems, it is highly desirable to have an easy-to-use approach to generate balanced design of combinations of liquid and gas flow rates under given drilling conditions. Based on the four phases fluids dynamics model, the design method could convert security window of bottom hole pressure to the security window of combination of the liquid and gas flow rates on the ground. The method adopted Excel Sheet to protract the window, and could choose the optimum combination. In the liquid-gas rate window, formation fluid pressure limits the upper bound of the flowing bottom hole pressure and wellbore collapse pressure was the lower bound of the circulation-breaking bottom hole pressure. The window was closed by fluid's cutting carrying capacity and wellbore washout criteria. And to verify the new approach, an illustrative example (SN4003) was presented in this paper to demonstrate how to use the new design method. this successful UBD field case was reviewed and compared with the optimum design results. Good consistency was indicated.

Key words: UBD; aerated mud; combinations of liquid and gas flow rates; new design approach

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Cementing technology used for protecting coal reservoir. LIU Ai-ping, DENG Jin-gen, XIAN Bao-an. ODPT, 2006, 28(2): 35-39

Abstract: It is very important to perform a systemic research on cementing operational parameters and its influence upon the coal-bed gas exploitation, because the cased-hole completion is the main well completion method for coal-bed gas well in China. Based on the brief review of cementing operation cases and the current research of coal-bed gas well, this paper analyzed the requirements of cementing quality and protection the coal reservoir. It tabled a proposal of the slurry and operation design method combining with the experiments and operations. The isolation of coal reservoir roof is the most crucial requirement in coal-bed well cementing and the most important challenge of operational safety was preventing the lost circulation. Considered the requirement of cementing job and protection the coal reservoir, it was proposed that the desired

cementing slurry density boundary should be 1. 20-1. 60g/cm^3, at the same time, the thick cement slurry should be under the low return rate, 0. 5-0. 8 m/s, in the cementing operation. The cement job quality qualification rate has reached 100% in the field application, which proves that this conclusion has be of certain applicability and be of directive meaning for coal-bed gas well cementation operation and design in future.

Key words: coal-bed gas; cementing; lost circulation; protection coal reservoir; slow flow displacement; shearing stress on the wall

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Microscopic porous flow mechanics of wetting alteration agents WANG Feng-qing, YAO Tong-yu, LI Ji-shan. ODPT, 2006, 28(2): 40-42

Abstract: In order to study the effect of wetting alteration agents to porous flow process, the microscopic porous flow mechanics was studied, contact angle of solid surface was measured by contact angle method and Washburn method, oil-water interfacial tension was measured by interfacial tensiometer, and the effect of the wetting alteration agents to the wettability of oil-wet surface was also studied. Finally, the porous flow mechanics of wetting alteration agents was studied by microscopic model. The experiments shows that the wetting alteration agents can change surface wettability, also it can reduce oil-water interfacial tension to 10^{-1} mN/m; and during the porous flow process, peeled off oil film, formed oil bridge and altered wettability. This study displays that both oil-water interfacial tension and wettability of rock surface influence the characteristics of porous flow, and it provide a good base for more study to improve porous flow of oil and water.

Key words: wetting alteration; micro porous flow mechanics; oil-water interfacial tension; microscopic model; contact angle

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Study on porous flow mechanics effected by slippage in Sulige gas reservoir. YAO Shang-lin, SHANG Gen-hua, SHAN Wen-wen, JIAO Xiao-hong. ODPT, 2006, 28(2): 43-45

Abstract: Based on percolation mechanism analysis of low permeability gas reservoirs, combined the effect of Klinkenberg, established non-linear percolation mathematical model. Measured coefficient of slippage, seepage index and seepage coefficient by experiment, and compared calculated results with spot results and verified the effectiveness of this method. Slippage effect exists in porous media flow, especially when pressure, velocity or permeability, it is very obvious, also gas flow equation in porous media with a slippage effect was presented. This research has provide a strong technical support for the optimization of development plans and recovery schemes.

Key words: low permeability gas reservoir; seepage index; modified coefficient of slippage; seepage coefficient; permeability

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Performance evaluation of a thermophilic MEOR strain. ZHANG Han-shi, DUAN Chuan-hui, GAO Guang-jun, CHENG Hai-ying, WANG Jing, ZHANG Qian-qian. ODPT, 2006, 28(2): 46-48

Abstract: A thermophilic bacterium of NA-3 was isolated from produced fluid in Shengli oilfield, and identified that it was a member of Bacillus sp. The NA-3 is Gram-positive, rod-shaped in (0. 5-0. 8) μm × (1. 4-2. 5) μm, facultative anaerobe and motive. The optimum growth temperature is 70 ℃, pH is 7. 0. salinity resist is 10 g/L. NA-3 could reduce nutritive fluid surface tension from 72 mN/m to 34 mN/m, pH from 7. 0 to 5. 2. Experiment shows that NA-3 can enhance the oil recovery to 11-15 percent, and it has great potential application in microbial enhanced oil recovery.

Key words: microbe oil recovery; thermophilic; facultative anaerobe; performance evaluation; laboratory experiment

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Experiment of indigenous microbe oil displacement technology in S12 block. GENG Xue-li. ODPT, 2006, 28(2): 49-51

Abstract: In view of exploitation and geology situation of S12 block, component of microbe and properties of fluid of reservoirs was studied, practicability of microbe oil displacement was identified. Nutritional formula to active microbe oil displacement was selected by laboratory experiment, and concentration of activator was simulated, test result shows that it can improve oil recovery over 9% after water flooding reservoir. Field test demonstrate that it can active bacterium of reservoir after injecting selected nutritional formula, and generated subject which can improve oil recovery.

Key words: indigenous microbe; activate; oil displacement; technology; testing

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