凝析气藏考虑毛管数和非达西效应的渗流特征

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摘要 近期的大量理论和试验研究发现,高速流动导致的毛管数和非达西效应对近井油气相对渗透率有显著影响,仅考虑非达西效应无法准确描述油气真实渗流状态。准确理解并考虑这2种效应的影响对凝析气藏渗流动态分析以及生产动态预测有很重要的意义。建立了油气两相渗流的定解问题,得到了拟稳态形式的流入动态方程。在三区渗流机理上,首次综合考虑了毛管数和非达西效应对相对渗透率的影响。实例分析揭示了高速流动下油气相对渗透率变化及油气分布状态新特征。对不同流入动态模型的对比分析表明,本方法比现有方法更有助于正确预测生产动态,评估气井产能。

关键词 凝析气藏 毛管数效应 非达西效应 渗流

凝析气藏展示了气和凝析油系统复杂的相态变化,在一定温度和压力条件下,气液两相共存并不断发生传热、传质,气液相体积分数也不断变化。凝析气系统的特点决定了凝析气藏渗流研究比常规气藏具有更大的难度和特殊性:气液两相变化难以准确描述,需要应用形式繁杂的状态方程;油气分布状态难以准确确定;渗流因素的耦合效应给渗流动态研究增加了难度。

国外早在20世纪40年代就开始了凝析气藏油气两相渗流机理研究,具有代表性的研究成果如文献[1~6]所述。国内在近几年加大了凝析气藏开发力度,凝析气藏渗流机理及应用研究正逐渐引起人们的重视,但还属于新兴的研究课题,理论和试验研究成果极为有限,对于渗流过程中的油气两相分布状态、油气相对渗透率变化以及微观影响因素还缺乏深入、系统的理论分析和试验工作。

最近的研究进展[7~15]揭示了凝析气藏渗流的一些新现象,发现多孔介质、润湿性、界面张力、流速等因素对渗流均有不同程度的影响,其中尤以高速流动影响最为显著。但现有的机理描述中大多只考虑了高流速带来的非达西效应,却忽视了高速流动引起的正效应——毛管数效应对油气渗流的影响,更缺乏综合考虑这2种因素的渗流动态分析。本研究的主要工作即在于深入理解近井区的油气两相渗流现象,分析考虑高流速效应对油气相对渗透率的影响,并将相对渗透率变化反映到流入动态分析中。实例分析表明,本研究有助于正确理解和准确描述凝析气藏渗流动态,为单井的优化生产提供更准确的生产动态数据。

1 数学模型

假设储层水平、均质、温度恒定,中心1口井以定产量生产;气相和油相均满足达西渗流规律;渗透率和孔隙度保持常数;地层中存在相平衡;忽略重力作用;毛管压力影响通过相平衡和相对渗透率曲线由物性参数的改变来间接反映。

在径向流动条件下,根据渗流力学理论和质量守恒定律,可以得到油气两相混合渗流微分方程

$$\nabla\circ\left[\left(\frac{\rho_g k_{rg}}{\mu_g}+\frac{\rho_o k_{ro}}{\mu_o}\right)\nabla p\right]=\frac{\varphi}{k}\frac{\partial}{\partial t}(\rho_g s_g+\rho_o s_o) \tag{1}$$

根据假设条件可得数学模型的定解条件为:
内边界条件

$$Q(t)=2\pi kh\left(\frac{\rho_g k_{rg}}{\mu_g}+\frac{\rho_o k_{ro}}{\mu_o}\right)r\left.\frac{\partial p}{\partial r}\right|_{r=r_w} \tag{2}$$

外边界条件

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$$\left.\frac{\partial p(t,r)}{\partial r}\right|_{r=r_e}=0 \tag{3}$$

初始条件

$$p(r,t)|_{t=0}=p_i \tag{4}$$

(1)~(4)式构成了油气两相渗流的数学模型。

考虑圆形地层的流量与其经过的体积成正比,在拟稳态下产量可以表示为

$$Q_m(t)=\pi(r_e^2-r_w^2)h\varphi\frac{\partial}{\partial t}(\rho_g s_g+\rho_o s_o) \tag{5}$$

结合式(1)和(5),得到

$$\nabla\circ\left[\left(\frac{\rho_g k_{rg}}{\mu_g}+\frac{\rho_o k_{ro}}{\mu_o}\right)\nabla p\right]=\frac{Q_m}{k(r_e^2-r_w^2)\pi h} \tag{6}$$

定义油气两相拟压力函数

$$\psi(r,t)=\int_{p_{wf}}^{p_r}\left(\frac{\rho_g k_{rg}}{\mu_g}+\frac{\rho_o k_{ro}}{\mu_o}\right)dp \tag{7}$$

非达西系数

$$D=\frac{1}{4\pi^2h^2}\int_{r_w}^{r_e}\left(\frac{k_{rg}}{\mu_g B_g}+\frac{k_{ro}}{\mu_o B_o}r_s\right)\beta\rho_g f_g^2\frac{1}{r^2}dr \tag{8}$$

将(7)、(8)两式代入(6)式,可以得到考虑油气两相流动的拟稳态流入动态方程为

$$\psi_e-\psi_{wf}=\frac{Q_m}{2\pi kh}\left(\ln\frac{r}{r_w}-\frac{3}{4}+S\right)+DQ_m^2 \tag{9}$$

其中,$Q_m=Q_g+24\ 056\frac{\gamma_o Q_o}{M_o}$, S 为总表皮因子。

由于两相拟压力函数考虑了油气相对渗透率变化,因此利用(9)式即可准确描述凝析气藏油气两相流入动态。

2　参数计算

2.1　相对渗透率修正

大量研究表明,渗流速度对相对渗透率影响较大。这种影响可以通过考虑毛管数的相关式来模拟。毛管数有多种定义形式,本研究主要采用常规的定义

$$N_c=\frac{\mu_g v_g}{\sigma} \tag{10}$$

Fevang 和 Whitson[16] 研究认为凝析油阻塞效应可通过 $k_{rx}=f(k_{rg}/k_{ro})$ 关系来间接描述。在给定 k_{rg}/k_{ro} 下,k_{rx} 随毛管数 N_c 的变化关系可用(11)式[10] 描述

$$k_{rx}=f_i k_{rxi}+(1-f_i)k_{rxm} \tag{11}$$

$$f_i=\frac{1}{(\alpha N_c)^j+1},\qquad j\ 一般为\ 0.65 \tag{12}$$

在高速流动条件下,非达西流动效应也不可忽视。非达西流动效应可通过非达西因子[10] 来模拟

$$F_{ND}=\frac{1}{1+\frac{\beta^* k\rho v_g}{\mu}} \tag{13}$$

因此,综合考虑毛管数和非达西效应影响的相对渗透率为

$$k_{rx}^*=F_{ND}'k_{rx}(k_{rg}/k_{ro},N_c) \tag{14}$$

2.2　拟压力求解

基于三区渗流机理[16~20],(7)式可表示为

Ⅰ区　$$\psi_1(p)=\int_{p_{wf}}^{p^*}\left(\frac{\rho_g k_{rg}^*}{\mu_g}+\frac{\rho_o k_{ro}^*}{\mu_o}\right)dp \tag{15}$$

Ⅱ区　$$\psi_2(p)=\int_{p^*}^{p_{dew}}\left(\frac{\rho_g k_{rg}^*}{\mu_g}\right)dp \tag{16}$$

Ⅲ区　$$\psi_3(p)=k'_{rg}(s_{wi})\int_{p_{dew}}^{p_r}\frac{\rho_g}{\mu_g}dp \tag{17}$$

(15)~(17)式中相对渗透率计算采用考虑毛管数和非达西效应的修正值。拟压力的计算关键是确定第 1 区的边界压力 p^*。由文献[5]的定义,p^* 等于生产井流体的露点压力,其值为 $R_s=1/R_p$ 时对应的压力。

如果气井的生产状态处于拟稳态阶段,拟压力函数的计算可采用稳定定理计算

$$\frac{k_{ro}}{k_{rg}}=\frac{\rho_g L\mu_o}{\rho_o V\mu_g} \tag{18}$$

(18)式最早是由 O' Dell 和 Miller[3] (1967)提出的,而后 Jones 和 Raghavan[16] 从理论上进行了严格证明。只要通过试验或闪蒸计算得到气、油相的摩尔分数、压缩因子,便可借助相对渗透率曲线,确定含油饱和度 s_o-p 分布,进而可以计算出拟压力。

3　实例计算及分析

原始数据来自大港千米桥凝析气藏 BS8 井。BS8 井在生产中期地层压力降为 41.62 MPa,露点压力为 43.53 MPa,气井供气半径为 967 m,气层有效渗透率为 $5.717\times10^{-3}\mu m^2$,孔隙度为 0.051,表皮因子为 4.55。

3.1　毛管数效应分析

为了分析毛管数效应对相对渗透率的影响,采用 Corey 相关式[11],其表达式为

$$k_{ri}(s_i,N_c)=k_{ri}^{\circ}(N_c)[s_i-s_{ri}(N_c)]^{n_i(N_c)} \tag{19}$$

图 1 为考虑毛管数效应的相渗曲线对比。可以看出,毛管数效应会增加油气两相的相对渗透率,但

油相对毛管数效应并不是很敏感。当毛管数达到一定程度时，油气两相相对渗透率趋于直线。图 2 为考虑非达西流动效应的相渗曲线对比。由图 2 可看出，考虑非达西效应的影响，在高凝析油饱和度下气相相对渗透率比不考虑非达西效应的值要低，而油相相对渗透率变化不大。这主要是因为油相的渗流速度一般较低，非达西流动效应对其影响不大。

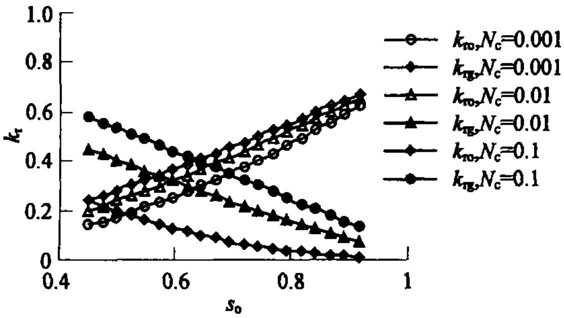

图 1　考虑毛管数效应的相渗曲线对比

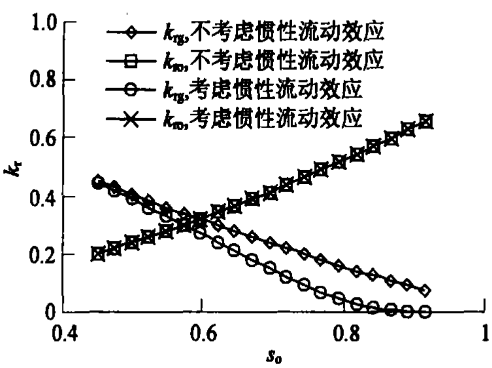

图 2　考虑非达西流动效应的相渗对比

图3 为低凝析油饱和度下气相相对渗透率与毛管数的半对数曲线。由图 3 可知，凝析油饱和度较低时，随着毛管数增加，油气两相相对渗透率均会增加，但气相相对渗透率递增更快。其原因在于，气相渗流速度高，对毛管数效应更为敏感。

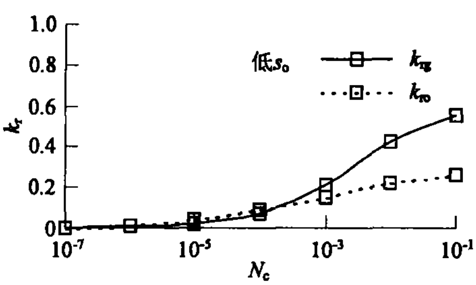

图 3　气相相对渗透率—毛管数曲线

图4 为高凝析油饱和度下气相相对渗透率与毛管数的半对数曲线。同样展示了与图 1 类似的趋势，但在高凝析油饱和度下，油气两相渗透率增加幅度没有低凝析油饱和度下增幅大。图 1 ~ 图 4 均表明，毛管数效应会显著改善油气两相相对渗透率。

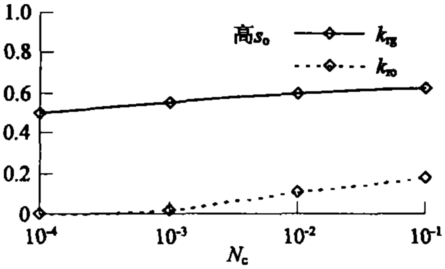

图 4　气相相对渗透率—毛管数曲线

图 5 为毛管数与半径的双对数曲线。图 5 说明，越靠近井筒，毛管数越高，即毛管数效应更加明显。由图3、4、5 可以得到考虑毛管数效应后的实际凝析油百分含量径向分布，如图 6 所示。由图 6 可以看出，在靠近井筒的区域，由于毛管数效应的影响，凝析油百分含量较低。凝析油沿径向的分布是先单调上升，然后再单调下降。这说明，如果增强近井的毛管数效应，将有助于改善气相渗流能力。图 6 还表明，目前对于凝析油阻塞造成的产能损失估计可能过低，这与那种仅采用单相气的方法会高估产能损失一样，都不利于气井动态的准确预测。

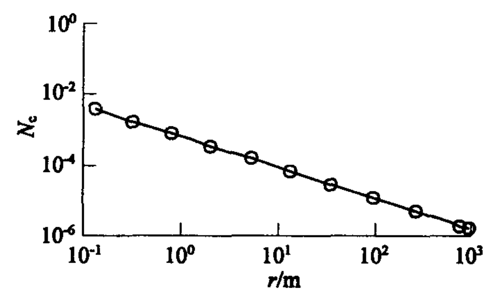

图 5　毛管数—半径分布

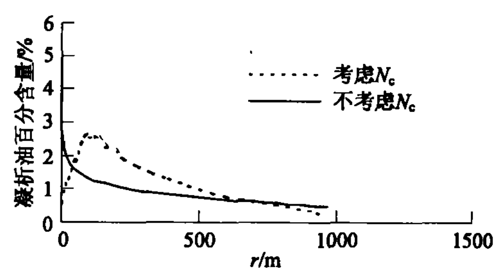

图 6　凝析油百分含量径向分布

3.2　流入动态及无阻流量

利用本文所述方法可以求得不同测试流压下对应的拟压力差 $\Delta\psi_{wfi}$，然后根据 $\Delta\psi_{wfi} \sim Q_m$ 曲线，可得到两相产能方程系数 A、B。最后求得的考虑毛管数效应和未考虑毛管数效应的三区拟流入动态方程，分别为(20)、(21)式

$$\psi_e - \psi_{wf} = 219\,604.4Q_m + 264.82Q_m^2 \qquad (20)$$

$$\psi_e - \psi_{wf} = 54\,534.58Q_m + 280.32Q_m^2 \qquad (21)$$

利用拟压力—压力关系(图 7)就可以求得压力—产量关系,并得到常规三区模型、考虑毛管数效应的三区模型、油气两相流与单相气流入动态曲线对比,如图 8 所示。

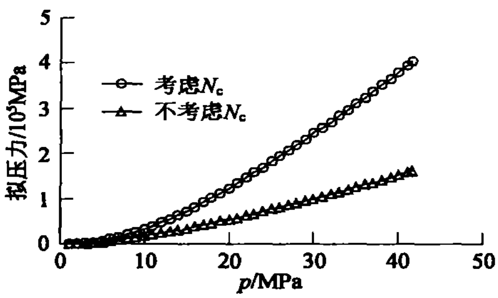

图 7　拟压力—压力关系

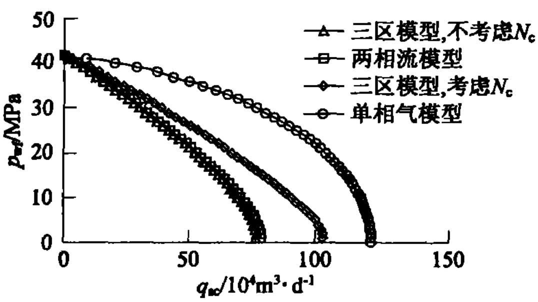

图 8　流入动态曲线对比

由图 8 可以看出,无论是油气两相流模型,还是三区模型,由于考虑了气液两相流动,其无阻流量均比单相气模型低。而基于三区模型、未考虑毛管数效应的无阻流量比油气两相流模型的无阻流量略低,其原因在于第 1 区的边界压力与地层压力较为接近,也即凝析油阻塞区的影响不很明显。但是如果考虑了毛管数效应,气井产能则有大幅度提高,但仍然低于采用单相气模型的预测值。因此,采用三区模型并且考虑毛管数效应有助于流入动态的正确预测,确定气井的最佳生产状态。

4　结论

(1)基于三区渗流机理,建立了油气两相渗流的定解问题,给出了拟稳态形式的解析解,得到与常规分析不同的凝析气藏流入动态预测方程。

(2)首次综合考虑了高速流动导致的毛管数和非达西效应来描述近井油气相对渗透率的变化,深入分析了高流速对油气渗流动态影响。实例分析表明,考虑毛管数效应后的油气两相相对渗透率均有所提高,但气相比凝析油相对毛管数效应更加敏感。而非达西效应只在高凝析油饱和度下对气相影响较为明显,油相则几乎没有变化。

(3)由于毛管数效应的影响,凝析油并非像常规认识那样在近井高度聚集,凝析油饱和度反而会低于远端。因此,增强近井的毛管数效应,将有助于改善气相渗流能力。

(4)对实例井进行了常规三区模型、考虑毛管数效应的三区模型、油气两相流与单相气流入动态对比分析。结果表明,仅采用单相气的方法会高估产能损失,而常规的油气两相模型和三区模型则会低估产能损失。因此,考虑毛管数效应影响对于及时、准确把握生产动态意义重大。

符　号　说　明

B_g、B_o——气相、油相体积系数;

f_g——气体流量与总流量之比;

f_i——插值权重;

h——有效厚度,m;

k——绝对渗透率,μm^2;

k_{rxi}、k_{rxm}——非混相、混相气相相对渗透率;

k_{rx}、k_{rx}^*——某一相的相对渗透率及修正相对渗透率;

k'_{rg}——束缚水下的气相相对渗透率;

k_{ri}°——相对渗透率的终点值;

L——液体体积分数;

M_o——凝析油分子量;

N_c——毛管数;

n_i——Corey 指数;

p_i、p_r——原始地层压力、地层压力,MPa;

p_{wf}——井底流压,MPa;

p_{dew}——露点压力,MPa;

$p(r,t)$——多孔介质内渗流压力,MPa;

p^*——第 1、2 区边界压力,MPa;

Q_g、Q_o——气相、油相流量,m^3/s;

Q_m——混合流量,m^3/s;

r_e、r_w——供气、井筒半径,m;

R_s、R_P——溶解气油比、生产气油比,m^3/m^3;

s_g、s_o、s_{wi}——气相、液相、束缚水饱和度;

s_{ri}——每相的残余饱和度;

S——表皮因子;

v_g——气体渗流速度,m/s;

V——气体体积分数;

α——与毛管数相关的参数;

β、β^*——紊流系数、修正紊流系数;

γ_o——油相相对密度；
ρ_g、ρ_o——气体、凝析油密度，kg/m^3；
μ_g、μ_o——气相、液相黏度，Pa·s；
φ——孔隙度；
$\psi(r, t)$——拟压力函数；
ψ_{wf}、ψ_e——井底流压、边界压力对应拟压力函数；
ψ_i——不同流动区对应拟压力函数，$i=1, 2, 3$；
$\Delta\psi_{wfi}$——不同流压对应拟压力差；
σ——油气界面张力，Pa。

参 考 文 献

[1] Muskat M. Physical Principles of Oil Production. McGraw—Hill Book Company, Inc. 1949

[2] Fetkovich M J. The Isochronal Testing of Oil Wells. Paper SPE 4529, presented at the 1973 SPE Annual Technical Conference and Exhibition, Las Vegas, Sep. 30—Oct. 3

[3] O' Dell H G, Miller R N. Successfully Cycling a Low Permeability, High — Yield Gas — Condensate Reservoir. JPT. 1967, 19(1): 41~47; Trans., AIME, 240

[4] Fussell D D. Single—Well Performance Production for Gas Condensate Reservoirs. JPT. 1973, 25(7): 860~870

[5] Fevang, Whiston C H. Modeling Gas—Condensate Well Deliverability. SPE. Res. Eng. 1996, 11(4): 221~230

[6] Rocbuck I F, Ford J R, Henderson G E. The Compositional Reservoir Simulation: Case I—The Linear Model. SPE, 1969—03

[7] 郭平. 超声波在凝析油临界流动饱和度测试中的应用. 天然气工业, 2001, 21(3): 22~25

[8] Jane D Gray. Modeling Low IFT Hydrocarbon Phenomena in Porous Media. SPERE, 1991: 353~359

[9] Danesh A, Khazamm M, Henderson G D, Tehrani D H, Peden J M. Gas Condensate Recovery Studies. DTI Improved Oil Recovery and Research Dissemination Seminar, London, June, 1994

[10] Rovert Mott, Andrew Cable, Mike Spearing. Measurements and Simulation of Inertial and High Capillary Number Flow Phenomena in Gas—Condensate Relative Permeability. paper SPE 62 932, presented at the 2000 SPE Annual Technical Conference and Exhibition Held in Dalas, Texas, October 1—4, 2000

[11] Brooks R H, Corey A T. Properties of Porous Media Affecting Fluid Flow of the Irrigation and Drainage Division, Proc. of ASCE, 92, No. IR2, 1996: 61~88

[12] Blom S M P, Hagoort J, Soetekouw D P N. Relative Permeability at Near Critical Conditions. SPE 38 935, Ann. Tech. Conf., San Antonio, October, 1997

[13] Boom W, Wit K, Schulte A M, Oedai S, Zeelenberg J P W, Maas J G. Experimental Evidence for Improved Condensate Mobility at Near Wellbore Conditions. SPE 30 766, Ann. Tech. Conf., Dallas, October, 1995

[14] Ali J, McGauley P J, Wilson C J. The Effects of High—Velocity Flow and Changes Near the Wellbore on Condensate Well Performance. SPE 38 923, Ann. Tech. Conf., San Antonio, October, 1997

[15] Mott R, Cable A, Spearing M. A New Method of Measuring Relative Permeabilities for Calculating Gas — Condensate Well Deliverability. paper SPE 56 484, presented at the SPE Annual Technical Conference and Exhibition, Houstion, October 3—6, 1999

[16] Jones J R, Raghavan R. Interpretation of Flowing Well Response in Gas Condensate Wells. paper SPE 14 204 presented at the 1985 SPE Annual Technical Conference and Exhibition, Las Vegas, Sep. 22—25

[17] Sarfraz A, Jokhio, Djebbar Tiab. Establishing Gas Phase Well Performance for Gas Condensate Wells Producing Under Three—Phase Conditions. paper SPE 76 752 presented at the 2002 SPE/AAPG Western Regional Meeting, May 20—22, 2002, Anchorage, Alaska, U. S. A

[18] Sarfraz A, Jokhio, Djebbar Tiab. Establishing Inflow Performance Relationship (IPR) for Gas Condensate Wells. paper SPE 75 503 presented at the SPE Gas Technology Symposium held in Calgary, Alberta, Canada, April 30—May 2, 2002

[19] Wang X, Mohanty K K. Multiphase Non—Darcy Flow in Gas—Condensate Reservoirs. paper SPE 56 486, presented at the 1999 SPE Annual Technical Conference and Exhibition held in Houston, Texas, October 3—6, 1999

[20] Ahmed H EI—Banbi, McCain W D Jr. Investigation of Well Productivity in Gas — Condensate Reservoirs. paper SPE 59 773, presented at the 2000 SPE/CERI CERI Gas Technology Symposium held in Calgary, Alberta Canada, April 3—5, 2000

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nough to withstand the collapsing load under non— uniform load conditions.

Key words collapse strength non— uniform load casing ellipticity finite element method

CHARACTERISTICS OF GAS CONDENSATE FLOW IN POROUS MEDIA CONSIDERING CAPILLARY NUMBER AND NON— DARCY EFFECT

by Kang Xiaodong, Qin Bin, Li Xiangfang, Cheng Shiqing, (University of Petroleum, Beijing)

Abstract It is found recently in numerous theoretical and experimental researches that capillary number and non— darcy effect caused by high velocity flow has magnificent effect on relative permeability within the immediate vicinity of the well. The classic methods only considering non— darcy effect are impossible to characterize the real flow behavior both gas and condensate accurately. So how to understand and to consider the effects caused by these two effects is important to analyze gas condensate flow and predict production performance. The paper defined a solution problem of two phase flow both gas and condensate and derived the inflow performance relationship equation under pseudo steady state. Based on three zones flow mechanism, the integrated consideration of capillary number and non— darcy effect is firstly presented. Applied analysis showed some new characteristics of gas/ condensate relative permeability and distribution under high velocity flow. Comparing with the different inflow performance relationship models, the result indicates that present method is more accurate than classic ones to predict the production performance and to evaluate the productivity.

Key words gas condensate reservoir capillary number Effect non— darcy effect flow through porous media

RESERVOIR SENSITIVITY EVALUATION OF BLOCK CAO104 IN LE' AN OILFIELD

by Cui Wenjun, Liu Dongliang, Tao Jun, Li Ming, Liu Yanbo, (Xianhe Production Plant of Shengli Oilfield Limited Company)

Abstract Clay minerals of ittite/ mont morillonite mixing layer, kaolinite, illite etc. and carbonate mineral of calcite etc. exist in Cao 104 reservoir in Le' an oilfield. Various sensitivity in these minerals may damage the reservoir in the different stages of oilfield exploration and development. The experiment study indicates that strong water sensitivity and moderate salt sensitivity exist in the reservoir. So attention should be paid to the compatibility between injected water and the formations in the period of water injection development. In addition, the reservoir has weak alkali sensitivity and no earth acid sensitivity, so earth acid can be used for acidizing stimulation.

Key words Le' an Oilfield reservoir clay mineral sensitivity

WATER BLOCKING INVESTIGATION ON LOW PERMEABILITY SANDSTONE RESERVOIRS

by Ma Hongxing, Shi Aiping, Wang Zhimin, Leng Shuling, (Production Technology and Research Institute of Shengli Petroleum Limited Company); Wang Xiaopeng

Abstract Aimed to the limitations of low porosity and permeability of standstone formations, which had the characters of water blocking damages in development, after core flow tests were conducted to simulate the process of water blocking in laboratory, this paper established a new method to evaluate water blocking damage mechanisms of low permeability sandstone formations. The results shows the oil phase permeability of low permeability sandstone cores will be damaged badly because of the invasion aqueous filtrate of workover fluids, the rate decreases from 7% to 60%, and flow pressure will increase from 1 to 3 times. Based on the results, a method avoiding or removing water blocking is worked out. Laboratory test by the core samples has showed that the chemical system has the giant effects on removing water blocking, which can remove 85% of water blocking. This water blocking remove technique has been applied successfully in different oilfields.

Key words low permeability sandstone reservoir water blocking damage water blocking remover

PRESENT DEVELOPMENT AND PROSPECTING OF HYDRAULIC FRACTURING TECHNOLOGY

by Jiang Ruizhong(University of Petroleum, Dongying, Shandong); Jiang Tingxue, Wang Yongli

Abstract Over 50 years of development, hydraulic fracturing has become one of the important way of stimulation and a method for reservoir evaluation, and achieved great progressing on such aspects as fracture model, dynamic prediction, fracturing fluid, propant, fracturing equipment and application fields, etc. Hydraulic fracturing has been further improved and developed in recent years, mainly on overall optimum fracturing, repeated fracturing, large— scale fracturing, high sand fracturing, and CO_2 foam fracturing, etc., and has been applied in the special well conditions such as slant well, horizontal well, deep and ultra— deep well, and slim hole. Domestically, this technology has approached the international advanced standard, especially on such aspects as design software, fracturing and acidizing material and field operation technology, etc. The suitable fracturing technology for different types of reservoir is presented, and the developing direction on novel fracturing material, testing technology, formation damage control and flow—back mechanism is also forecasted.

Key words hydraulic fracturing present development investigation prospecting improvement

RESEARCH AND APPLICATION ON SECOND SAND FILLING FRACTURING

by Lu Xiufeng, Wang Xingzun, Ji Hongbo, Chen Jie, Wang Yansheng, Xia Zengde, (Downhole Servicing Company of Huabei Petroleum Administration Bureau)

Abstract The formation of Huabei Oilfield has the character of low Yang' s Modulus and soft rock. The formation doesn' t possess the ideal barrier bed, which forms the fractures extend over the height of formation, so most parts of the proppants are filled in non — production formation, as well as serious proppant embedment. All of these decline the flow conductivity and come into many ineffective wells and low— effective wells. The article based on the research and analysis causing ineffective and low — effective, and conducted the process of second sand filling fracturing. This technology develops the normal fracture height controlling technology. Through changing the rock mechanics and the flow routine of fracturing fluids, it reached the purpose of controlling fracture height. Also through increasing the layer numbers of proppant filling, it extended the width of fractures and increased fracture flow conductivity. This technology has applied more than 40 wells onsite, it surely increased efficiency and production period after fracturing, and got valuable economic and social benefits.

Key words fracturing second sand filling production increasing mechanics application onsite

INTEGRATION PREVENTION TECHNIQUE OF TUBING DAMAGE IN SHENGLI OILFIELD

by Du Bingguo(Beijing Jiaotong University); Shi Zhongqing, Zhu Wenbing, Feng Cunzhang

Abstract Aimed at the serious status of tubing damage in Shengli oilfield, the paper researched the styles, characters and mechanics of tubing damage, and built the united and perfect tubing damage prevention technique system. It perfected the tubing damage prevention and protection systematic technique from whole process of well drilling, completion, cementing and development, formed the main tubing repairing technique, as expanding trimmer,