煤层气无限导流垂直裂缝井数值试井模型

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摘要 建立了考虑解吸作用的煤层气无限导流垂直裂缝井试井模型, 推导出其有限元方程, 并求得模型的数值解。绘制出无限导流垂直裂缝井的双对数试井理论曲线和煤层中的压力场。从计算所得的试井理论曲线可以看出, 无限导流能力裂缝井的试井理论曲线上存在一段压力和压力导数曲线平行且斜率为 0.5 的直线, 表明了线性流动的存在。从计算结果的压力场图可知, 裂缝周围是椭圆流动, 而远离裂缝区是径向流动。分析了煤层气解吸作用对试井理论曲线的影响, 主要表现为在试井理论曲线的中后期, 压力和压力导数曲线下降, 原因是煤层气解吸缓解了压力下降, 分析了裂缝关于井筒的不对称性。计算结果表明, 裂缝关于井筒的不对称性对试井理论曲线的影响很小, 原因在于裂缝是无限导流垂直裂缝。

关键词 煤层气 数值试井 解吸 无限导流 裂缝井 理论曲线

0 引 言

我国煤层气藏存在低压、低渗透的特征, 为提高煤层气井单井产量, 绝大多数煤层气井需要经过大规模水力压裂才能投产, 而裂缝井的试井测试能够评价出压裂的效果, 确定压力后煤层参数的变化, 因而裂缝井的试井在煤层气开采中具有重要作用。

关于垂直裂缝井, 早在 1972 年就有 Gringarten 和 Ramey 等人[1~3] 做了试井解释的研究, 建立了垂直裂缝井均匀流量和无限大导流模型, 而 Anbarci 和 Ertekin[4] 在 1990 年做了煤层气垂直裂缝井的试井研究, 建立了煤层气双重介质非稳态裂缝井模型, 国内陈伟, 何应付等人[5,6] 建立了新的有限导流压裂井评价和考虑煤层气藏的介质变形的模型。对于煤层气压裂井试井模型, 目前普遍采用的是双重介质模型, 而实际试井时, 煤层并不表现双重介质的特征[7], 而是均匀介质的特征; 另外, 对于裂缝井模型的求解, 普遍采用的是 Laplace 变换的方法, 数值试井的方法研究的较少。基于此, 本文采用均匀介质模型, 其中煤层气的解吸作用用恒定的源来描述, 并利用有限元方法对模型进行数值求解。

垂直裂缝井有多种模型[8], 本文采用裂缝是有厚度且具有无限大导流能力的模型, 并讨论分析了有没有井筒及解吸作用对结果的影响。

本文建立了考虑解吸作用的煤层气无限导流垂直裂缝井试井模型, 推导出其有限元方程, 并求得了模型的数值解, 绘制出了无限导流垂直裂缝井双对数试井理论曲线和煤层中的压力场, 分析了煤层气解吸作用、井筒及裂缝储存、裂缝关于井筒的不对称性对试井理论曲线的影响。

1 物理模型和数学模型

1.1 物理模型描述

煤层为均匀各向同性介质, 煤层中的流体为弱可压缩、定常粘度的牛顿流体, 流体在地层中的流动为层流状态, 遵从达西定律; 裂缝为垂直裂缝, 有一定的宽度且具有无限大导流能力, 即裂缝中没有压差; 裂缝关于井筒可以存在不对称性; 由于测试时间相对较短, 故在整个测试过程中认为, 煤层气稳定解吸或不解吸, 只讨论单相气体渗流, 水仅影响气的相渗透率; 忽略重力和温度变化对流动的影响, 且不考虑其它物理化学的影响。

1.2 数学模型描述

控制方程:

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$$\frac{\partial^2 p_D}{\partial x_D^2}+\frac{\partial^2 p_D}{\partial y_D^2}+\alpha_{1D}=\frac{1}{C_{Df}}\frac{\partial p_D}{\partial T_D} \quad (1)$$

初始条件: $p_D=0$ (2)

边界条件(考虑井筒及裂缝储存):

内边界条件:

$$\sum L_{iD}\left(\frac{\partial p_{iD}}{\partial y_D}\right)\Bigg|_{y=\pm\frac{y_f}{x_f}}=2\pi\left(-1+\frac{\mathrm{d}p_{Dw}}{\mathrm{d}T_D}\right) \quad (3)$$

外边界条件:

无限大边界条件: $p_D\big|_{x,y\to\infty}=0$ (4)

定压边界条件: $p_D\big|_{\Gamma out}=0$ (5)

封闭边界: $\left.\frac{\partial p_D}{\partial n}\right|_{\Gamma out}=0$ (6)

1.3 有限元方程

利用伽辽金加权余量法, 令其权函数为差值函数 $N_i=a_i+b_ix+c_iy$, 则有

$$\iint_A N_i^e\left(\frac{\partial^2 p_D}{\partial x_D^2}+\frac{\partial^2 p_D}{\partial y_D^2}+\alpha_{1D}-\frac{1}{C_{Df}}\frac{\partial p_D}{\partial T_D}\right)\mathrm{d}A=0 \quad (7)$$

其弱表示形式为

$$\iint_A\left(\frac{\partial N_i^e}{\partial x_D}\frac{\partial p_D}{\partial x_D}+\frac{\partial N_i^e}{\partial y_D}\frac{\partial p_D}{\partial y_D}-N_i^e\alpha_{1D}+\frac{N_i^e}{C_{Df}}\frac{\partial p_D}{\partial T_D}\right)\mathrm{d}A=\int_\Gamma N_i^e\frac{\partial p_{Dw}}{\partial n}\mathrm{d}l \quad (8)$$

离散后得到有限元方程为

$$\left(b_1^2+c_1^2+\frac{1}{6C_{Df}\Delta T_D}\right)p_1^{e,n+1}+\left(b_1b_2+c_1c_2+\frac{1}{12C_{Df}\Delta T_D}\right)p_2^{e,n+1}+\left(b_1b_3+c_1c_3+\frac{1}{12C_{Df}\Delta T_D}\right)p_3^{e,n+1}-\frac{L}{3}\frac{\partial p_1^{e,n+1}}{\partial n}-\frac{L}{6}\frac{\partial p_{2/3}^{e,n+1}}{\partial n}$$
$$=\frac{1}{6C_{Df}\Delta T_D}p_1^{e,n}+\frac{1}{12C_{Df}\Delta T_D}p_2^{e,n}+\frac{1}{12C_{Df}\Delta T_D}p_3^{e,n}+\frac{\alpha_{1D}}{3}$$

$$\left(b_1b_2+c_1c_2+\frac{1}{12C_{Df}\Delta T_D}\right)p_1^{e,n+1}+\left(b_2^2+c_2^2+\frac{1}{6C_{Df}\Delta T_D}\right)p_2^{e,n+1}+\left(b_2b_3+c_2c_3+\frac{1}{12C_{Df}\Delta T_D}\right)p_3^{e,n+1}-\frac{L}{3}\frac{\partial p_2^{e,n+1}}{\partial n}-\frac{L}{6}\frac{\partial p_{1/3}^{e,n+1}}{\partial n}$$
$$=\frac{1}{12C_{Df}\Delta T_D}p_1^{e,n}+\frac{1}{6C_{Df}\Delta T_D}p_2^{e,n}+\frac{1}{12C_{Df}\Delta T_D}p_3^{e,n}+\frac{\alpha_{1D}}{3}$$

$$\left(b_1b_3+c_1c_3+\frac{1}{12C_{Df}\Delta T_D}\right)p_1^{e,n+1}+\left(b_3b_2+c_3c_2+\frac{1}{12C_{Df}\Delta T_D}\right)p_2^{e,n+1}+\left(b_3^2+c_3^2+\frac{1}{6C_{Df}\Delta T_D}\right)p_3^{e,n+1}-\frac{L}{3}\frac{\partial p_3^{e,n+1}}{\partial n}-\frac{L}{6}\frac{\partial p_{1/2}^{e,n+1}}{\partial n}$$
$$=\frac{1}{12C_{Df}\Delta T_D}p_1^{e,n}+\frac{1}{12C_{Df}\Delta T_D}p_2^{e,n}+\frac{1}{6C_{Df}\Delta T_D}p_3^{e,n}+\frac{\alpha_{1D}}{3}$$

由内边界总流量等于生产量可知

$$\frac{\sum L_i\frac{\partial p_{Di}^{e,n+1}}{\partial n}}{2\pi}+\frac{1}{\Delta T_D}p_{Dw}^{e,n+1}=1+\frac{1}{\Delta T_D}p_{Dw}^{e,n}$$

内边界各点的压力相等, 即

$$p_{Di}=p_{Dw}$$

其中

$$A=\frac{1}{2}\begin{vmatrix}1&1&1\\x_1&x_2&x_3\\y_1&y_2&y_3\end{vmatrix}$$

$$b_1=\frac{1}{2A}(y_2-y_3),\ b_2=\frac{1}{2A}(y_3-y_1)$$

$$b_3=\frac{1}{2A}(y_1-y_2),\ c_1=\frac{1}{2A}(x_3-x_2)$$

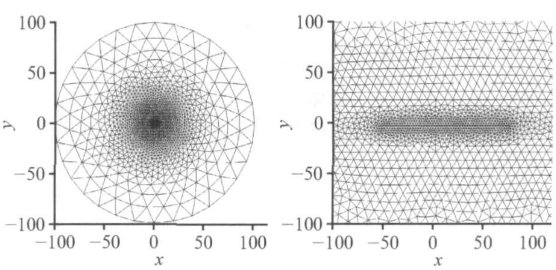
$$c_2=\frac{1}{2A}(x_1-x_3),\ c_3=\frac{1}{2A}(x_2-x_1)$$

式中: A —— 面积。

联立上述方程, 由单元方程组组装系统方程组, 求解系统方程组, 既可得到任意网格点(x,y) 上 $n+1$ 时刻的压力值 $p(x,y)$ 及裂缝上的压力导数值。

1.4 有限元网格离散

为了进行有限元计算, 需对计算区域进行离散, 采用非结构三角形网格, 外边界为圆形边界。对于圆形封闭煤层, 离散结果如图 1 所示。图 1a 表明了整个研究区域的网格划分情况, 但由于网格尺度的差异, 无法详细了解裂缝附近的网格划分状况。因此, 需要对网格图进行放大。裂缝附近的网格放大图如图 1b 所示。



a. 圆形煤层全区网格图　　b. 裂缝附近区域的网格图

图1 煤层气地层的非结构网格图

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2　计算结果及分析

根据所建立的数学模型和推导出的有限元方程, 利用所划分的有限元网格计算了不同裂缝存储系数、不同煤层气解吸系数以及不同裂缝关于井筒对称情况下的煤层气试井对数理论曲线及煤层中的压力场分布。

2.1　裂缝存储对试井理论曲线特征的影响分析

考虑没有解吸的情况, 即 $\alpha_{1D}=0$, 取边界半径为100, 所得到的无限导流垂直裂缝井双对数曲线如图 2 所示。

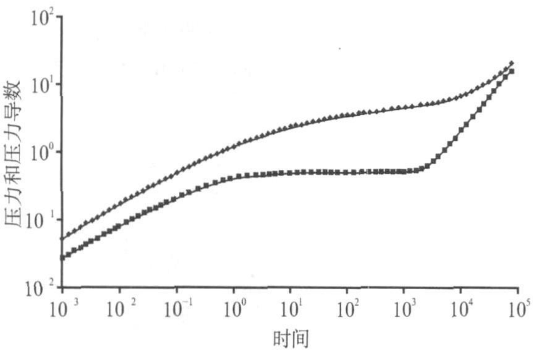


图2　封闭地层中无井储无限导流的双对数图

由图 2 可以看到, 煤层气试井曲线大致可分为三个阶段: 第一个阶段为线性流阶段, 压力和压力导数曲线平行且直线斜率为 0.5; 第二阶段是径向流阶段, 试井理论曲线中的压力导数曲线为数值等于 0.5 的水平直线段; 第三个阶段为边界影响阶段, 在封闭边界的影响下, 试井理论曲线中压力和压力导数曲线呈现斜率为 1 的直线。

2.1.1　考虑裂缝储存对煤层气井试井理论曲线的影响

取无量纲裂缝存储系数为 0.001、0.01 和 0.1, 分别计算所研究区域的试井理论曲线, 计算结果如图3 所示。在图 3 中, 曲线 1、2 和 3 分别代表无量纲存储系数为 0.001、0.01 和 0.1 时的计算结果。

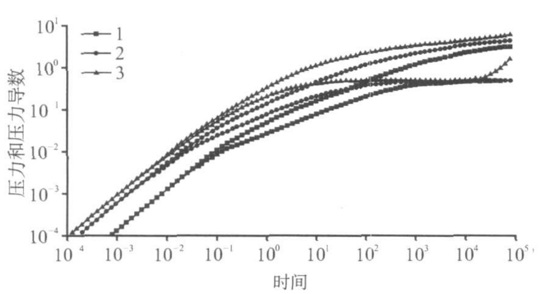
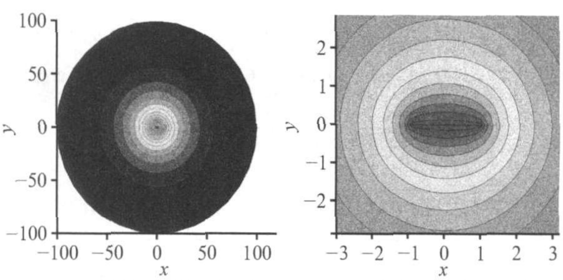


图3　不同裂缝存储系数的双对数曲线图的影响

从图 3 可以看到, 流动大致可分为四个阶段: 第一个阶段为裂缝存储阶段, 同常规井筒存储系数对试井理论曲线的影响一样, 试井理论曲线中压力曲线与压力导数曲线重合且为斜率等于 1 的直线段, 说明早期的试井理论曲线仍然是由流体的压缩所引起的存储效应所控制; 第二个阶段是裂缝线性流阶段, 试井理论曲线中的压力和压力导数曲线呈现为 0.5 斜率的平行直线, 说明了煤层中线性流动的存在。另外, 裂缝存储系数越大, 线性流阶段越短, 1/2 线越难见到; 第三个阶段是径向流阶段(0.5 水平线), 表明整个系统达到稳定流动状态; 第四个阶段为边界影响阶段。

2.1.2　煤层压力场特征分析

将以上任何一种情况的计算结果做出煤层中的压力场分布图如图 4 所示。



a. 圆形煤层全区的压力场图　　b. 裂缝附近区域的压力场图

图4　煤层压力场分布图

从图 4a 可以看出, 在远离裂缝区流动呈现为径向流, 压力等值线为同心圆; 从图 4b 可以看出, 在裂缝周围压力等值线为椭圆且不交于裂缝, 即裂缝周围为椭圆流动且裂缝各点压力相等, 裂缝无压差, 这是无限导流能力垂直裂缝的特征。

2.2　煤层气解吸作用对试井理论曲线的影响分析

考虑煤层气解吸作用对地层压力的影响, 分别取稳定解吸系数 α_{1D} 为 0、-10^{-4}和 -2.04×10^{-4}, 井储 $C_{Df}=0.01$, 边界半径 $R=100$, 所得到的试井理论曲线如图5 所示。

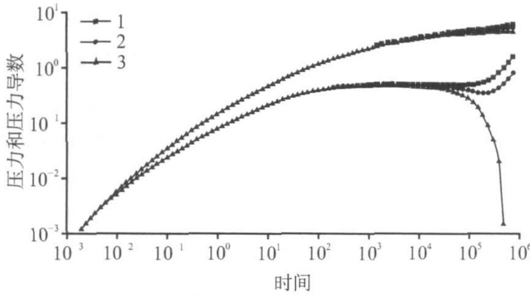


图5　考虑煤层气解吸作用的试井理论曲线图

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从图 5 可以看到,煤层气解吸作用不影响曲线的早期,但对曲线的晚期影响比较大,煤层气解吸强度越大,缓解压力降落的能力越大。当煤层气解吸强度达到一定时,如曲线 3 流动类似于遇到了定压边界,压力导数曲线下掉,压力保持不变,流动达到稳定的状态。

2.3 裂缝关于井筒的对称性对试井理论曲线的影响分析

目前,绝大部分裂缝井模型都没有考虑裂缝关于井筒对称性的影响,只考虑了裂缝边界特征。由于有限元数值计算在处理不规则边界的优越性,笔者考虑了裂缝关于井筒的对称性对试井理论曲线的影响,分 3 种情况进行讨论: ①不考虑井筒的存在,这是目前大多数垂直裂缝井试井分析所采用的模式。②考虑井筒的存在,而且裂缝关于井筒对称。③考虑井筒的存在,但是裂缝关于井筒不对称。这 3 种模式的物理模型如图 6 所示。根据图 6 的 3 种物理模式所计算得到的试井理论曲线如图 7 所示。

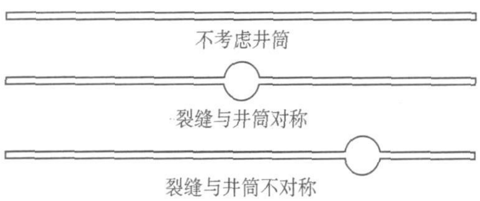

图6 三种物理模型的示意图

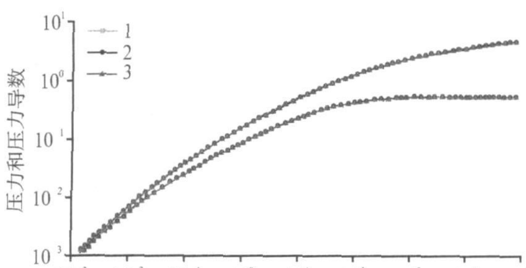

图7 三种模型的双对数曲线

从图 7 的计算结果可以看出,3 种情况计算出的试井理论曲线基本重合,说明裂缝关于井筒的对称性对于煤层气无限导流垂直裂缝试井理论曲线几乎没有影响,原因在于裂缝是无限导流垂直裂缝。因此,在裂缝特征方面,对于煤层气无限导流垂直裂缝试井理论可以只重点考虑裂缝边界。从试井理论曲线可以看出,在试井理论曲线的早期存在压力和压力导数曲线平行且斜率为 0.5 的直线段,表明无限导流垂直裂缝的特征是非常明显的,说明了煤层中的线性流动是存在的。另外,煤层系统的径向流动也是明显的。这些结论与图 4 所示的煤层中的压力场图所表现的结果是完全一致的。

3 结 论

压裂改造能够改善煤层气井底渗流条件,有效降低井底流压,对煤层气井进行压裂是提高煤层气单井产量的有效措施。通过对煤层气压裂井进行数值试井分析,得到压裂井的试井理论特征曲线具有裂缝特征,无限导流能力的裂缝井在特征曲线上具有斜率为 0.5 的直线段,裂缝周围呈现椭圆流动,在远离裂缝区呈现径向流动状态。煤层气解吸作用对试井理论曲线中后期具有明显的影响,由于煤层气解吸作用缓解了压力下降,使得试井测试后期理论压力导数偏小。

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the problem why CBM is cleaner, efficient and safe energy resource. First, CBM is a new energy showed by it' s development history and unconventional properties. Second, CBM is cleaner than other energy resources considering it' s combustion products. Third, CBM is more efficient due to it' s calorific value and utilization ratio. In addition, CBM is safe in atmospheric environment and coal mine environment. In this paper, C/H ratio is considered to be a key factor to energy resources mainly comprised of carbon element and hydrogen element in determining the quality of the energy. That is to say, the smaller the C/H ratio is, the better(cleaner, more efficient and safer) the energy is. Finally, according to the advantages of CBM, it plays an important role in energy supply and environment protection, which shows the importance of development and utilization of CBM.

Key words: coalbed methane, clean energy, efficient energy, safe energy, environment pollution

Study on AGA8-92DC Method of Gas Deviation Factor Calculation. 2010, 19(6) : 29~ 36

Su Zhongliang, Liu Yuewu (Institute of Mechanics, Chinese Academy of Sciences), Zhang Junqing (International Division, CNPC)

The deviation factor, as one of the most important physical property parameters of natural gas, plays an important role in the exploration, production, transportation, processing and use of natural gas. In this paper, the existing methods of calculating the gas deviation factors are summarized, and a special research of a widely used method named AGA8-92DC (AGA8) is conducted. Although AGA8 has been an international standards on calculating gas deviation factors since 1992, few studies have been conducted up to now. So the scope of application or the accuracy of AGA8 is not well known. Using the self-compiled C+ + program for AGA8, we obtain the deviation factors of the gases with different components under different temperatures and pressures. By comparing the computed deviation factors with the Standing-Katz chart data or experimental data , the scope of application of AGA8 is determined. This study will lay a solid foundation for the application and extension of AGA8 method.

Key words: natural gas, deviation factor (compressibility factor) , critical properties, EOS

Review on CBM Desorption / Adsorption Mechanism. 2010, 19(6) : 37~ 44

Liu Yuewu, Su Zhongliang, Zhang Junfeng (Institute of Mechanics, Chinese Academy of Sciences), Fang Hongbin (Institute of Aerospace Engineering and Mechanics, Tongji University)

By analyzing factors that restricting the development of CBM and energy demand at home and abroad, the paper pointed out that researching CBM desorption and adsorption mechanism is significant. Through analyzing domestic and international history and current status of CBM desorption and adsorption mechanism, CBM desorption and adsorption mechanism was grouped into two classes: monolayer adsorption and multi-molecular layer adsorption. CBM desorption and adsorption mechanism model was divided into five categories: Langmuir isothermal and the extended model, BET multi-molecular layer adsorption model, adsorption potential theoretical model, adsorption solution model and experimental data analysis model. Factors that affecting CBM desorption and adsorption which included coal bed property, pore structure, components of CBM, pressure conditions, temperature conditions and so on were analyzed in detail. The research showed future direction of desorption and adsorption mechanism, especially the way of methane and water combining and separation with carbon molecules in coal bed, was to study mainly the dynamic process of CBM desorption and adsorption states in the condition of complex factors at current.

Key words: coalbed methane (CBM) , absorption/desorptio, mechanisum, model

Research on Unstructured Grid Generation for CBM Numerical Well Testing. 2010, 19(6) : 45~ 48

Li Haisheng (College of Computer and Information Engineering, Beijing Technology and Business University) , Liu Yuewu (Institute of Mechanics, Chinese Academy of Sciences)

This paper analyzes the unstructured grid generation methods in numerical well testing. The" winged edge" data structure is designed by using the good characteristics of Delaunay triangulation. The constrained Delaunay triangulation algorithm with good mesh quality is achieved. Examples show that the resulting grid with boundary constraint consistency and better quality, which can meet the requirements of CBM computing numerical well testing.

Key words: CBM well tesing, unstructured grid, Delauany triangulation, constrained, Voronoi diagram

Numerical Well Testing Method for Well by Considering CBM Desorption. 2010, 19(6): 49~ 52, 70

Ouyang Weiping, Liu Yuewu (Institute of Mechanics, Chinese Academy of Sciences)

The distinguish character between CBM well test and normal gas well test is the desorption phenomena in coalbed. This paper developed a new well test model for CBM well by considering the desorption effect in homogeneous coalbed. The stable source method is introduced to describe the desorption effect in the governing equation. And the numerical solution is obtained by finite element method. By analyzing the desorption coefficient, it shows that the desoption effect made the pressure drop slowly and the pressure wave propagate slowly also. When the desorption coefficient reached a certain value, the desorption rate will be equal to the production rate and the pressure wave will stop propagate. It is similar to that there exists a constant pressure boundary in the coalbed. In addition, by considering the effect of critical desorption pressure, it shows that the smaller difference between the critical desorption pressure and the initial pressure, the earlier emerging of the desorption effect and the greater impact on well test type test curve.

Key words: CBM, seepage, desorption, numerical well testing, finite element

Numerical Well Test Model for CBM Infinite Conductivity Vertical Fracture Well. 2010, 19(6) : 53~ 56

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Considering the effects of CBM desorption and absorption in coalbed, a new infinite conductivity vertical fracture well test model is developed in this paper, the finite element equation was derived and numerical solution was obtained. The type curve in double logarithmic form and pres-

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sure distribution field in coalbed are all showed in detail. The well test type curves showed that there are parallel straight section lines in pressure and pressure derivative curve with slope equal to 0.5, which confirmed the existence of linear flow in coalbed. From the pressure distribution field map, we found that the elliptic flow around fractures, but the radial flow far away from fractures. The effect of CBM desorption to theoretical curves showed pressure and pressure derivative curves drew down in middle and later periods of curves. And the reason was CBM desorption delayed the pressure decrease. By analyzing the fracture asymmetry about the wellbore, the results show that there is less impact of fracture asymmetry on the well test type curve for the different calculation cases, since the fractures are infinite conductivity vertical fracture. wellbore asymmetry had well test theory curves.

Key words: CBM, numerical well testing, desorption, infinite conductivity, fractures well, type curve

The Exploration of Finite Volume Method in CBM Numerical Well Testing. 2010, 19(6): 57~ 63

Niu Congcong, Cai Qiang, Li Haisheng (Beijing Technology and Business University), Liu Yuewu (Institute of Mechanics, Chinese Academy of Sciences)

By comparing the advantages and disadvantages among the normally used numerical methods in modern numerical well testing technology, it shows that the finite volume method is the best one for solving the governing equation of CBM. So we choose finite volume method to solve CBM numerical well testing model. 1-D radial flow and 2-D flow model are developed for the well in circular CBM region with steady desorption. The corresponding discrete equation forms of the finite volume method are derived for both 1-D and 2-D cases. The influence of desorption coefficient, the boundary distance, boundary properties, the combination coefficient etc on test well test type curves are discussed in detail in this work. The results show that the type curves clearly reflected the pressure changes of CBM wells in the different conditions, and finite volume method is very suitable for solving CBM well test problem. Finite volume method provides a new numerical calculation method for solving CBM well test model. It leads a productive progress on developing CBM numerical well test.

Key words: CBM, finite volume method, numerical well test, steady desorption

Research on Pressure Field in Circle Bounded Coalbed With Two Wells. 2010, 19(6): 64~ 70

Liu Yuewu, Ouyang Weiping, Su Zhongliang (Institute of Mechanics, Chinese Academy of Sciences), Zhao Peihua (Coalbed Methane Ltd. Comp, PetroChina)

The nature of CBM production is draining water to drop pressure and produce methane. So it is important to know the pressure dropping effect for producing methane. By considering CBM desorption effect, mathematical model for unsteady seepage flow is developed in circle bounded coalbed with two wells. The numerical solutions are obtained by using the finite element method. The desorption effects on the well test type curve are analyzed in detail. The results show that CBM desorption decrease the pressure wave transmitting velocity in the coal bed. The effect of the neighbor well property on type curve is also analyzed for describing the development of pressure field. Four kind of description methods are intrduced and evaluated in this paper. The effects of well property, flow rate of the neighbor well and property of the outer boundary on the pressure field are analyzed for the pressure field changing under different conditions.

Key words: coalbed methane, pressure field, well test, desorption

Numerical Study on Seepage Field in Coalbed With Cavity Well. 2010, 19(6): 71~ 75

Liu Yuewu, Ouyang Weiping, Su Zhongliang (Institute of Mechanics, Chinese Academy of Sciences), Zhao Peihua (Coalbed Methane Ltd. Company, Petrochina), Fang Huijun (Guangzhou Institute of Geochemistry, Chinese Academy of Sciences)

Physical model of fluid flow in coalbed with CBM cavity well is described in this paper at the first time. Near the wellbore there exists a high permeability region whose permeability is far greater than that of the coalbed far from the CBM well. The fluid flow in this region also obeys Darcy's flow. Based on the description of physical model, mathematic model for fluid flow in coalbed wih CBM cavity well is developed in this paper. Seepage field in coalbed with CBM cavity well is obtained under circular and arbitrary quadrilateral outer boundary by using finite element method. In order to compare seepage field in coalbed with CBM cavity wells with that of open hole completion well, seepage is simulated about one cave completion, one open hole completion and one cave completion, two open hole completions. So the difference of seepage between cave completion and open hole completion is visible. The results of this research is significant important to comprehend fluid flow mechanics and pressure distribution in coalbed with CBM cavity wells.

Key words: CBM, model, seepage, seepage field, finite element

Software Design and Development of CBM Well Test. 2010, 19(6): 76~ 81

Li Qi, Cai Qiang, Li Haisheng (Beijing Technology and Business University), Liu Yuewu (Institute of Mechanics, Chinese Academy of Sciences)

The significance of design and development of CBM well test analysis software is introduced and the characteristics of oil and gas well test analysis software normally used at home or abroad are summarized in this paper. With the development of CBM well test technique and the requirements of CBM well test analysis, software technical requirement and development are introduced, framework and all function modules of the software are designed, all based on the special nature of CBM such as desorption, deformation, low permeability, etc. CBM well test analysis software is designed and developed based on software engineering thought. The software includes data preparation module, well test analysis module, well test design module and report generation and output module. The software has friendly UI, rich models, powerful function and friendly framework.

Key words: software, CBM, well test, design and development

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