应用漏斗粘度计测定幂律流体的流变参数 *

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摘　要　流体在漏斗粘度计中的流动规律及流变参数的确定 ,是目前国内外尚未很好解决的问题。根据位能与动能的变化关系 ,作者研究了在非恒定静压作用下幂律流体垂直下落的规律及流变参数与时间的关系 ,从而为计算漏斗粘度计中流体的流变参数提供了理论依据。文章采用流体静压头下降成比例的测量方法 ,记录其流动时间 ,简便地解决了幂函数求解指数的显函数方法。文章最后应用四种不同性能的液体 ,采用旋转粘度计实测的有关参量 ,与漏斗粘度计及旋转粘度的计算结果对比 ,说明了漏斗粘度计在一定条件下具有较高的测量精度 ,能较好地用于钻井液的流变学设计。

主题词　漏斗粘度计　幂律流体　流变参数　有效粘度

通过钻井液在漏斗粘度计的流动时间来判断其流动性能 ,是目前现场钻井界最常用的方法。这种方法虽然反映了液体的流动性能 ,但并不能反映其液体的流变性能 ,特别不能反映非牛顿流体流变性能的内涵 ,不能进行钻井液的流变学设计。M. J. Pitt 在 2000 年 SPE 杂志上发表过有意义的文章[1] ,如何应用马氏漏斗粘度计测定和计算有效粘度的问题 ,并给出了该粘度计中 ,测量流出 1 000 cm^3 (1 500～500 cm^3) 液体的时间与有效粘度的通用关系式 , $\mu_e = \rho(t_s - 25)$ 。作者的意图是通过测定任意液体在漏斗粘度计中流出 1 000 cm^3 的总时间 t_s[2] ,即可算出有效粘度(μ_e) 。在测量清水时 , $t_s = 26$ s ,故 $\mu_e = 1$ mPa·s ,从而说明公式的准确性。这里有以下几个问题 ,是值得进一步研究的。①在测量清水时 ,清水在漏斗粘度计管嘴中的流态已属紊流状态 ,雷诺数为 10 285 ,测出的粘度值应小于 1 mPa·s ,而不是等于 1 mPa·s ;而对于粘度大于 4 mPa·s 的牛顿液体 ,管嘴中的流动已属层流测量 ,引入式子同样不完全适合 ; ②对于幂律流体 ,引用牛顿液体的剪切速率来计算有效粘度 ,特别是非牛顿性强的流体 ,误差偏大很多。

上面分析说明 ,通过测量牛顿液体在漏斗粘度计中定量的流动时间 ,可以计算出有效粘度 ,但不是前面所介绍的公式。对于幂律流体 ,这种方法却仍不能计算液体的有效粘度、流性指数 n 和稠度系数 K 值。这也是本文所要解决的问题。

幂律流体在漏斗粘度计中的流动规律

漏斗粘度计的结构如图 1 所示。流体在漏斗粘

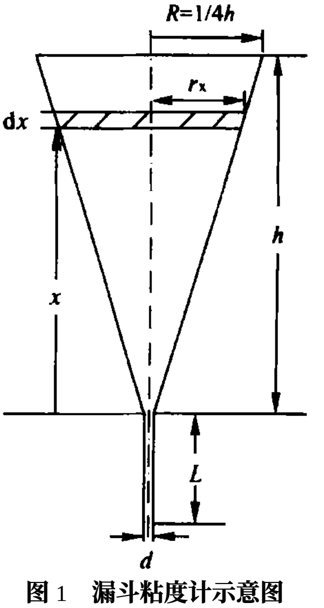

图 1　漏斗粘度计示意图

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度计中自上而下的流动,具有以下特点:①流体是在自重静压头作用下流动,其压头并不恒定,而是在不断变化;②流体经漏斗及管嘴的流动时间 t_s 包括两部分,一部分是流体自由下落的时间 t_{fa},这部分时间与流体性质无关,只和静压头的大小及变化有关;而另一部分是流体摩阻所消耗的时间 t_f,这部分时间不仅与静压头大小及变化有关,而且与流体的流变性质有关;③流体在管嘴中的流速要比漏斗中液体下落速度大 450～900 倍,故摩阻只考虑管嘴部分。

1. 流体自由下落的时间

当流体盛入漏斗粘度计时(图1),在任意静压 x 时的情况下,管嘴的流速为 v_x:

$$v_x = \sqrt{2hx} \tag{1}$$

当从管嘴流出高度为 dx 的流体时,其流出的体积和流动时间分别为:

$$V = \pi r_x^2 dx = \pi \left(\frac{R}{h}\right)^2 x^2 dx \tag{2}$$

$$dt = \frac{Ex^2}{v_x} dx = \frac{Ex^2}{\sqrt{2gx}} dx$$

当漏斗内的流体从 h_4 降至 h_3 时,其自由下落的时间则为:

$$t_{fa} = \frac{0.4E}{\sqrt{2g}} (h_4^{2.5} - h_3^{2.5}) \tag{3}$$

2. 幂律流体摩阻所消耗的时间

根据压头与幂律流体摩阻的平衡关系,可求出幂律流体管嘴流速及流动时间的表达式:

$$\rho g x = A v_x^n$$

$$v_x = \left(\frac{\rho g}{A}\right)^{\frac{1}{n}} x^{\frac{1}{n}} \tag{4}$$

$$dt = E\left(\frac{A}{\rho g}\right)^{\frac{1}{n}} x^{2-\frac{1}{n}} dx$$

当漏斗内的流体从 h_4 降至 h_3 时,因流体摩阻经管嘴所消耗的时间为:

$$t_f = \frac{2E(3n+1)}{(3n-1)d}\left(\frac{0.04LK}{\rho d}\right)^{\frac{1}{n}}\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right) \tag{5}$$

对于国产漏斗粘度计 $L = 10$ cm, $d = 0.5$ cm, $E = 0.25\ d^{-2} = 1\ cm^{-2}$;对于马氏漏斗粘度计 $L = 5.08$ cm, $d = 0.476$ cm, $E = 1.103\ 4\ cm^{-2}$。将两组数据代入式(5),分别得出国产漏斗粘度计和马氏漏斗粘度计中管嘴的摩阻公式为:

$$t_{f1} = \frac{4(3n+1)}{3n-1}\left(\frac{0.8K}{\rho}\right)^{\frac{1}{n}}\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right) \tag{6}$$

$$t_{f2} = \frac{4.636(3n+1)}{3n-1}\left(\frac{0.427K}{\rho}\right)^{\frac{1}{n}}\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right) \tag{7}$$

实测的 t_f 是根据钻井液在漏斗中流动的总时间 t_s 与同一条件下,流体自由下落时间 t_{fa} 之差确定,即 $t_f = t_s - t_{fa}$。

3. 流体在漏斗粘度计中的有效粘度

(1) 牛顿液体在管嘴中的有效粘度

根据式(6)、(7)及流出定量的流体,其有效粘度的表达式为:

国产漏斗粘度(盛流体 700 cm^3,流出 500 cm^3),

$$\mu_{eN1} = \frac{(t_{s1} - 13.34)\rho}{1.795\ 2} \tag{8}$$

马氏漏斗粘度计(盛流体 1 500 cm^3,流出 1 000 cm^3),

$$\mu_{eN2} = \frac{(t_{s2} - 25.71)\rho}{1.692\ 1} \tag{9}$$

式(8)、(9)的有效粘度,单位为 mPa·s。

(2) 幂律流体在管嘴中的有效粘度

国产漏斗粘度计:

$$\mu_{eL1} = 0.312\ 52 n\rho(3n+1)^{-1}\left[\frac{t_{f1}(3n-1)}{n\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right)}\right]^n v_{43}^{n-1} \tag{10}$$

马氏漏斗粘度计:

$$\mu_{eL1} = 0.297\ 44 n\rho(3n+1)^{-1}\left[\frac{0.906 t_{f2}(3n-1)}{n\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right)}\right]^n v_{43}^{n-1} \tag{11}$$

从式(8)～(11)可知:①将清水实测流动时间数据 $t_{s1} = 15$ s, $t_{s2} = 26$ s 代入式(8)、(9),即可求出清水的有效粘度 μ_{eN1} 和 μ_{eN2},由于清水在管嘴已处于紊流状态,μ_{eN1} 和 μ_{eN2} 均小于 1 mPa·s,说明公式相对于 M.J. Pitt 提出的公式更合理;②幂律流体的有效粘度不能用 M.J. Pitt 提出的表达式及公式(8)、(9)进行计算,而是应用式(10)、(11)计算;③应用流体在漏斗粘度计的单点流动试验数据,是无法求解幂律流体的流变参数。只有通过两组或两组以上的流动试验数据,计算 n、K 值后,幂律流体的有效粘度才能予以确定。

在漏斗粘度计中幂律流体流变参数的测定

现应用国产漏斗粘度计多组流体流动时间的试验数据,计算其流变参数。

当流体初始静压头 h_4 降至 h_3 时,流体摩阻实测消耗的时间为 t_{f43}:

$$t_{f43} = \left(\frac{0.8K}{\rho}\right)^{\frac{1}{n}} \frac{4(3n+1)}{3n-1} h_4^{3-\frac{1}{n}}\left[1 - \left(\frac{h_3}{h_4}\right)^{3-\frac{1}{n}}\right] \tag{12}$$

流体继续从静压头度 h_3 降至 h_2 时,t_{f32} 为:

$$t_{f32} = \left(\frac{0.8K}{\rho}\right)^{\frac{1}{n}} \frac{4(3n+1)}{3n-1} h_3^{3-\frac{1}{n}} \left[1 - \left(\frac{h_2}{h_3}\right)^{3-\frac{1}{n}}\right] \tag{13}$$

h_2 再降至 h_1 时,t_{f21} 为:

$$t_{f21} = \left(\frac{0.8K}{\rho}\right)^{\frac{1}{n}} \frac{4(3n+1)}{3n-1} h_2^{3-\frac{1}{n}} \left[1 - \left(\frac{h_1}{h_2}\right)^{3-\frac{1}{n}}\right] \tag{14}$$

如 $\frac{h_3}{h_4} = \frac{h_2}{h_3} = \frac{h_1}{h_2}$

则

$$\left(\frac{h_4}{h_3}\right)^{3-\frac{1}{n}} = \frac{t_{f43}}{t_{f32}} \tag{15}$$

$$\left(\frac{h_3}{h_2}\right)^{3-\frac{1}{n}} = \frac{t_{f32}}{t_{f21}} \tag{16}$$

将式(15)和(16)取对数相乘,经整理得:

$$n = \left[3 - \sqrt{\frac{\left(\ln\frac{t_{f43}}{t_{f32}}\right)\left(\ln\frac{t_{f32}}{t_{f21}}\right)}{\left(\ln\frac{h_4}{h_3}\right)^2}}\right]^{-1} \tag{17}$$

$$K = 1.25\rho\left[\frac{t_{f43}(3n-1)}{4(3n+1)\left(h_4^{3-\frac{1}{n}} - h_3^{3-\frac{1}{n}}\right)}\right]^n = 1.25\rho\left[\frac{t_{f32}(3n-1)}{4(3n+1)\left(h_3^{3-\frac{1}{n}} - h_2^{3-\frac{1}{n}}\right)}\right]^n \tag{18}$$

表 1 为满足 $\frac{h_3}{h_4} = \frac{h_2}{h_3} = \frac{h_1}{h_2}$ 时,不同漏斗粘度计的 h_4、h_3、h_2、h_1 及相应范围 $h_4 \sim h_3$,$h_3 \sim h_2$,$h_2 \sim h_1$,所流出的体积。

表 1　满足相邻静压头恒定比值的有关参量

漏斗粘度计类型		h_4	h_3	h_2	h_1	h_4/h_3
国产	静压头(cm)	22.033	19.170	16.679	14.511	1.149 4
	流出量(mL)	239	155	106		
马氏	静压头(cm)	28.405	25.141	22.252	19.695	1.129 8
	流出量(mL)	460	298	242		

实验结果比较

下面采用旋转粘度计[3]和国产漏斗粘度计的测量方法,对钻井液及聚丙烯酰胺水溶液等四种液体,进行幂律流体流变参数的有关计算[4],并与旋转粘度计所测得的剪切应力进行对比,以证明漏斗粘度测量方法的可靠性。

表 2、3 为四种流体,应用两种粘度计测试的基本数据及流变参数计算值。

表 2　不同流体在漏斗粘度计及旋转粘度计中的测试数据

粘度计类型	液体编号	$h_4 \sim h_3$			$h_3 \sim h_2$			$h_2 \sim h_1$		
		流体流动时间(s)								
		t_s	t_{fa}	t_f	t_s	t_{fa}	t_f	t_s	t_{fa}	t_f
国产漏斗粘度计	1	12.17	6.050 34	6.12	8.95	4.272 18	4.678	6.95	3.016 6	3.573
	2	17.75	6.050 34	11.70	13.32	4.272 18	9.05	10.04	3.016 6	7.023
	3	14.79	6.050 34	8.690	10.79	4.272 18	6.518	8.89	3.016 6	5.873
	4	19	6.050 34	12.95	16.54	4.272 18	12.268	10.67	3.016 6	7.653

	液体编号	测量格数					
		$\phi600$	$\phi300$	$\phi200$	$\phi100$	$\phi6$	$\phi3$
旋转粘度计	1	16.5	10	8	5	0.1	0.05
	2	40	26.5	20.5	14	3	1
	3	38	25	19	13	4	3
	4	48	32.5	25	13	10	8

注:t_s、t_{fa}、t_f 分别为漏斗粘度计中定量流体流完后测出的总时间,自由下落计算时间及摩阻所消耗的时间,$t_f = t_s - t_{fa}$。

表 3　不同粘度计中幂律流体的流变性能

序号	ρ	旋转粘度计		漏斗粘度计	
		n	$K(\mathrm{Pa \cdot s^n})$	n	$K(\mathrm{Pa \cdot s^n})$
1	1.0	0.800 2	0.032 94	0.936 2	0.013 37
2	1.0	0.919 7	0.034 89	0.857 0	0.044 325
3	1.044	0.604 1	0.295 3	0.569 2	0.302 06
4	1.405	0.562 5	0.497 50	0.54	0.515 1

从表 4 可知:①从四种流体对比情况来看,两种粘度计的计算剪切应力与旋转粘度实测剪切应力的平均误差相当,剪切速率大于 340 s^{-1} 时,旋转粘度计计算剪切应力比漏斗粘度计的误差要小,而低剪切速率的剪切应力,则漏斗粘度计的计算值更接近实测值;②从配方 3、4 的流变参数比较,两种粘度计的计算结果非常接近,n、K 值的平均相对误差为 4.9%和 2.1%;③两种粘度计计算的剪切应力误差虽然较大,但并不影响两种粘度计相互对比结果。误差较大只能说明,试验流体不能很好适应幂律流体的流变规律;④漏斗粘度计的计算剪切应力一般为负误差,容易进行修正。

结　论

(1) 以清水作为标准,判断漏斗粘度计的准确程度,是较方便的方法。该方法不能作为有效粘度小于 4 mPa·s 液体的具体测量。

(2) 由于钻井液的粘度一般都大于 4 mPa·s,使用漏斗粘度在现场测量其流变参数是较为方便的方法。

(3) 在漏斗粘度计中,单点测试牛顿液体的流动时间,可以应用推导的公式计算有效粘度。

表4　幂律流体剪切应力计算值与旋转粘度计实测值相比较

序号	参数		剪切速率(s^{-1})						平均相对误差(%)
			1 022	511	340.6	170.3	10.22	5.11	
			测量格数						
			φ600	φ300	φ200	φ100	φ6	φ3	
1	测量值		16.5	10	8	5	0.1	0.05	
	旋转粘度计	计算值	16.5	9.48	6.85	3.93	0.414	0.238	121.83
		相对误差(%)	0	5.2	14.4	21.4	314	376	
	漏斗粘度计	计算值	17.16	8.97	6.14	3.21	0.23	0.120 1	57.3
		相对误差(%)	4	10.3	23.3	35.8	130	140.2	
2	测量值		40	26.5	20.5	14	3	1	
	旋转粘度计	计算值	40	21.15	14.56	7.7	0.579	0.306	40.72
		相对误差(%)	0	-20.20	-28.97	-45.02	-80.7	-69.4	
	漏斗粘度计	计算值	32.09	17.72	12.52	6.91	0.62	0.343	47.91
		相对误差(%)	-19.78	-33.13	-38.93	-50.64	-79.3	-65.7	
3	测量值		38	25	19	13	4	3	
	旋转粘度计	计算值	38	25	19.57	11.31	2.35	1.548	17.60
		相对误差(%)	0	0	3	-13	-41.25	-48.4	
	漏斗粘度计	计算值	30.52	20.57	16.33	11.01	2.219	1.496	26.90
		相对误差(%)	-19.7	-17.7	-14	-15.3	-44.53	-50.13	
4	测量值		48	32.5	25	13	10	8	
	旋转粘度计	计算值	48	32.5	25.87	17.52	3.60	2.44	28.63
		相对误差(%)	0	0	3.5	34.77	-64	-69.5	
	漏斗粘度计	计算值	42.52	29.24	23.49	16.16	3.54	2.432	30.99
		相对误差(%)	-11.4	-10	-6	24.3	-64.6	-69.6	

(4)在漏斗粘度中,根据流体静液面下降成比例的原则,多点测试其流动时间,可简便地计算幂律流体的流变参数 n、K 值和有效粘度,否则只有用叠代近似方法求解。

(5)漏斗粘度计测量和计算幂律流体的流变参数,由于相对误差与旋转粘度计测量相近,其计算结果可用于相同条件下的钻井液流变学设计。

(6)由于马氏漏斗粘度计所测量的流体体积比国产漏斗粘度计多一倍,其测量准确程度前者比后者更高。

(7)在漏斗粘度计中,其它本构方程流体流变参数的计算方法,需继续进行研究。

符　号　说　明

μ_{eN}为牛顿液体的有效粘度,mPa·s;μ_{el}为幂律流体的有效粘度,Pa·s^n;n为流性指数,无因次;K为稠度系数,Pa·s^n;d为漏斗粘度计管嘴直径,cm;L为漏斗粘度计管嘴长度,cm;v为漏斗粘度计中流体在管嘴中的流速,cm/s;t_s为流体在漏斗粘度计中流动的总时间,s;t_{fa}为流体自由下落某一段的时间,s;t_f为流体经管嘴因摩阻所消耗的时间,s;t_{f43}、t_{f32}、t_{f21}分别表示各段流体在漏斗粘度计管嘴中摩阻所消耗的时间,s;h_4、h_3、h_2、h_1分别表示漏斗粘度计中测量点的位置,cm;g为重力加速度,980 cm/s^2;ρ为液体密度,g/cm^3。

下标43、32、21为漏斗粘度计中液面自上而下流完定量体积的高度范围。

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crete methods adopted in Sichuan are introduced.

SUBJECT HEADINGS: Sichuan, Natural gas, Drilling, Pressure control

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COMPUTER SIMULATING ANALYSIS OF EXPANDABLE CASING

Lian Zhanghua and Shi Taihe (Southwest Petroleum Institute), Gao Zhihai (Xi'an Research Institute of Tubular Goods, CNPC), Dong Fan and Li Yuan (No. 5 Oil Production Plant of North China Oil Field) and Xu Ying and Ye Linxiang (Southwest Sichuan Field District of SPA). *NATUR. GAS IND.* v. 23, no. 4, pp. 41～43, 7/25/2003. (ISSN1000-0976; **In Chinese)**

ABSTRACT: The research on expandable casing is in an exploring stage in China at present. A mechanical model of the expanding process of expandable casing was set up in light of the elastoplastic finite element contact problem, by which a detail computer simulating study was carried out for N80 casing expanding process, i. e. expanding from Ø114. 3 mm to Ø139. 7 mm. The qualitative curves expressing the variation of the equivalent stresses and residual stresses in the expandable casing with the displacements of piston were acquired when the friction coefficient were o. o, 0. 05. 0. 1 and 0. 15 respectively. On the basis of a lot of numerical simulations, it was concluded that the residual stresses in the expandable casing were decreased with the increase in the friction coefficients and the maximum equivalent stress occrred in the expandable casing of piston cone. These results are of great guiding significance for the structural design and lubricating design of the expandable casing.

SUBJECT HEADINGS: Expandable casing, Friction coefficient, Contact problem, Residual stress, Equivalent stress

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ESTABLISHING DYNAMIC MODEL OF PETROLEUM BACK-PRESSURE HYDRAULIC IMPACTOR

Yuan Guangjie and Yao Zhenqiang (Mechanical and Power Engineering Institute of Shanghai Jiaotong University) and Huang Wanzhi and Chen Ping (Petroleum Engineering School of Southwest Petroleum Instiute). *NATUR. GAS IND.* v. 23, no. 4, pp. 44～46, 7/25/2003. (ISSN1000-0976; **In Chinese)**

ABSTRACT: In order to meet the needs of the deep expansion of oil and gas exploration and development, a great deal attention has been paid to the petroleum hydraulic percussive-rodary drilling technique taking as a high effective method for drilling hard formation by domestic and foreign scientific research personnel. It is the key of popularizing such a technique on a large scale to design and make an impactor with excellent performance. Through analyzing the working conditions of the impactor, establishing and verifying the dynamic model of percussive paramters, a suit of design methods of the percussive parameters are proposed in the paper, which provides a reliable basis for designing and improving the impactor in production units.

SUBJECT HEADINGS: Petroleum, Natural gas, Impactor, Percussive-rotary drilling, Model

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MEASURING RHEOLOGICAL PARAMETERS OF POWER LAW FLUID BY FUNNEL VISCOMETER

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ABSTRACT: The flowing law of fluid and the determination of rheological parameters in funnel viscometer are not yet well settled up at home and abroad currently. According to the principle of mutual transformation between potential energy and kinetic energy, the vertically falling law of power law fluid by the action of unconstant static pressure and the relation between rheological parameter and time were studied, thus providing a theoretical basis for calculating the rheological parameters of fluid in funnel viscometer. In light of the measure way of fluid static pressure falling in proportion, the explicit function method of solving exponent by power function was simply and conveniently acquired through recording fluid flowing times. By applying four kinds of fluids and through contrasting the relevant parameters measured by rotary viscometer with the calculation results from funnel viscometer and rotary viscometer, it is indicated that the funnel viscometer is of relatively high measuring accuracy and can be well applied to the rheological design of drilling fluid.

SUBJECT HEADINGS: Funnel viscometer, Power law fluid, Rheological parameter, Effective viscosity

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DYNAMIC SIMULATION OF SHALE-HYDRATED PROCESS

Deng Hu and Meng Yingfeng (Southwest Petroleum Institute). *NATUR. GAS IND*. v. 23, no. 4, pp. 51～53, 7/25/2003. (ISSN1000-0976; **In Chinese)**

ABSTRACT: On the basis of considering various physicochemical reactions of drilling filtrate on shale and through synthesizing the influence of various driving forces on the migration of different constituents in the filtrate, a quantitative description of the compliated relation between various energy transports (as hydraulic flowing, ionic diffusion and pressure transmission) in shale and different chemical changes (as ion exchange and water content change) controlling the stability of shale was carried out and a dynamic model was set up to simulate the process of drilling fluid's entering into shaly formation and various physicochemical reactions occurring between them. in other words, the changes of shale pore pressure, ion content and water content with time can be simulated by the model.

SUBJECT HEADINGS: Drilling fluid, Filtrate, Mudstone, Shale, Hydration, Dynamic simulation

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OPTIMIZATION OF KY65 - 21 NOVEL OFFSHORE OIL/GAS PRODUCTION WELLHEAD EQUIPMENT STRUCTURE

Liu Qingyou and Zhu Xiaohua (Mechanical and Power Engineering School of Southwest Petroleum Institute) and Liu Huiqing (Management Co. of Goods and Materials, Talimu Petroleum Exploration and Development Headquarters. *NATUR. GAS IND*. v. 23, no. 4, pp. 54 ～ 56, 7/25/2003. (ISSN1000-0976; **In Chinese)**

ABSTRACT: At present, the traditional design and calculation methods are used for most of the conventional offshore oil/gas production wellhead equipment in China, thus causing the wellhead equipment to be complex, voluminous and costly. In addition, when some high pressure operations, such as fracturing and acidizing, etc., have to be done, it is necessary to change wellhead equipment or to install a wellhead protector. For this reason, a novel simplified offshore oil/gas production equipment has been designed to meet the domestic needs. It can meet not only the needs of normal oil/gas production but also the demands for fracturing and acidizing, etc., through wellhead equipment structure's being simplified. On the basis of the service conditions of KY65 - 21 novel offshore oil/gas procduction wellhead equipment, by applying the mechanical design automatization software PRO/E and through establishing the 3 - D full-scale mockups of major parts of the equipment, the finite element analysis and calculation are carried out in the paper, thus finding out the stress distribution and dangerous portions of these major parts under various loads and different structural parameters. Based on these, optimal structural designs of these parts have been finished. The equipment improved is of the following characters, such as simglified structure, light volume, large reliability, high automatization and good integral performance, etc. It is more suitable to offshore Oil/gas production operation.

SUBJECT HEADINGS: Offshore oil/gas production wellhead equipment, Finite element calculation, Optimizing design, Application

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DISCUSSION ON HOLE STABILIZATION UNDER THE CONDITION OF LOW DENSITY DRILLING FLUIDS

Cheng Zhongshi (Sichuan Petroleu Administration) and Deng Chuanguang (Research Institute of Drilling and Production Technology, SPA). *NATUR. GAS IND*. v. 23, no. 4, pp. 56～58, 7/25/2003. (ISSN1000-0976; **In Chinese)**

ABSTRACT: A good deal of attention has been always paid to the hole stabilization in the process of drilling by drilling workers. On the basis of citing the research results of hole unsteadiness, the feasibility of reducing the density of drilling fluid is discussed in the paper. At some intervals in certain structures at some regions, the principal reason of causing hole unsteadiness is the swelling of mudstone and shale by hydration. Not only lost circulation can be prevented but also well sloughing may be retarded by applying low density air, foam or aeration drilling fluid.

SUBJECT HEADINGS: Low density, Borehole, Stabilization, Discussion, Collapse, Hole unsteadiness

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