一种钻井液用白油润滑剂HML的研究*

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摘　要　钻井液润滑剂是一种重要的钻井液化学处理剂, 它的作用是改善钻井液润滑性, 降低井壁与钻具(或套管)之间的摩擦, 降低钻柱旋转扭矩和起下钻阻力, 从而减少卡钻事故的发生。文章根据目前使用的白油钻井液润滑剂存在的不足, 提出研制一种新型白油钻井液润滑剂。通过正交实验优选了润滑剂配方。经室内实验和现场实验证明该产品润滑性能好, 与钻井液配伍性好, 无毒性对环境影响小。

主题词　白油　钻井液　润滑剂　处理剂　防卡　环境保护

白油是由石油的润滑油馏分经脱腊、加氢精制和化学精制而成的液体油品, 白油常用于化纤纺织、合成纤维的集束、平滑、精纺及变形工艺和棉纺、缝纫等机械的润滑、防腐等。因白油无毒、无味、荧光级别低, 不影响地质荧光录井, 其在石油钻探中也常用作钻井液润滑剂, 改善钻井液润滑性, 降低井壁与钻具(或套管)之间的摩擦, 降低钻柱旋转扭矩和起下钻阻力, 从而, 减少卡钻事故的发生。

近年来, 油田对钻井液润滑剂需求量较大, 但目前该类润滑剂产品成分单一, 性能较差, 特别是在海水钻井液中摩擦系数降低率低, 滤饼粘附系数下降不到0.1以下, 难以满足定向井特别是大斜度、大位移定向井钻井的需求。且由于乳化剂的选择不合适, 往往引起多种问题: ①导致钻井液起泡, 须加大量的消泡剂处理; ②引起钻井液粘度、切力升高, 不利于钻井液现场维护; ③乳化剂抗盐、抗钙不理想, 在海水钻井液中不稳定; ④润滑剂极压膜强度低, 难以满足定向井高侧压力条件下的要求; ⑤对环境有不良影响等。因此急需研制一种新型白油钻井液润滑剂, 以满足定向井、深井、勘探井、海上钻井的需要。

钻井液润滑剂HML配方优选

在大量的文献调研、理论分析和实验研究并考虑了润滑剂的成本基础上, 确定了用符合GB1791-84标准的10号工业用白油作为白油润滑剂的主要成分。并添加聚氧乙烯聚氧丙烯二醇醚、非离子型乳化剂、改性的脂肪酸铝。然后用正交实验优选各组分的加量, 把不同组分按表1加量加入10号白油中配制成润滑剂样品, 然后加入室内配制的钻井液中(加量为1%), 测定滤饼粘附系数和极压润滑系数(结果见表1)。

表1　润滑剂配方优选正交试验结果

序号	因素水平			滤饼粘附系数(μ)	极压润滑系数(f)
	A	B	C		
1	5%	0.5%	1%	0.09	0.28
2	5%	1.0%	3%	0.06	0.14
3	5%	1.5%	2%	0.08	0.11
4	10%	0.5%	3%	0.06	0.16
5	10%	1.0%	2%	0.02	0.09
6	10%	1.5%	1%	0.03	0.09
7	15%	0.5%	2%	0.05	0.11
8	15%	1.0%	1%	0.02	0.09
9	15%	1.5%	3%	0.04	0.09

A:	平均(μ)	平均(f)	B:	平均(μ)	平均(f)	C:	平均(μ)	平均(f)
5%	0.08	0.18	0.5%	0.07	0.18	1%	0.05	0.15
10%	0.04	0.11	1.0%	0.03	0.11	2%	0.05	0.10
15%	0.04	0.11	1.5%	0.05	0.10	3%	0.05	0.13

注: A. 分子量为1 200~10 000的聚氧乙烯聚氧丙烯二醇醚;
B. HLB值为6~8的非离子型乳化剂; C. 活化不饱和脂肪酸铝。

通过直观分析发现: A和B的加量是影响润滑性能的显著因素, 这样就确定了HML的配方为: 10%A+1%B+2%C+10号白油。

* 本文系胜利石油管理局重点科技攻关项目(编号950511)成果的部分内容。

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钻井液润滑剂 HML 室内评价

1. 白油钻井液润滑剂 HML 的润滑性能

(1) 把 1.6 g 的纯碱加入 400 mL 蒸馏水中, 再加入 24 g 二级膨润土, 高速搅拌 30 min, 配成淡水泥浆, 静置 24 h, 分别加入不同量的润滑剂 HML, 高速搅拌 5 min 测定其润滑系数、滤饼粘附系数(结果见表 2)。

表 2　常温下新型钻井液润滑剂 HML 的润滑性能

类别	加量	滤饼粘附系数	滤饼粘附系数降低率(%)	润滑系数	润滑系数降低率(%)	极压膜强度(MPa)
淡水钻井液	0	0.110		0.48		14.06
	0.5% HML	0.040	63.6	0.09	81.3	168.6
	1.0% HML	0.020	81.8	0.08	83.3	218.7
	1.5% HML	0.020	81.8	0.06	87.5	220.5
	2.0% HML	0.020	81.8	0.06	87.5	220.5
海水钻井液	0	0.280		0.30		14.48
	1.0% HML	0.110	40.0	0.18	40.0	165.0
	2.0% HML	0.050	60.0	0.12	60.0	183.2
	3.0% HML	0.045	70.0	0.09	70.0	190.8
	4.0% HML	0.045	70.0	0.09	70.0	189.2

(2) 把二级膨润土 36 g、纯碱 3.6 g 加入 400 mL 海水中, 静置 24 h, 高速搅拌 30 min, 养护 24 h, 加入不同量的 HML, 测定润滑剂不同加量的泥浆润滑系数、滤饼粘附系数和极压膜强度(结果见表 2)。

从表中可以看出: 在淡水钻井液中该润滑剂的加量 0.5%~ 1%, 润滑系数降低率 81.3%, 滤饼粘附系数降低率达 81.8%, 极压膜强度达到 168.6 MPa 以上。在海水钻井液中该润滑剂的加量是 2%~ 3%, 润滑系数降低 70%, 滤饼粘附系数降低率达 70%、极压膜强度达到 165 MPa 以上。

2. 钻井液润滑剂 HML 对钻井液性能的影响

(1) 对钻井液常规性能的影响

配制两个淡水钻井液和两个海水钻井液, 取出一个海水钻井液和一个淡水钻井液分别加入 3% 和 1% 的 HML, 高速搅拌 5 min, 分别测定加润滑剂前后钻井液性能。

从分析结果中可以看出该钻井液润滑剂对粘度, 切力影响不大。对滤失量略有降低。

(2) 对钻井液起泡性能的影响

分别在淡水钻井液和海水钻井液中加入一定量的钻井液润滑剂 HML, 高速搅拌 30 min。观察无泡沫产生, 用量筒测量高速搅拌前后泥浆的体积(结果见表 3) 。从表 3 中可以看出润滑剂不会引起钻井液起泡。

表 3　润滑剂在钻井液起泡趋势

钻井液组成	高搅前体积(mL)	高搅 30 min 后体积(mL)
淡水钻井液+ 1% HML	400	400
海水钻井液+ 3% HML	400	400

3. 钻井液润滑剂 HML 对环境的影响

在配制好的海水钻井液中加入白油钻井液润滑剂 HML 3%。委托中科院海洋研究所环境保护中心评价钻井液的毒性, 参照美国 EPA 及 API 推荐的钻井液生物试验程序, 以及 ASTM 推荐的生物试验标准方法进行评价。试验结果钻井液对黑褐新糠虾(5±1d) 的 96 h 半致死浓度(96hLC50) 为 308 000 mg/L。根据国际公认的毒性评价标准, 可认为“ 无毒”。钻井液 96hLC50 值大大高于美国“ 国家污染物排放控制系统(NPDES) 总则” 中关于钻井液倾倒的毒性限制值(96hLC50 为 30 000 mg/L)。

钻井液润滑剂 HML 的现场应用

1997 年 5 月 19 日在 桩斜 895 井上试用了新型钻井液润滑剂 HML。该井井眼轨迹复杂, 造斜点高(井深 303 m 开始), 稳斜段长(井深 700~ 4103 m), 水平位移大(1 629 m), 钻柱侧压力大, 摩擦力大, 这就给我们的钻井液的润滑性提出了严格的要求, 要求我们使用的钻井液润滑剂有较好的润滑能力和较强的极压膜强度。1997 年 5 月 22 日井深 1 197 m 时我们加入 2.0 t 新型钻井液润滑剂 HML, 滤饼粘附系数从 0.12 降到 0.05, 极压润滑系数从 0.32 降到 0.10。起下钻阻力从 12 t 降到 8 t。以后不断加入一定量 HML 保持其含量在 1%~ 2% 之间。保证较低的扭矩和起下钻阻力, 减少了卡钻发生的可能性。保证了定向井的顺利完钻。降低了钻井液的成本。

结　论

(1) 钻井液润滑剂 HML, 润滑性能好, 在现场能有效地降低钻柱扭矩和起下钻阻力, 减少卡钻事故的发生。

(2) 钻井液润滑剂 HML 对钻井液无不良影响, 不增稠, 不起泡, 对滤失量略有降低作用。海水钻井液和淡水钻井液都适用。

(3) 钻井液润滑 HML 剂加入钻井液中, 不会使钻井液毒性增加, 对环境影响小。

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Blast-furance slag, High temperature, Crack, Mechanism

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APPLICATION OF SLIMHOLE DRILLING AND TUBINGLESS COMPLETION IN THE GAS FIELD HOUWUJIAHU*

Liu Yanxue (Northeast Petroleum Bureau of CNSPC). *NATUR. GAS IND.* v. 22, no. 4. pp. 45~47, 7/25/ 2002. (ISSN1000- 0976; **In Chinese)**

ABSTRACT: There will be no obvious profit from shallow gas if the regular way is adopted in drilling and completion work. In order to reduce the exploitationcost, slimhole drilling and tubingless completion, in which oil tubing was used as production casing for cementing and perforation completion and afterwards was never used again during the production, was applicated in the Gas Field Houwujiahu for the first time by Northeast Petroleum Administration (NEPA). During the whole process of operation, such problems were extremely complicated as rigs selection, well control and completion and so on. At the same time, many techniques are discussed here such as the seleetion of rigs, well construction, well control and gas well testing etc.. It is also analyzed the reason that the rate of penetration (ROP) is low. Thus, it is put forward some methods of improving the ROP with the optimum PDC bits and drilling parameters. Meanwhile, it is evaluated on the economical benefit from the application of this technique.

SUBJECT HEADINGS: Shallow gas, Rig, Slimhole drilling, Tubingless completion, Evaluation, Shongliao Basin

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STUDY ON A NEW TYPE DRILLING FLUIDS WITH WHITE OIL LUBRICANT HML-1*

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ABSTRACT: A lubricant is one kind of important chemical additives in drilling fluids, whose functions are to improve the lubricity of drilling fluids, to ease the friction between the well wall and the drilling tools (or casing), and to weaken the rotation torque of strings and resistance during the round trip so as to lessen the danger of drilling pipe sticking. According to the shortcomings in using the white oil lubricant in drilling fluids at present, another new type white oil lubricant is put forward to be studied on. The ingredients of this lubricant is finely chosen in a special way through perpendicular experiments. After experiments in labs and on fields, this lubricant is eventually proved to be excellent with good properties of fine lubricity, compatibility with drilling fluids and being poisonless (little bad effects on the environment).

SUBJECT HEADINGS: White oil, Drilling fluid, Lubricant, Additive, Antisticking, Environmental protection

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EXPERIMENTAL RESEARCH ON BACK-PRESSURED HYDRAULIC IMPACTOR

Yuan Guangjie (Mechanical Engineering Institute of Shanghai Jiaotong University) and Chen Ping and Huang Wanzhi (Southwest Petroleum Institute). *NATUR. GAS IND.* v. 22, no. 4. pp. 50~52, 7/25/ 2002. (ISSN1000- 0976; **In Chinese)**

ABSTRACT: Along with the deep-going expansion of oil and gas exploration and development, more and more hard strata have been drilled and the drillability extrema and hardnesses of the strata are increased. The percussive-rotary drilling technology being the most efficient way to break up the hard rocks has been highly thought of by oil-drilling circles commonly at present. The percussive-rotary drilling technology is a combinative method of both percussive drilling and rotary drilling. In the process of drilling hard strata, this technology is of many advantages, such as high drilling rate, low drilling cost, large drilling cuttings, low WOB and small deviation angles, etc. and it has been widely adopted in many oil and gas fields. In the paper, through the experimental research on back-pressured hydraulic