·开发设计·

测井绞车液压传动系统的设计和创新

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摘 要: 介绍了油田测井绞车闭式液压系统原理,并着重介绍超低速阀的结构原理,新设计液压系统中采用了超低速阀,满足了测井车超低速测井工况。

关 键 词: 测井绞车; 液压传动; 超低速

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0 引 言

液压测井绞车是油田中途测试和试井的高科技综合设备。要求传动系统结构简单紧凑、重量轻和噪音低。其工作原理将汽车底盘发动机的功率通过液压系统驱动变(减)速器带动由缠绕在防磁滚筒上的电缆将测井仪器提升和下放到油井内,并能满足不同的速度和拉力。

液压系统与变(减)速器组成的传动系统有以下几种传动型式:(1)力士乐系统与 W16T 变速器($i=39,161$)组成的全液压传动系统,测井速度为 60 m/h～8 000 m/h;(2) 力士乐液压系统与进口 8SC 减速器组成的液压链传动系统,速度范围 60 m/h～7 500 m/h;(3) 力士乐系统液压系统与原南阳华美石油公司设计的五档变速器组成的液压链传动系统,速度范围 20 m/h～7 000 m/h,但因换挡机构复杂、质量事故多及随钻工况不好,现已经淘汰;(4)用力士乐液压系统与两档变速器组成的液压链传动系统,速度范围 120 m/h～15 000 m/h,可做射孔车。通过实践证明,综合性能较好的传动方式为第一和第二种。可测核磁时需要测试速度范围 30 m/h～50 m/h。常规测井速度范围 200 m/h～6 000 m/h,射孔速度超过 10 000 m/h。可整个油井的测试工作是:常规测井占使用时间的比例为 70 %～80 %,其余工况占的使用时间的比例 20 %～30 %。国内现在的许多测井仪器,都可以满足测核磁、射孔和常规测井多种工况。为了满足用户的需求,降低成本,我们经过认真的分析发现,从液压系统着手,增加一个全新的液压阀:即超低速阀,就可满足要求,并赋予了实施和应用在中国石油测井有限公司、大港测井公司等多家公司设计生产的 7 000 m、8 000 m 液压测井绞车上 ,收到良好的应用效果 。本文主要介绍液压传动系统设计中的一些特点和液压系统中超低速阀的运用方法。

1 液压传动系统设计原理

液压传动系统是测井绞车的关键系统之一。全液压测井绞车传动系统包括:机械传动部分和液压系统及电控系统 3 部分组成。

机械传动部分包括汽车发动机、取力器、传动轴和液控换挡变速器;电控部分主要包括变量柱塞油泵和变量柱塞马达的电控手柄、对油泵电控伺服阀的精确调整、测井仪器预设张力输出信号控制油泵的卸荷等组成。因实现测试工况速度和拉力的要求主要有液压系统和变速器的性能决定,而电控部分主要是操作控制,所以本文重点介绍液压系统的设计特点,其液压系统原理如图 1 所示。

液压系统执行部分由三部分组成:主回路有 REXOTH 公司生产的变量柱塞油泵、变量柱塞马达和调压阀组成;2 个辅助回路主要有辅助齿轮泵、液压缸和先导阀组成测井排缆系统以及辅助齿轮泵、电磁阀和液压换挡变速器组成的变速器换挡系统。(注:两辅助回路由一个辅助齿轮泵提供动力)

主回路工作原理:测井绞车根据每次测井要求,油泵电控手柄控制变量油泵EP伺服阀,伺服阀开启大

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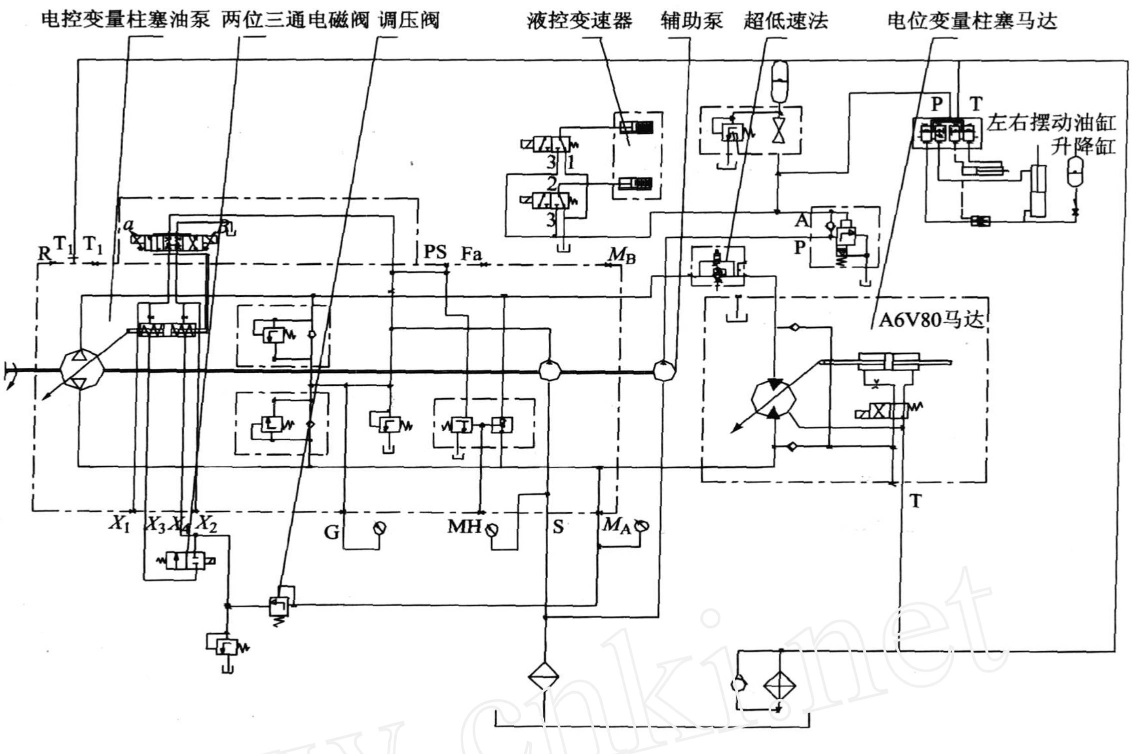

图 1 液压系统原理图

小和方向控制柱塞变量马达的输出转速和正反转,马达安装在液控变速器的输入端,变速器带动缠绕有电缆的防磁滚筒旋转,从而带动电缆上提或下放。油泵控制手柄离开中位角度和变速器的档位选定,达到所需速度的要求。如果电缆拉力超过测井仪器设置的拉力的值,测井仪器输出一电压信号,控制安装在油泵伺服缸两端的两位三通电磁阀,使油泵斜盘回中位,无动力输出,保证液压系统和测井仪器的安全。同时在液压系统中还设置二次调压阀,通过设定该阀液压系统压力大小与变速器档位选定,达到电缆拉力和速度的要求。变量柱塞油泵内设的高压溢流阀、外置二次调压阀和紧急卸荷阀,可保护液压传动系统的安全。

2 设计特点

测井铰车传动系统主要有闭式液压系统和变(减)速器组成。设计测井绞车液压系统主回路时,要满足以下条件:(1) 电缆提升线速度最低 20 m/h;(2) 变速器的速比(i = 39,161) 不能变(如调整变速器速比,会影响其他测井工况);(3) 采用力士乐 A4VG90EP2 变量轴塞泵和 AA6VM80EP2 变量轴塞马达。力士乐行走液压技术资料显示,AA6VM80EP 变量柱塞马达最低稳定转速为 50 rpm。

要求缠绕电缆滚筒直径为 650 mm 处,线速度达到 20 m/h;

根据手册可知:$V = 60\pi n/i$

其中:V = 20 m/h;i = 161,n 为马达输出转速,n = 26.3 rpm。

通过以上计算可知,马达的最小稳定转速降到 26 rpm,就可满足要求。那么,怎样才能将液压马达的最小稳定转速在驱动负荷的情况下降下来,我们研究发现,提高液压马达低压侧的压力,可使液压马达输出转速降低下来并且低速运转平稳。

超低速阀的作用就是在液压系统中用来提高马达低压侧的背压,可将马达低速稳定性由 50 rpm 降到 26 rpm。从而满足测井低速工况要求。超低速阀原理如图 2 所示。将此阀安装在马达提升工况时的低压工作侧。即 P_1 口接马达,P_3 口接油泵,P_4 口回油箱,P_2 口接测试压力表。该阀有插装式两位两通电磁阀 1 和顺序阀 2 和单向阀组合而成。

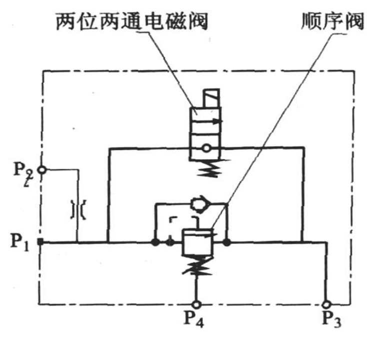

图 2 超低速阀原理图

超低速阀参数:

额定压力:32 MPa;

顺序阀设定压力:4 MPa～7 MPa;

单向阀和两位两通电磁阀通径:Φ30 mm;

顺序阀通径:Φ4 mm;

工作电压:24 V。

需超低速工作时,马达的排量不超过 2 L/min,必须将两位两通电磁阀关闭,马达回油到油泵,液压油必须经过顺序阀仅 Φ4 mm 的孔,而马达的油路通径为 Φ25 mm,这样马达回油时,因通径突然变小,在马达的低压侧产生背压,而马达的高压侧压力超过 10 MPa 这样马达两侧产生压力差,使马达输出轴运转,因提高了低压侧的压力,可降低输出轴爬行的转速,从而提高了马达低速性能稳定性。在测井时,仅提升时需要低速,因此在设计液压系统时仅在马达上提工作时的低压侧安装此阀,就可满足测井工况的要求也节约了成本。而下放时,高压油经过单向阀和常规测井时将两位两通电磁阀开启,使马达的回油非常顺畅,不影响常规工作。因此,在测试速度要求在 20 m/h～60 m/h 时此阀工作,其他工况时此阀不会影响整个液压系统。

3　结束语

1) 本液压系统的设计,采用顺序阀和电磁阀组合阀方式,运用各自的特点,科学的组合在一起,改善了马达低速稳定性,从而简化了测井绞车的传动系统,操作简单可靠。

2) 因超低速阀工作时,整个系统的效率有所降低,因此常规测井时,必须对此阀内地两位两通阀成通路,这样对液压系统不产生任何有害影响。

3) 此阀设置顺序阀的压力是关键,通过我们试验可知,不同的马达结构(包括型号不同),通过仪器检测,当电缆拉力不小于 50 kN,马达的转速可低至 20 rpm 时运转平稳,无爬行现象,压力在 4 MPa～7 MPa 之间。

4) 超低阀与液压马达结构配合使用非常重要,该阀与弯轴轴塞马达相配效果好,与直轴轴塞马达相配效果不明显。

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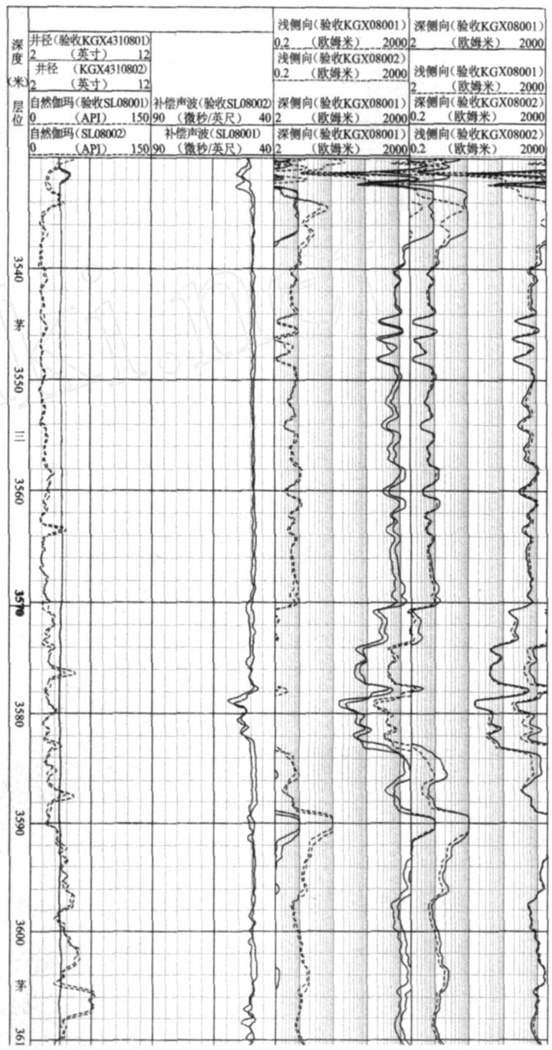

图 1　小直径系列测井仪测井曲线

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ABSTRACTS

Vol. 23 No. 5 Dec. 2009

Yang Yang, Dang Ruirong, Song Xijing and Ren Zhiping. Research on the electromagnetic logging responses in the cased hole. PI, 2009, 23(5) :1～3

Based on the Maxwell's electromagnetic field theory, this paper derives the theoretical formula for the electromagnetic logging in the casing borehole of multi-cylindrical-layer model about borehole, the casing and the formation. The effects of the casing measurements and the sensitivity of the electromagnetic response to the formation resistivity were analyzed. At low frequency band, most of the magnetic lines can pass through the casing and electromagnetic responses are more sensitive to the low resistivity layers. Numerical simulation results show that the amplitude of the formation actuated signal decreased with the increase of the casing wall thickness. The numerical results of different permeability of the casing show that we can reduce the shielding effect by the method of decrease the permeability of the casing.

Key words: cased hole; electromagnetic field; electromagnetic logging responses; numerical calculation

Zou Yueyuan and Liang Dali. Development of small-diameter logging tools with ultra-high pressure and ultra-high temperature performance. PI, 2009, 23(5) :4～6, 9

It becomes more and more urgent to develop new serial logging tools to satisfy the requirement of exploration of the extra-deep well. According to this situation, a serial of small-diameter logging tools with ultra-high pressure and ultra-high temperature performance were developed. And now it is verified that the tools all reached the design goal. The design thoughts of tools, including tool performance are introduced in the article.

Key words: ultra-high pressure; ultra-high temperature; small-diameter tool; integrated thick film circuit

Zheng Fengming and Wu Ming. Design of the hydraulic system of the logging truck. PI, 2009, 23(5) :7～9

This paper introduces the principle of the closed hydraulic system of the logging truck, especially the structure principle of the ultra-low speed valve. The logging truck can work under the ultra-low speed working condition if the ultra-low speed valve is used in the hydraulic system.

Key words: logging truck; hydraulic system; ultra-low speed

Cheng Defa, Sun Qiang, Liu Hong, Xiong Min, Tan Dongjie and Wang Likun. The leak detection system of Lan-Cheng-Yu products pipeline. PI, 2009, 23(5) :10～12

In order to resolve the problems that are difficult to detect the leakage of product oil pipeline caused by natural or man-made factors, the leak detection system (LDS) is developed. The OPC technology is used to communicate between the leak detection system and pipeline SCADA system. Field experiments for oil leakage show that the system can monitor the pipeline leakage accident in time and locate leakage position accurately.

Key words: product oil pipeline; leakage; location; OPC technology

Meng Qingxin and Wang Xiao. Design of the lightning current detect system for oil tanks. PI, 2009, 23(5) :13～15

Lightning strike is the major safety risk for oil tanks located on a vast flat area. In order to take better measures to reduce losses caused by lightning, it is necessary to learn more about some of the important parameters of lightning. Based on the investigation of the characteristics of the oil storage base, a CANBUS-based lightning current acquisition system, with Rogowski coil current sensor and AVR microcontroller, is introduced in this paper. The system is low cost, high performance and easy to install and use.

Key words: lightning current detect; oil base safety; CANBUS

Luo Xuedong, Li Yuxia, Wang Guofeng, Li Yamin, Xu Zhongqing and Tian Liping. The comparison and study of two kinds of isolators of mulipole array acoustic logging tool. PI, 2009, 23(5) :16～18

In this paper, the constitute and mechanical strength of two isolators are compared and analyzed. The instruments' performance are tested through an special experiment setup respectively. The paper points out that B-isolator has wider application prospects.

Key words: mulipole array acoustic logging tool; isolator; constitute; mechanical strength; experiment setup; performance testing

Zhang Aijuan, Tong Maosong, Zhang Jiaju, Yang Xiao and Li Zuo. Phase-sensitive technology and its application in complex resistivity logging tool. PI, 2009, 23(5) :19～21

For resistivity logging tools, the DC signal, whose amplitude is linearly related to that of the measured signal, should be obtained. The often used technology is the phase-sensitive detection. In traditional resistivity tools, the phase difference between the reference signal and the measured signal affects the logging results. In this paper, this phase-sen-