水击泄压阀在长输油管上的应用

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摘要 详细介绍了 DANFLO 水击泄压阀的结构和操作原理,以及长输管道发生水击的原因,并根据水击泄压阀在输油管道上的使用情况,提出在运行中的操作和维修建议。

关键字 泄压阀 结构 操作原理 运行分析

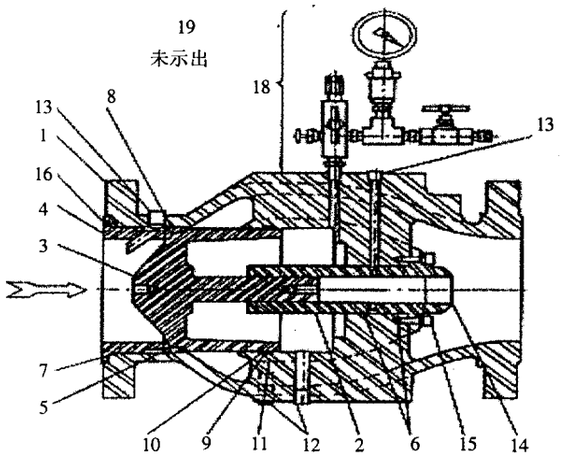
1 前言

水击泄压阀是由美国 DANIEL 阀门公司制造,用于保护输油管线安全,防止在输油过程中因意外或阀门紧急关断造成管线过压和紊流。DANFLO 水击泄放系统可以减小水击冲击波,避免因输油管线超压而导致管线发生破裂事故。

2 结构和操作原理

2.1 泄压阀结构

DANFLO 水击泄压阀结构见图 1 所示。



1 阀体 2 导向套 3 柱塞 4 定位器 5 座环 6 导向套
7 定位 O 型圈 8 阀座固定环 9 柱塞 O 型环 10 支承架
12 排放口旋塞 13 阀体旋塞 14 导向套旋塞 15 导向套螺栓
16 定位器螺栓 18 控制装置 19 缓冲气瓶(埋入地下)

图 1 DANFLO 水击泄压阀结构示意图

2.2 氮气控制系统

如图 2 所示,氮气控制系统主要用于为泄压阀提供充足的气源和稳定的工作压力。一方面,当阀门中氮气压力低于设定值时,氮气控制系统可自动向泄压阀充入氮气直至达到设定值。另一方面当气源的供气瓶缺少氮气时,它通过自动化监控系统自动切换备用氮气瓶,并发出缺气信号。此外为了防止泄压阀充气超压在控制系统中安装有安全泄压阀。

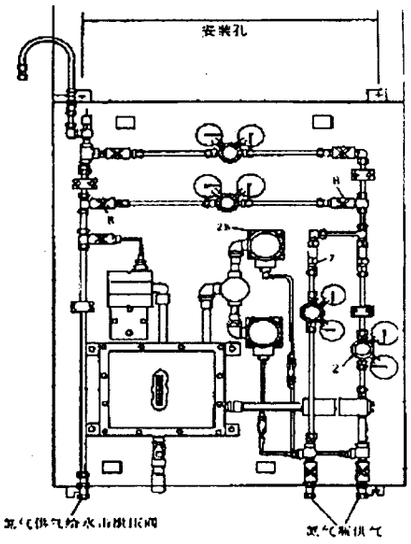


图 2 氮气控制系统

2.3 操作原理

DANFLO 是氮气加载的水击泄压阀,它是一种轴流式阀门。阀门并联安装在与受水击保护管线上,阀门上游一侧与受水击保护的管线相连通,下游一侧与水击泄放管线相连。在投用前应预先向阀门的柱塞腔内充入确定数量的氮气,这样柱塞腔内氮气的压力将使阀门的柱塞与密封环紧贴。输油管线在正常压力下运行时,管线中的液体不会通过泄压阀,当输油管线因某种原因产生瞬时的水击波,使管道内

的压力超过泄压阀预先设定的氮气压力值时，水击压力顶开泄压阀的柱塞，此时管线中的水击波通过阀门，并将部分液体泄放到水击泄压管线中，从而达到保护输油管线的目的。

水击泄压阀是通过阀柱塞腔内的氮气充装压力来跟踪水击压力的，当水击压力衰减到小于氮气压力设定值时，阀门将会缓慢平稳关闭，并自动恢复到水击泄放前的初始状态。

DANFLO 水击泄压阀是一个全自动阀门，它可以根据压力的需要人为干预设定值和报警值，这一点在使用过程中是非常重要的。

DANFLO 水击泄压阀核心部件是柱塞组件，它是依靠氮气压力来达到与管道内液体的压力平衡。通过柱塞轴向滑动来实现阀门对液体的通过或隔断。水击泄压阀顶部控制器装置的充气阀是用来向柱塞腔内充入氮气，阀门的充气是由氮气控制盘的 Tescom 压力调节器来进行的。

3 泄压阀的特点

(1) 流通能力强，总体最大泄放量可达 1358m^3/h，因此可以有效的避免突发原因造成的水击现象的发生，确保管线在输油过程中的安全。

(2) 反映灵敏，泄压阀可跟踪阀前端水击压力的变化，当阀前压力达到水击压力设定值时，阀门迅速开启，直到水击压力波衰减至设定值以下 15 分钟内自动关阀，图 3 为水击泄压阀开启前后压力波变化曲线。

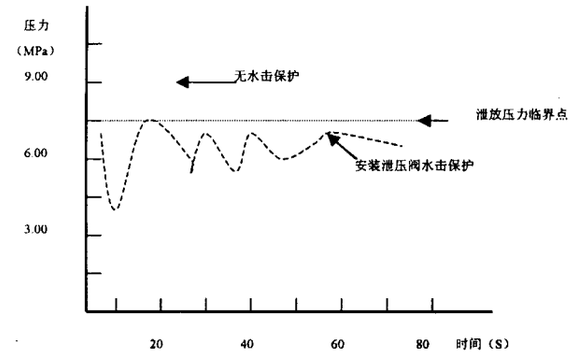


图 3 泄压阀安装前后压力波变化

(3) 工作适用性强

由于将氮气做为泄压阀动力气体，因此适用于易燃易爆工作环境，以及地理环境差的工作条件下稳定工作。

(4) 自动化控制程度高

当水击泄压阀因某种原因达到泄放值开始泄压时，输油泵仍可以正常工作，直到压力达到管道最高停运设定值时输油泵才停止工作。

4 DANFLO 型泄压阀在库鄯输油管道上的运行

4.1 库鄯线简介

库鄯输油管线位于新疆维吾尔自治区，西起库尔勒市，东至终点鄯善，管道水平长度 474.59 km；管道管材采用 API5LX65(部分为 API5LX60)；管径 ϕ610 mm；钢管壁厚 7.11～11.1 mm；输送原油能力 500×10^4 t/a；首站出站最高压力 8.0MPa。管线沿途地形条件复杂，人烟稀少，社会依托条件极差，其中管道沿线海拔最高点为 1560.2 m，最低点为 - 104.5 m，落差 1664.7m 左右。全线设有库尔勒首站、觉罗塔格减压站和鄯善末站各一座，高点与低点相距 113 km。管线沿途共设 18 个截断阀室，其中有 3 个为遥控型截断阀和 5 个止回阀，可以有效的避免因突发原因造成管线破裂跑油，避免不必要经济损失和环境的破坏。全线采用常温输送工艺，在运行上采用密闭输油一泵到底的输油方式，运行管理上以 SCADA(监控及数据采集) 系统作为全线指挥中枢。首站设分控中心，用来对全线进行集中自动监控和统一调度管理，减压站为无人值守站，末站承担着原油外运任务。

4.2 安装水击泄压阀的依据

水击是长输管道运行中常有的一种水击波。管道在稳定工况下运行时流动的液体在纵切面上和横截面上速度和压力的分布的平均值是基本保持稳定的，但一方面由于局部条件的改变使运行工况发生变化；另一方面原油种类的变化使原油的密度和粘度等物性发生了改变，使这一稳定的水力系统被破坏，导致管道内液体的水力状态发生变化。尤其是在突然断电(造成停泵)、阀门的快速开启和关断，都会使稳定状态遭到破坏。在输油过程中由于压力的突变，形成的压力波值超出了管道允许的弹性值及设备的承压能力时，引起输油管道和输油设备的损坏，严重时造成爆管事故的发生。

安装水击泄压阀主要目的在于当管道中的液体发生水击，并达到水击泄压阀的设定值时，水击泄压

阀快速开启。由于泄压阀的开启使管路中液体的体积发生了变化,液体的压能得到释放,使水击压力波的强度得到减弱,因此起到了保护管道和设备的安全的目的。

4.3 DANFLO 泄压阀在库鄯输油管道上的应用

库鄯输油管线共设有首站、减压站和末站各一座。为了确保管线的安全,分别在库尔勒首站的出站处、觉罗塔格减压站和鄯善末站进站处并联安装有 DANFLO 型泄压阀,各站安装有两台,即一台投用、一台备用。根据泄压总体泄放量以及管道内液体的压力和密度的不同,水击泄压阀可分为三种类型:

(1)库尔勒首站

泄压阀:管径规格 6in ANSI.150# RF;设定压力 16.0bar;氮气设定压力 11.6bar。

工艺要求:总体泄放流量 994m³/h;允许过压 10%;原油密度 837.8kg/m³。

(2)觉罗塔格减压站

泄压阀:管径规格 8in ANSI.600# RF;设定压力 66.5bar;氮气设定压力 50.3 bar。

工艺要求:总体泄放流量 1169m³/h;允许过压 10%;原油密度 850.1kg/m³。

(3)鄯善末站

泄压阀:管径规格 8in ANSI.150# RF;设定压力 16.5bar;氮气设定压力 12.4bar。

工艺要求:总体泄放流量 1358m³/h;允许过压 10%;原油密度 851.0kg/m³。

库鄯线三座输油泵站泄压阀的结构和原理基本相同,因此我们对首站的水击泄压工况进行分析。

为了保证首站泄压阀在管线超压 10%时能够准确的开启泄压,获得足够的氮气充入量是确保阀门正确开、闭的关键。因此在给阀门充入氮气时必须在 11.6bar 的压力下充气,才能够得到 16.0bar 的水击泄放压力设定值,这样才能保证控制器顶部的压力表和正在使用的 Tescom 压力调节器的出口压力表的读数为 11.6bar。此时当管道内压力达到泄压阀充入氮气设定压力值 16.0bar 时水击泄压阀就会打开,当压力达到设定值的 110%时,阀门的泄放量达到 994 m³/h,随着水击压力逐渐衰减阀门开始关闭,但阀门不会立刻关死,而是继续跟踪管道内压力波的衰减,并缓慢关闭,当水击压力衰减到低于氮气充入值 16.0 bar 时,水击泄压阀完全关死。

库鄯线首站允许最高工作压力为 8.0 MPa,输油管道在运行时当出站压力 > 8.0MPa 时水击泄压阀开始泄放,如果当泄放时间 ≥15 分钟泄压阀仍未关闭或当出站压力 ≥8.8MPa 时,为确保管线的安全,全线将保护停运。

5 操作及维护

(1) 在运行时应定期核对压力表示数是否正确,如果运行压力有增加或者减少时,一方面可能是运行的输油管线或输油泵存在问题;另一方面可能是充气系统有故障。因此准确判断是那一类故障是十分重要的。

(2) 要定期对阀内通过液体处进行清洗,避免因杂质堆积导致在阀门开启或关闭时阀门损坏,以及泄压阀工作时出现误判现象,导致管线发生不必要停输。

(3) 当发现阀门动作迟缓时应及时投用备用阀,清理柱塞腔内的液体以保证阀门动作快速灵敏。

(4) 无论是测试或是维修泄压阀,还是正在使用的压力调节器发生故障时,都必须切断气源并排放阀中的气体,避免发生气体压力超高引发伤人事故。

(5) 在维修控制盘时应关掉水击泄压阀的充气阀,并逆时针转动压力调节器的手柄,排泄掉控制盘和氮气管路中的压力,方可维修。

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Shanghai Chemical Engineering Design Institute
Shanghai 200233

Abstract: In this paper, the types of steel oil storage tanks in petrochemical industry and the types of the foundations for the tanks as well as the design and structure of the foundations were introduced to the design and construction personnel for reference.

Keywords: steel oil storage tank, dome roof tank, floating roof tank, covered floating roof tank, foundation, design

Installation of Safety Accessories for Organic Heat Carrier Heaters

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Abstract: The effect and installation requirements of the safety accessories for organic heat carrier heaters were introduced and potentially hidden troubles that are inconsistent with the safety requirements were pointed out in this paper.

Key words: organic heat carrier heater, safety accessories, installation requirement

An Understanding of Flexibility Analysis in ASME B31.3 Process Piping

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Abstract: Based on the provisions specified in ASME B31.3 Process Piping, some views on the questions about the flexibility analysis of the process piping including the relationship between flexibility analysis and fatigue evaluation, and whether the effect of pressure was included in the flexibility analysis or not etc. were put forward for discussion.

Key words: process piping, flexibility analysis, fatigue evaluation, displacement stress, pressure stress, severe cyclic condition, ASME B31.3, ASME VIII-2

Technology of Leak Location for Oil Pipelines

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Abstract: The technology of leak location for the pipelines is paid a great deal of attention by the personnel engaged in the pipeline management. The system of pipeline leak location is an important component part of the pipeline leak detection system. In this paper, some methods used worldwide and some other rising technology of leak location for oil pipelines were introduced. The advantages and disadvantages of those methods were also analyzed. It was figured out that the loss can be minimized only when the leakage point is located quickly and accurately and thus the measures are taken as soon as possible.

Key words: pipeline, leak detection; leak location

Application of Pressure Relief Valves against 'Water Hammer' in Long Oil Pipeline

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Abstract: The structure and operating principle of the DANFLO type pressure relief valves against 'water hammer' were introduced in detail. The causes of 'water hammer' occurred in long oil pipeline was also explained in this paper. Based on the service conditions of the pressure relief valves in the long oil pipeline, some recommendations on operation and maintenance of them in service were put forward.

Key words: pressure relief valve, structure, operating principle, running-analysis

Experience in Revamping Centrifugal Compressors in Synthetic Ammonia Plant

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Abstract: In this paper, the experience in revamping the process air compressor and the synthetic gas compressor in the 1000 t/d ammonia plant for its technical modification project with a capacity increase of 50% was introduced. For the modification of process air compression, it is a method with less revamping work amount, less risk and less investment to add a parallel compressor that is a multi-shaft motor-driven centrifugal compressor than to modify the existing process air compressor unit, which can save millions of RMB. For the modification of synthetic gas compression, changing the internal parts or renewing the HP/LP casings of the synthetic-gas compressor should be quoted by the two manufacturers rather than only by the original manufacturer to avoid high price from a single offer. The existing steam turbines for the synthetic gas compressor unit do not need to revamp as their power is enough to drive after having increased the efficiency of the compressor and modified the synthetic process.

Key words: synthetic ammonia, centrifugal compressor, technical modification

Failure Analysis of Mechanical Seals for Residual Oil Pumps and Technical Improvement

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Abstract: In this paper, the causes on frequent failure of mechanical seals for the residual pumps in the ethylene plant were analyzed. By improving the structure of the mechanical seals and selecting the compatible flushing fluid, a good sealing effect was achieved.

Key words: mechanical seal, failure, analysis, flush

Reliability Analysis and Development of Application of Aluminized Steel Tube Bundle

Wang Hong, Jiang Guanghong
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Wang Peiwen
Shandong Qilu petrochemical construction corporation
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Abstract: In this paper, the demonstration through test and analysis on the reliability of the aluminized steel tube bundle in application to the sulphur-bearing medium was presented. The difficult problems in the fabrication of the aluminized steel tube bundle were researched and its fabricating process was determined.

Keyword: aluminized steel, aluminized steel tube, reliability analysis, tube-to-tubesheet joint, fabricating process

Scale and Size of Drawing Sheets in CAD for Chemical Equipment

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Abstract: Some matters needing attention on selection of the scale and the size of drawing sheets in CAD for chemical equipment were presented in this paper.

Key words: chemical equipment, CAD, scale, size of drawing sheet