文章编号: 1001－2060(2000)01－0067－03

锅炉制造业几种简易设备的研制

(黑龙江机械制造学校)　赵　岩
(哈尔滨市锅炉检验研究所)　董大昌
(鹤岗市水电热力公司)　宋　唯

摘　要: 介绍了几种自制简单适用的设备: 弯管机、集箱收口机、封头割边机。用此设备可降低锅炉的制造成本, 增加企业与产品的市场竞争能力。

关　键　词: 锅炉制造; 设备; 研制

中图分类号: TK226

文献标识码: B

1　前言

在锅炉制造与维修过程中, 会遇到下面许多生产实际问题, 例如: 直径大于 108 mm 管子的弯制, 集箱端盖结构的改进(由平端盖改进成热缩口), 冲压封头直段的加工等, 所有这些都会增加企业的投资。针对上述问题本文介绍了几种简易的自制设备的结构、原理与使用。

2　几种简易自制设备

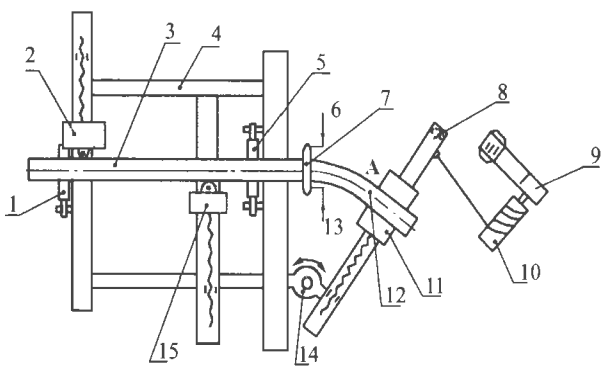
2.1　弯管设备

2.1.1　结构

一般锅炉厂具备冷态弯制 Φ108 mm 以下管子的能力, 这样的弯管设备较普遍, 若要弯制大于 Φ108 mm 的管子, 要委托外厂协作加工, 增加了锅炉的制造成本, 若用自制弯管机则可降低产品造价, 且产品质量还符合制造工艺要求。自制弯管机结构见图 1。

2.1.2　原理

欲弯管件平放在机台 4 上, 由托辊 1、5 支撑, 套上水火圈 7, 调整好弯管半径和弯曲起点 A, 使水火圈与 A 点重合, 并且用可调夹紧装置 2、11、15 夹紧管件, 由 6 通入自来水冷却, 由 13 通入丙烷并点燃(加热用的水火圈宽为 15 mm), 在管端观察管件内壁, 若水火圈所加热处管件内壁发红, 加热温度在 900 ℃～1000 ℃, 则可启动减速装置 9, 卷扬机 10 动作, 行走轮 8 转动, 管件被弯制。注意调节电机转速, 不宜太快, 同时观察管件内壁加热状态(颜色), 并且用样板测量所弯制的圆弧段。注意回弹角度, 若欲弯制 α° 的弯头, 按样板实测弯到 α° 停车, 则冷却后再量弯制角度不是 α°, 而是 $\alpha^\circ \pm \Delta\alpha^\circ$, 与设计值误差为 $\Delta\alpha^\circ$, 这个误差值 $\Delta\alpha^\circ$ 称为回弹角度。实验表明回弹角度与加热温度、弯制角度、弯管直径、管子壁厚、弯管半径等有关, 其中加热温度影响尤为显著, 如弯制 Φ159×6 mm 的管子, 弯制角度是 120°, 加热温度是 1 100 ℃, 回弹角度是 4°～5°, 加热到 800 ℃, 回弹角高度是 8°～10°, 即所谓加热程度越深, 回弹角度越小, 加热程度越浅, 回弹角度越大, 因此, 控制加热温度是关键。



1、5－托辊　2、11、15－夹紧装置　3－欲弯管件　4－机台　6－通冷却水口　7－水火圈(铜制)　8－行走轮　9－减速装置　10－卷扬机　12－弯管圆弧起点　13－通丙烷口　14－支撑铰

图 1　简易弯管机(俯视图)

2.2　集箱收口机

在锅炉制造中, 集箱的制造占有相当重要的地位。集箱制造的关键是端盖的焊接, 就中低压锅炉而言, 通常端盖采取平端盖或翻边凸缘端盖形式。无论采用哪种端盖形式, 大都是用手工电弧焊方式焊接, 这条环焊缝因是单面焊, 根部质量难以保证, 焊后要进行无损探伤, 且因焊接工作量大, 探伤难度大, 致使返修次数多, 生产周期长, 从而往往成为整个锅炉生产的咽喉工序。为了改变这一状况, 我们研制了封头热缩口这一专用设备, 投资少, 见效快, 不仅省去了手工焊端盖这一劳动强度大的工序, 而且缩口封头在内压力作用下形成薄膜应力, 而不是弯曲应力, 压力状态较理想, 许多锅炉厂做了应力测

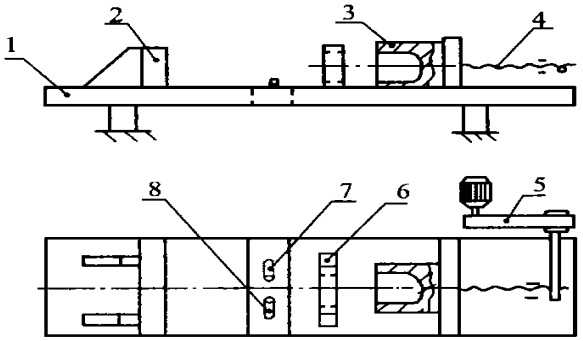
收稿日期: 1999－01－20; 修订日期: 1999－04－30

作者简介: 赵　岩(1964－), 男(满), 黑龙江五常人, 黑龙江机械制造学校高级讲师, 从事锅炉结构设计、锅炉强度方面的教学与科研工作.
通讯处: 150080　哈尔滨市南岗区学府路 7 号

定和爆破试验，试验结论是一致的：在工作压力下端盖壁中的应力远远小于材料的许多应力，冷态爆破时的爆破压力是工作压力的 20 多倍，由于强度裕度大，因而省去了射线探伤这一昂贵的检验过程。一般说来，缩口集箱比焊端盖集箱每端要降低成本 150 余元，因此，热缩口集箱形式深受厂家欢迎。

2.2.1 结构

集箱热压成形收口机结构见图 2



1— 床身 2— 挡块 3— 可拆收口模具 4— 传动装置 5— 减速装置 6— 分合卡紧装置 7、8— 万向球面滚珠支撑

图 2 集箱热压成形收口机

2.2.2 原理

将集箱放在床身 1 上，集箱一端紧靠在挡块 2 上，由万向球面滚珠 7、8，分合卡紧装置 6 支撑住，根据经验在集箱收口端划线，距端部为 140 mm 划一圈标记（用石笔即可），用丙烷火焰（或乙炔火焰）周向烘烤集箱收口端，加热到发红状态（900 ℃ ~ 1000 ℃），加热区域宽度为 150 ~ 180 mm，启动减速装置 4，收口模具 3 被向前推进，直至模具 3 端面与集箱标记线重合时，停止马达，则收口完成。

2.2.3 适用范围

a. 锅炉压力

适用于压力小于或等于 2.5 MPa 锅炉用集箱。

b. 集箱直径

这种简易设备可对 Φ159 × 5 mm、Φ219 × 7 mm 进行热压成形收口，大直径集箱的缩口技术发展得较缓慢。

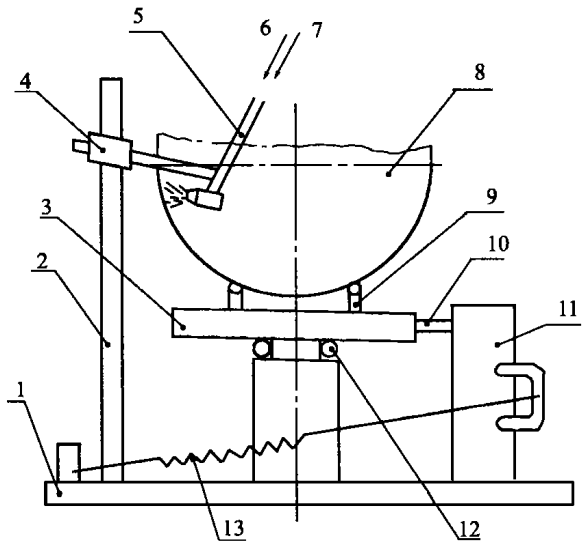
c. 集箱壁厚

集箱收口的球面半径为 $R\rho$，集箱壁厚为 S，一般的集箱（$R\rho/S$）> 10，均为薄壁管，其热缩口过程可以认为是薄壁圆柱毛坯在型腔（凹模）内受挤压变形过程。若集箱壁厚为 10 mm，则挤压力可达 100 吨，因此，该设备只适用于壁厚为 8 mm 以下的 Φ159 mm、Φ219 mm 集箱的收口。

2.3 封头直段切割机

2.3.1 结构

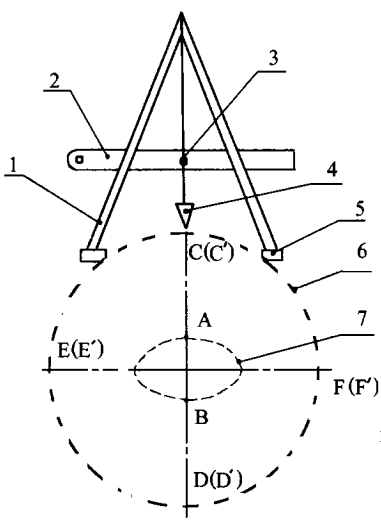
封头直段切割机结构见图 3。



1— 底座 2— 支架 3— 支撑圆盘 4— 固定装置 6— 丙烷气进口 7— 氧气进口 8— 切割件（封头） 9— 球面滚珠支撑 10— 行走轮 11— 自动切割小车 12— 支撑轴承 13— 拉撑张紧弹簧

图 3 封头直段切割机简图

2.3.2 原理



1— 三角架 2— 钢板尺 3— 小孔 4— 铅锤 5— 底脚 6— 锅筒 7— 人孔圈

图 4 确定锅筒基准线的三角架

将小车 11 固定在底座 1 上（用夹具夹紧），并用弹簧 13 拉紧，小车可用自动切割机代替，并且使自动切割小车的行走轮 10 与支撑圆盘 3 紧紧靠住，以便行走轮转动时靠摩擦力带动支撑圆盘转动，支撑圆盘 6 用 6 mm 厚钢板制成，距底座 220 mm 高，圆盘 3 装在支撑轴承 12 上可自由转动，封头 8 放在球面滚珠支撑 9（共三个）上，调整好水平位置，将割枪与切割角度调整好，根据操作者习惯割枪也可以放在封头外侧，对准欲切割的尺寸线，通丙烷与氧气并点燃，小车 11 通电，行走轮 10 带动圆盘 3 转动，封头也转动切割开始，圆盘转动一周时切割结束。

（下转 74 页）

降,随着偏压的提高,脱除效率呈线性提高。这表明,即使在足够高的偏压下也不能保证碱金属化合物全部离子化。事实上这种方法的脱除效率在 900 V 偏压下大约为 50%,这并不能满足 PFBC 烟机入口对碱金属浓度的要求,要想使这一方法真正可行,则必须要提高碱金属的电离化程度才行。

4 结束语

对碱金属脱除的研究已随着 PFBC 技术的发展而变得日益重要。添加剂在碱金属的脱除中发挥了重要的作用,不同添加剂的作用是不尽相同的,不同的脱除方法所使用的添加剂及所依据的脱除原理也不尽相同,根据合理的经济技术比较,采用或开发高效的碱金属脱除设备是 PFBC 进一步发展的需要。

参考文献

〔1〕 Spacil H S, Luthre K L. Volatilization/condensation of alkali salts in a pressurized fluidized bed coal combustor/gas turbine cycle. *J. Electrochem. Soc.*, 1982, 129(9): 2119~2126.

〔2〕 Peterson J R, Lucke V H. Commercial power plant design development for coal fired combined cycle. *Combustion*, 1979, 50(7): 29~36.

〔3〕 Benson S A, Holm P L. Comparison of inorganic constituents in three low-rank coals. *Ind. Eng. Chem. Prod. Res. Dev.*, 1985, 24(1): 145~149.

〔4〕 Howarth O W, Ratcliffe G S, Burchill P. Solid-State nuclear magnetic resonance Studies of sodium and aluminium in coal. *Fuel*, 1987, 66(1): 34~39.

〔5〕 Hodges N J, Richards D G. The fate of chlorine, sulphur, sodium, potassium, calcium and magnesium during the fluidized bed combustion of coal. Fuel, 1989, 68(4): 440~445.

〔6〕 Spiro C L, Wong J, Lytle F W, Greegor R B, Maylotte D H, Lamson S H. Forms of potassium in coal and its combustion products. *Fuel*, 1986, 65(3): 327~336.

〔7〕 Osborn G A. Review of sulphur and chlorine retention in coal-fired boiler deposits. *Fuel*, 1992, 71(2): 131~142.

〔8〕 Ahluwalia R, Im K, Chuang C F, Geyer H K. Evolution and deposition of ash particles in coal-fired gas turbines. Proc. of the First Annual Heat Engines Contractor's Meeting, Morgantown, WV, 1996, 5: 317~325.

〔9〕 Wenglarz R A. Deposition erosion and corrosion protection for coal-fired gas turbines. The Beijing International Gas Turbine Symposium and Exposition, Beijing China, 1985, 9: 85-IGT-61.

〔10〕 Calvert S, Amladi P, Yung S. The a.p.t. dry plate scrubber for alkali vapor contral. Proc. of the U.S. Department of Energy Contractor's Meeting, Morgantown, WV. 1981, 2: 405~420.

〔11〕 Cooper J L, Moresco L L. Alkali contral in fluid bed combustion systems at CPC. Proc. of the U.S. Department of Energy Contractor's Meeting Morgantown, WV. 1981, 2: 421~442.

〔12〕 Lee S H D, Johnson I. Removal of alkali vapors by a fixed granular-bed filter using activated bauxite as a filter medium. Proc. of the U.S. Department of Energy Contractor's Meeting, Morgantown, WV. 1981, 2: 385~404.

〔13〕 Lee S H D, Johnson I. Removal of gaseous alkali metal compounds from hot flue gas by particulate sorbents. *J. Eng. Power*, 1980, 102(4): 397~402.

〔14〕 Lee S H D, Myles K M. Alkali measurement in PFBC and its control by a granular bed of activated bauxite. Proc. of the 9th Int. Conf. on Fluidized Bed Combustion, Mustonen, Jp. ASME, 1987, 793~801.

〔15〕 Boericke R, Luthra K, LeBlanc O, Zarchy A. Alkali control in PFB combustion systems. Proc. of the U.S. Department of Energy Contractor's Meeting, Morgantown, WV. 1981, 2: 457~470.

(渠 源 编辑)

(上接 68 页)

2.4 划锅筒基准线用三角架装置

2.4.1 结构

确定锅筒基准线用三角架结构见图 4。

2.4.2 原理

《工业锅炉通用工艺规则 水管锅炉锅筒划线》锅筒纵向中心线(纵向基准线)找正,第 3.5.1.1 条:"将锅筒放置在滚轮架上,转动锅筒,使其纵向基准线处于顶部,用水平仪在锅筒两端找正锅筒的水平位置……",第 3.5.1.2 条:"在锅筒的一端搁置平桥尺,用水平仪找正……"。在滚轮架上的锅筒两端用水平仪找正是不方便的;用平桥尺,靠水平仪找正也不方便。过去,有的厂家确定基准线的方法大多用目测,但目测法不精确。基准线确定的准确与否,不仅影响锅炉的制造质量而且还将影响锅炉的安装质量,以至在锅炉运行时产生不可预见的附加外载,所以,应重视基准线的确定。用下面的三角架确定基准线既准确又方便。

根据经验,首先用目测法找人孔圈最高点 A(如图 4),再用铅垂吊线法找到人孔圈最低点 B,连结 AB 并向上延伸到 C 点,C 点有可能是锅筒基准线上的一点(C 点是否是基准线上的点要用三角架复测),复测方法:将三角架 1 放在锅筒上,使三角架两底脚 5 与锅筒靠牢无间隙,观察铅锤是否通过小孔中心,若通过则 C 点是锅筒基准线上的点,否则重新确定 C 点。同理,在锅筒的另一端可确定基准线上的另一点 C′(注意:测定 C′时的三角架的方向应与测 C 点时的方向相同,不能用反),连结 CC′,则 CC′即为锅筒的最高基准线。再分别从 C、C′点沿锅筒左右外壁环向量 $1/2\pi D_w$(其中 D_w 为锅筒外直径),若左右两侧 $1/2\pi D_w$ 重合(若不重合,取平均值),再从 C、C' 点沿锅筒左右外壁环向量 $1/4\pi D_w$ 找到两水平基准线找 EE′、FF′,有了 CC′、FF′、DD′、EE′四条基准线,即可进行划线。这四条线也是锅炉安装的基准线。

3 结论

上述几种设备及装置已在锅炉厂得到了应用,这些设备制造的零部件质量符合锅炉制造行业标准的技术要求,给制造厂带来了良好的社会效益和经济效益。因此,上述设备与装置具有一定的推广价值和参考价值。

(何静芳 编辑)

mance variation relationship and the specific features of the air-cooling tower inner and outer flow fields under cross-wind operating conditions. By revealing the major cause of the drop in heat dissipation the above work is helpful in providing some new ideas for further improving the cooling-air tower performance. **Key words**: air-cooling tower, Heller type indirect air-cooling system, k -ε dual equation model, numerical simulation, turbulent flow field

燃机 Mark V 遥控监控系统=**Mark V Remote-controlled Monitoring System for Gas Turbines**〔刊, 中〕/Wang Jingyi, Shen Qingwen, Yun Ruitian (Harbin No. 703 Research Institute), et al //Journal of Engineering for Thermal Energy &Power, 2000, 15(1). —55 ~ 58

The application of an industrial control PC is described. Through the preparation of a pertinent software the use of GE Co. Mark V gas turbine control system as a remote-controlled monitoring system was successfully realized. Furthermore, a detailed account of the software design process is also given. **Key words**: gas turbine control system, remote-controlled monitoring, software design

工业锅炉热力计算软件编制=**Preparation of a Thermodynamic Calculation Software for Industrial Boilers**〔刊, 中〕/Han Muxin, Fan Wei (Harbin No. 703 Research Institute), Lu Hengyu (Harbin Boiler Works), et al //Journal of Engineering for Thermal Energy &Power, 2000, 15(1). —59 ~ 61

By the use of a target-oriented programming language the authors have developed a Windows 95-based industrial boiler thermodynamic calculation software. Described in this paper are the specific features of the above development process. A proper approach for solving some key technical issues has also been expounded. **Key words**: industrial boiler, thermodynamic calculation, OOP

用 VB 编制 AutoCAD 阀门绘制程序=**Application Program of AutoCAD Plotting of Valves with the Help of a Visual Basic Language**〔刊, 中〕/Lin Xiangdong (Harbin No. 703 Research Institute) //Journal of Engineering for Thermal Energy &Power, 2000, 15(1). —62 ~ 64

The preparation of an application program for AutoCAD plotting of valves with the aid of a visual basic language is briefly described in this paper for use in a thermodynamic system. This results in a significant enhancement of the AutoCad plotting efficiency. **Key words**: AutoCAD, VB language, plotting of valves

利用冷却塔排放湿法脱硫锅炉净烟气的技术=**New Technology Featuring the Discharge of Desulfurized Gas via a Cooling Tower for Boilers with a Flue Gas Wet Desulfurization System**〔刊, 中〕/Luo Chuankui Nong Youxing, Ying Chunhua (Zhejiang Provincial Electric Power Design Institute) //Journal of Engineering for Thermal Energy & Power, 2000, 15(1). —65 ~ 66

With the development and gradual sophistication of flue gas desulphurization technology, especially flue gas wet desulphurization, there emerged in succession various versions of this new technology. The discharge via a cooling tower of desulphurized flue gas represents one of the typical methods currently widely employed in some developed countries with high effectiveness. By contrast, the use of such technology in China is still in its infancy. Nevertheless, its rapid popularization can be readily expected in view of its varied technical merits. After a brief description and economic evaluation of the above technology the present paper proposes some original approaches for stepping up its engineering applications in China. **Key words**: cooling tower, discharge of flue gas, desulphrization

锅炉制造业几种简易设备的研制=**Development and Fabrication of Some Simple Machines Used in Boiler Manufacturing Industry**〔刊, 中〕/Zhao Yan (Heilongjiang Provincial Machine Manufacturing Technicum), Dong Dachang (Harbin Boiler Inspection Research Institute), Song Wei (Hegang Municipal Water, Electricity and Thermal Power Co.) //Journal of Engineering for Thermal Energy &Power, 2000, 15(1). —67 ~ 68, 74

This paper describes several types of self-made, simple and applicable equipment items, such as tube bending machines, collector tube closing-up machines and boiler head edge cutters, etc. The use of these machines is conducive to lowering the fabrication cost of boilers, thus enhancing the competitive edge of boiler makers and their products in the world market. **Key words**: boiler manufacture, equipment, development and fabrication

改变补充水方式的节能效益解析＝**An Analysis of the Economic Benefits Derived from Energy-saving through a Change in a Make-up Water Supply Mode**〔刊, 中〕/Chen Guohui, Ling Wanchao, Xing Qinan (Xi' an Jiaotong University), et al // Journal of Engineering for Thermal Energy & Power, 2000, 15(1). —69 ~70

This paper discusses the economic benefits enjoyed by small and medium-sized thermal power plants using extra-pure demineralized water. Specially noted are the dual economic benefits realized by cogeneration power plants through a change in a make-up water supply mode. In this case when the make-up water is fed into a condenser the exhaust steam waste heat can be utilized, resulting in a reduction of the cold source loss. Moreover, heat regeneration economy may be enhanced when the make-up water inlet is relocated from a deaerator to the condenser. **Key words**: thermal power plant, exhaust steam waste heat utilization, make-up water system, improvement, energy-saving

PFBC 烟气中碱金属的脱除＝**Removal of Alkali Metal in PFBC Flue Gases**〔刊, 中〕/Han Chunli, Zhang Jun, Liu Kunlei (Southeastern University), et al// Journal of Engineering for Thermal Energy & Power, 2000, 15(1). —71 ~74

The presence of alkali metal in coal may cause corrosion of a flue gas-fired turbine in a PFBC unit. The present paper expounds the alkali metal removal mechanism and method, providing a realistic basis for the further study of such a removal process. **Key words**: alkali metal, removal, additive

汽轮机抗燃油的运行管理和监督＝**Operation Management and Supervision of Turbine Fire-resistant Oil**〔刊, 中〕/Li Zhi (Test Research Institute of Guangdong Electrical Power Bureau), Wei Qiang (Chemical Division of Shenzhen Energy Source Group Company Power Generation Subsidiary), Pan Riming (Zhanjiang Power Generation Plant), et al // Journal of Engineering for Thermal Energy & Power, 2000, 15(1). —75 ~77, 79

The operation supervision of fire-resistant oil for a large-sized turbine electro-hydraulic control system pertains to a new and weak link in power plant management. The authors in a systematic summing-up of their work experiences have given a detailed account of the above-mentioned supervision. **Key words**: steam turbine, electro-hydraulic control system, fire-resistant oil, operation supervision, purification device

由屏过爆管看集箱隔板损坏及处理＝**Analysis of the Failure of a Collector Partition Plate from the Perspective of a Platen Superheater Tube Explosion and its Treatment**〔刊, 中〕/Zhao Weiqing (Jinling Petrochemical Co. Thermal Power Plant) // Journal of Engineering for Thermal Energy & Power, 2000, 15(1). —78 ~79