

# 错动炉排套管式节能热水锅炉(2.8 MW)的研制

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**摘 要:**介绍了 2.8 MW 错动炉排热水锅炉的研制过程和经历, 同时介绍了两项专利技术: 错动炉排及套管式对流受热面, 在小型供暖锅炉方面又提供了一种新产品。该型锅炉特点是组装式结构, 套管式对流受热面节省 1/3 空间, 辐射受热面为自然循环, 运行安全可靠、锅炉热效率高及出力足, 可燃用低热值贫煤、型煤及果壳类物料。

**关 键 词:** 锅炉; 错动炉排; 套管; 节能

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## 1 前 言

目前, 在国内供暖行业中, 总的趋势是向着大规模大容量方向发展, 但在局部地区, 偏远地区应用最多的仍是组装层燃热水锅炉, 在层燃锅炉中又以链条炉排锅炉和往复炉排锅炉居多。链条炉排锅炉发展历史较长, 应用较广。其特点是运行平稳可靠, 炉

排使用寿命长和维修方便。缺点是煤种适应性较差, 出力受到影响; 往复炉排具有较好的拨火功能, 在适应煤种方面优于前者。但作为组装炉或快装锅炉, 其共同缺点是: 因受运输尺寸限制, 在设计中往往炉膛容积偏小, 辐射受热面及对流受热面不足。因而在实际应用中, 普遍出现锅炉出力低和热效率低等缺点。作者通过对上述现状的思考, 开发研制了一种既有快装锅炉体积小和安装周期短等优点, 又具备散装锅炉出力足和热效率高的小型燃煤锅炉。

## 2 锅炉设计

### 2.1 总体构思

该锅炉的设计思想是: 便于运输、组装方便、运

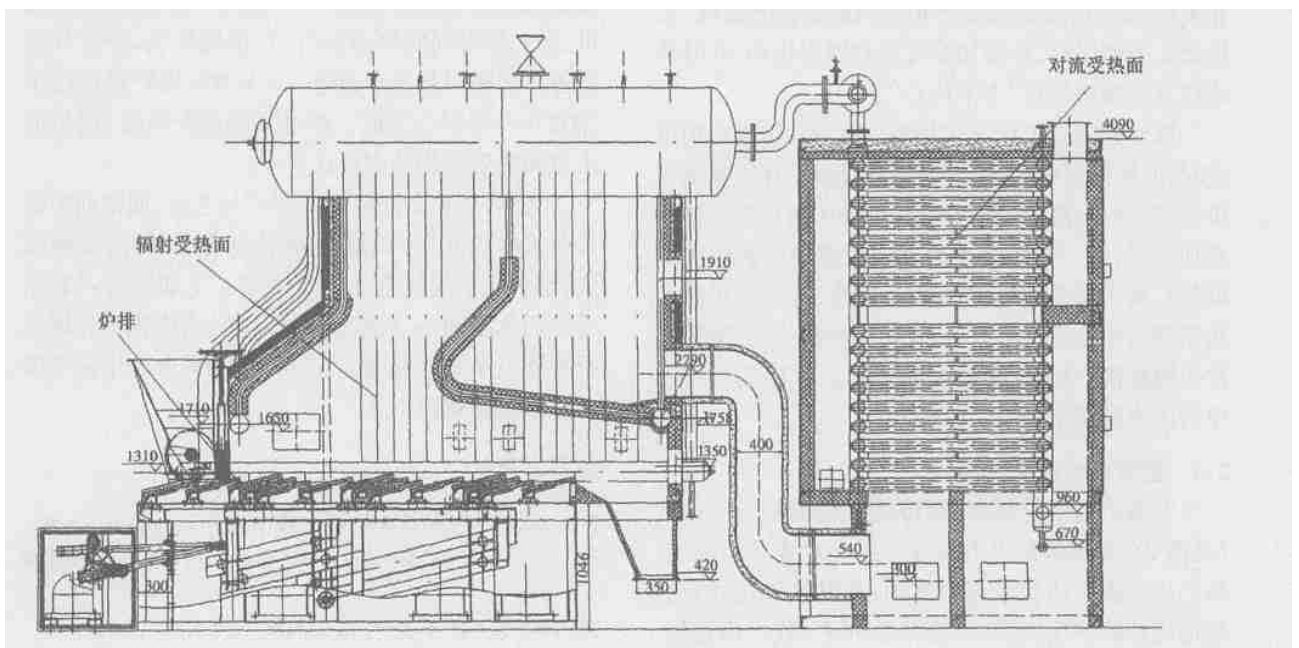


图 1 2.8 MW 锅炉结构

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行安全可靠、出力足、热效率高、适应煤种性广、可燃用低热值贫煤和型煤及果壳类物料。使之适应于中、小城镇特殊环境和条件,同时能够较好地燃用型煤,在环保节能方面发挥作用。该锅炉设计为3大部件(见图1):(1)炉膛部分(辐射受热面);(2)对流受热面部分;(3)炉排总成。

## 2.2 炉膛

锅炉设计中考虑到在满足运输尺寸条件下,布置足够的炉膛容积,同时考虑在实际运行中遇突然停电时,锅炉安全问题,采用了单纵锅筒配合前、后和侧集箱组成自然循环辐射受热面,被加热工质通过下降管从上锅筒引至各个集箱,经各辐射受热面上升回到上锅筒。分别构成4个简单循环回路。前和后水冷壁组成近似于散装层燃炉的前、后拱,提供了较为合理的燃烧空间,同时构成了较大空间的炉膛及燃尽室。

## 2.3 错动炉排

本锅炉燃烧设备采用的是错动炉排。

错动炉排是在传统往复炉排基础上进一步完善和创新。

传统往复炉排具有一定的拨火功能,燃料在运动中有轻微的翻滚。可以燃用16 720 kJ/kg左右的II类烟煤。对于燃用12 540 kJ/kg左右的褐煤、贫煤及I类烟煤时,须要加厚煤层和增大挠动,此时传统往复炉排就显得“力不从心”了。

错动炉排的工作方式是当一组活动炉排向前推进时,间隔的另一组活动炉排向后运动,在重叠的炉排处形成较大落差。一方面在运动中对燃料的挠动更加强烈;另一方面较大的落差使燃料的翻滚更加剧烈。基于错动炉排这种特殊功能,其在燃用颗粒状型煤时使之燃烧更充分,通过强烈的挠动,能够一次次地拨落外层灰,直至全部燃尽。该错动炉排已申请国家发明专利。

## 2.4 套管式对流受热面

本锅炉对流受热面采用的是套管式对流受热面(见图2),其结构是由内和外管组合形成环状通道,被加热工质在环状通道内流动,高温烟气在外管表面横向冲刷一次,再沿内管纵向冲刷一次。内管加

工成螺纹线,以增大纵向冲刷换热系数。采用此项技术,对流受热面在相同空间内可增大1/3以上。

工质在套管内流动靠循环泵强制循环,保持较高水速。锅炉烟气在进入对流管束时温度在800℃以下,平均烟温在500℃以下。因此,当遇突然停电情况时,由于密集管束水冷度较大,同时周围没有诸如炽热煤层及高温炉墙蓄热等影响,所以该对流受热面没有气化的危险。该项技术已申报国家实用新型专利。

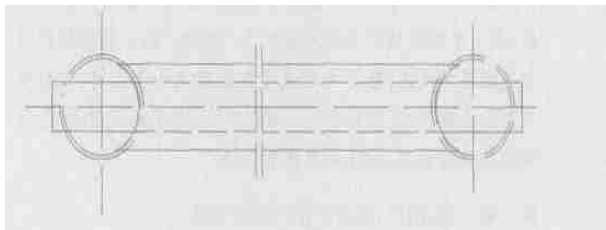


图2 内外套管示意图

## 3 结束语

错动炉排套管式对流受热面节能热水锅炉是黑龙江省科技攻关项目。我们攻关组于1999年完成了炉排构架设计,2000年完成了锅炉本体结构及对流受热面结构设计,2.8 MW错动炉排于2001年问世,经一段时间的冷态运行,在机械传动,炉排片型状等方面做了若干次改进。2.8 MW锅炉样机已于2002年冬季制造完成。经过实际运行检验,锅炉的出力和热效率均达到设计要求。

当然,该设备还存在一些不足之处,如错动炉排传动机构较复杂,机械故障率会增大,所占空间较大,给炉排下配风造成一定困难。又如套管式对流受热面水空间小,对水质要求严格,否则锅炉长期运行可能发生结垢现象。在今后的设计改造中应考虑此类问题的解决。

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ing valve, thus controlling the entrainment quantity of hot flue gases and achieving a stable ignition by adapting to various ranks of coal. By using the combustion system under discussion the retrofitting of a 150 t/h pulverized coal-fired boiler at the Thermal Power Plant of Dandong Chemical Fiber Co. Ltd. was implemented and operating tests at 10 different working conditions performed. Test results indicate that the combustion system can adapt well to various ranks of coal and to load variations. Under various operating conditions a stable combustion and high combustion efficiency can be attained.

**Key words:** concentration, preheating, combustion system

船用增压锅炉热力计算方法有关问题分析 = **A Study of Some Issues Related to the Thermodynamic Calculation of a Supercharged Marine Boiler** [刊, 汉] / LI Yan-jun, JIANG Ren-qiu, SUN Bao-zhi (College of Power and Nuclear Energy Engineering under the Harbin Engineering University, Harbin, China, Post Code: 150001) // Journal of Engineering for Thermal Energy & Power. — 2005, 20(1). — 93~96

Concerning some key issues encountered in the thermodynamic calculation of supercharged marine boilers an in-depth theoretical study was carried out, and some calculation formulas and methods presented. This has in a certain sense offered a theoretical basis for the final establishment of a thermodynamic calculation method for supercharged marine boilers. By making use of the research results thermodynamic calculations of supercharged marine boilers made in the former Soviet Union were conducted and the results of calculation can relatively well meet boiler performance requirements. **Key words:** supercharged boiler, thermal balance, supercharged combustion, thermodynamic calculation

错动炉排套管式节能热水锅炉(2.8 MW)的研制 = **Research and Development of an Energy-saving Hot Water Boiler (2.8 MW) Equipped with Staggered Grates and Casing Pipes** [刊, 汉] / DING Li-qun, WANG Wen-yu (College of Municipal Environmental Engineering under the Harbin Institute of Technology, Harbin, China, Post Code: 150001) // Journal of Engineering for Thermal Energy & Power. — 2005, 20(1). — 97~98

The development process and experience of a 2.8 MW hot-water boiler equipped with staggered grates is described along with the presentation of two items of patented technology, namely staggered grates and casing-pipe convection heating surfaces. A new product among small-sized heating boilers, the recommended boiler features a packaged construction. The casing-pipe type convection heating surfaces can bring about a 1/3 economy in space requirements. A safe and reliable operation of the boiler is secured by the use of natural circulation-based radiation heating surfaces. The boiler with a high thermal efficiency and full steam output can operate on lean coal of low calorific value, formed coal and shell-like refuse. **Key words:** boiler, staggered grate, casing pipe, energy saving

国产 600 MW 超临界机组直流锅炉启动系统 = **Start-up System of a Chinese-made 600 MW Supercritical Once-through Boiler** [刊, 汉] / DUAN Yong-cheng (Taicanggang Environment-protection Power Generation Co. Ltd., Taicang, Jiangsu Province, China, Post Code: 215433) // Journal of Engineering for Thermal Energy & Power. — 2005, 20(1). — 99~100

Shanghai Boiler Co. Ltd. in China has for the first time imported the manufacturing technology of 600 MW supercritical once-through boilers from Alstom Co. of USA. A major difference exists between the start-up process of a supercritical boiler and that of a subcritical one. There are few supercritical boilers presently in operation in China and in the majority of cases external steam-water separators are used. Through a brief account of the construction features of a once-through boiler start-up system the author has analyzed the adjustment principle of drainage employed in the boiler start-up system. This can serve as a guide and resource of useful information for other analogous units. **Key words:** supercritical parameter, once-through boiler, start-up system