220 t /h百叶窗分级循环流化床投资成本分析

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〔摘要〕 本文介绍了佳木斯热电厂 220 t /h百叶窗分级循环流化床投资本成,并与旋风炉进行了对比分析。

关键词　百叶窗分级循环　循环流化床　成本分析
分类号　TK229. 66

0 前言

佳木斯热电厂工程是 1990年国家计委批复的 56个大中型项目之一,总投资为 41004万元,装机容量为 7. 5万千瓦,配一台 5万千瓦的双抽凝汽式汽轮机组,一台 2. 5万千瓦背压式汽轮机组,两台 220 t /h立式旋风炉,其燃烧系统采用钢球磨煤机仓储式热风送粉系统,一台 220 t /h百叶窗分级循环流化床锅炉。该电厂是以供热为主、热电结合的电厂。

1 结构及附属系统简介

1. 1 锅炉设计参数

额定蒸发量	220 t/h
过热蒸汽压力	9. 8 MPa
过热蒸汽温度	540℃
给水温度	215℃
一次风温度	230℃
二次风温度	150℃
热效率	90. 9%
脱硫率	> 85%
负荷调节	50% – 100%
燃煤粒度	0– 12 mm
锅炉外型尺寸	28 m× 14 m× 12 m

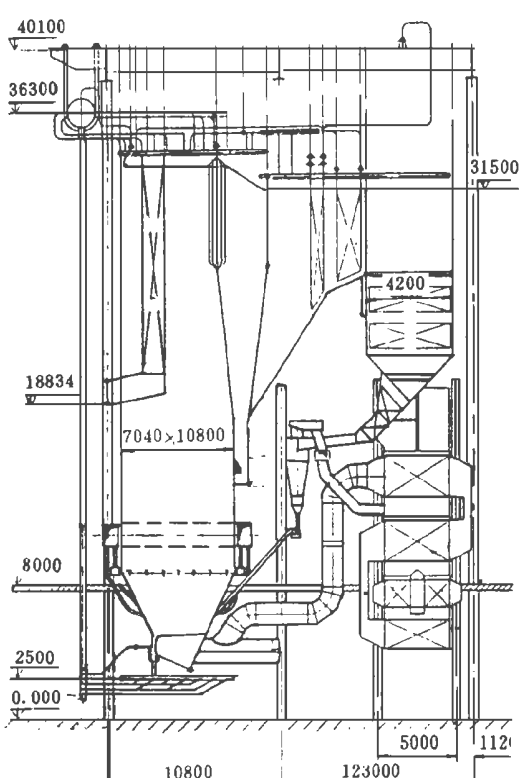

图 1　WGC 220/9. 8– 1型循环流化床锅炉总图

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1.2 结构简介

本锅炉为门形布置,如图 1所示,该锅炉采用自然循环,炉墙四周布满膜式水冷壁,水平烟道两侧、尾部转向室和顶棚均采用包墙结构;尾部省煤器分两级:一级为卧式膜片省煤器,二级分成两支,分别形成水平烟道底包墙和高温分离器的支吊管;空预器亦分两组,一次风预热器为卧管式,空气在管内流动;而二次风预热器是烟管立式,搁置结构。二级分离系统中高温百叶窗分离器置于炉膛出口,低温分离器置于省煤器后,它是采用百叶窗—— 旋风分离器组合式,共四组,90% 的烟气经分离叶栅后直接进入空预器,而浓集有物料的另外 10% 的烟气则进入旋风分离器,物料被收集并经低温返料器送回床内再次燃烧,而烟气则从中心管返回烟道并与主烟气汇合,最后经除尘器进入烟囱流入大气。

1.3 附属系统简介

1.3.1 *破碎系统* 经一级破碎机(与旋风炉合用)后,粒度≤ 35 **mm**的煤再经二级破碎机破碎到 0– 12 **mm**粒度的煤,经刮板机和带式运输机送入循环流化床原煤仓。

1.3.2 *给煤系统* 0– 12 **mm**粒度的煤经计量式皮带给煤机和管式输送机进入布置于前墙的三个给煤管,藉助自身重力和引入的二次风进入床内。

1.3.3 *供风系统* 一次风分二路进入锅炉水冷风室,经风帽通过床料进入炉膛,二次风从两侧进入,绕炉膛环形风道分三层喷嘴进入炉内。冷渣风机从一次风机出口总管吸风。

1.3.4 *除灰渣系统* 从炉膛溢流出的渣经过冷渣器、电动三通至一级埋刮板机后,经二级埋刮板机送入主灰仓装车外运。

2 成本分析

由于佳木斯热电厂工程同期上两种不同炉型,图 2为立式旋风炉布置图。这样可以利用成本分析的基本方法—— 指标对比分析法,对两种炉型的投资成本的三项主要指标(1)设备成本、(2)安装成本、(3)建筑成本进行比较分析。

表 1为两种炉型主要设备(不含公用设备)价格及安装工程费明细表,表 2为锅炉土建主要工程概算表。下面分析其本体风烟系统设备、燃煤制备及给料系统设备和除尘及除灰设备各项成本。

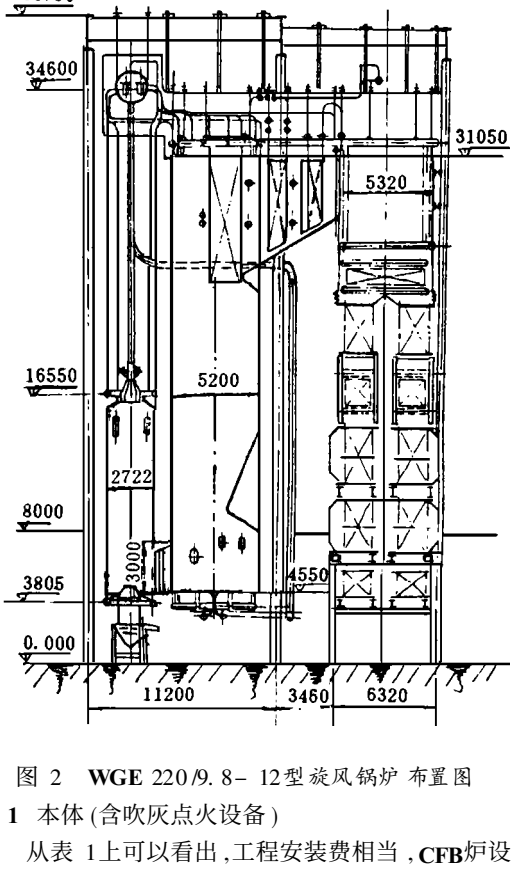

图 2 **WGE** 220/9.8– 12型旋风锅炉 布置图

2.1 本体(含吹灰点火设备)

从表 1上可以看出,工程安装费相当,**CFB**炉设备价格略高于旋风炉,本体造价高于旋风炉这是合理的。这是因为:(1)循环流化床耗钢 1256吨,而旋风炉耗钢仅为 1180吨(皆不含吹灰器);(2)本体结构较复杂、工艺要求更高;(3)独特的防磨工艺和昂贵的防磨耐磨材料。

由于该炉具有相对低的燃烧温度及高的烟气流速,受热面积灰不如旋风炉严重,则其吹灰装置费用(15.95万)低于旋风炉(25.81万)。但点火方式复杂(风道预燃室加热空气,炉膛喷油助燃启动,其点火装置费用(9万)则高于旋风炉(4.4万)。

2.2 风烟系统设备

循环流化床风烟系统设备比旋风炉复杂,设备价格和安装价格均高于旋风炉。

2.3 燃煤制备及给料系统

循环流化床采用 0– 12**mm**的颗粒,其燃料制备系统仅靠破碎机即可完成(见图 1),旋风炉采用中储式制粉系统,系统复杂设备庞大。由于 **CFB**锅炉的燃料制备及给料系统简单,因而设备及系统(风烟煤管

表 2 锅炉土建主要工程概算表 (万元)

序号	工程名称	定额总价	备 注
1	CE 轴 (锅炉间)主厂房本体	1055.0	所有工程费为1992年概算价格
2	主厂房 (锅炉间)及设备桩基等	1250.0	
3	引风机室及除尘排烟系统	530.0	以上项目为三台炉合价
4	二级碎煤机室	27.5	循环流化床单独使用,一级碎煤机室三炉合用未列
5	沉渣池室	251.38	二台旋风炉合用

道)造价及安装工程费远低于旋风炉 (即使计入二级破碎机的土建费亦如此)。

2.4 除尘及除渣系统

由于采用相同的高效除尘器,设备价格及安装费基本一样。旋风炉液态排渣,采用水力机械除灰系统,排出的液态渣经沉淀后由桥式抓斗起重机捞出并运走;**CFB**锅炉由于灰渣量较大,渣温达 850℃,为回收余热和灰渣综合利用,而采用干式除渣方式,即排出的渣经冷渣器至埋刮板除渣机运走,该过程须将渣从 800– 850℃降为 70– 80℃左右,设备及工程安装费均比旋风炉要高得多。但旋风炉因须设沉渣池,如果将其土建费计入,旋风炉为 212.65万元 (沉渣池土建费用由两台旋风炉均摊),而 **CFB**炉为 226.6万元,则价格相差不多 (不含表 2中 1 2 3 项),如果 **CFB**炉采用水力除灰系统,该项投资价应低些。

3 综合分析

从以上分析中得知: 在设备价格及安装工程费方面,**CFB**炉本体设备、风烟系统和除尘、除渣系统均高于旋风炉,而燃料制备及给料系统却低于旋风炉,如果将土建费计入,综合表 1、表 2,**CFB**炉的投资费用少于旋风炉 78.295万元,(当然由于该炉是实验炉,生产厂家在价格上做了一定让步)。

实际上从各种资料表明 **CFB**炉的投资费用应略高于常规煤粉炉 (含旋风炉)。但传统的煤粉炉由于受煤种限制,庞大的制粉系统,事故率较高和高挥发份煤的制粉系统存在爆炸的隐患等是煤粉炉的弱点。更主要是由于环保要求的提高和石油的日趋枯竭,促使世界各国寻找清洁高效的燃煤方式而发展起来的 **CFB**炉具有清洁高效的优点,而且该炉型通常投资和运行费用适中,虽略高于常规煤粉炉,但比配制脱硫装置的煤粉炉仍低 15% – 20%,图 3是 **Circofluid**锅炉与带烟气脱硫煤粉锅炉的造价比较,比较条件中考虑了给煤机、制料和燃烧设备、蒸发器、再热器、送引风系统及风机、空预器、烟气系统及除尘器、烟气脱硫装置、钢结构和安装费用。从图中可以看出,该种炉型与带烟气脱硫装置的同样蒸发量的煤粉炉要便宜约 20% ~ 25%。由于 **CFB**锅炉技术经济上更为合理,因而能得到越来越广泛的应用。

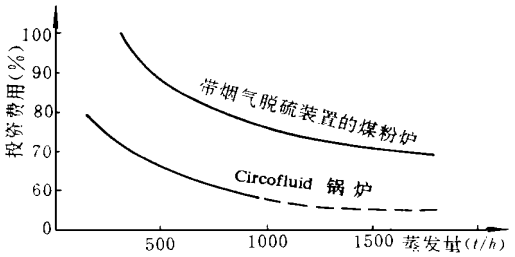

图 3 **Circofluid**锅炉与带烟气脱硫煤粉锅炉的比较

4 前景预测

4.1 50 **MW**循环流化床电站锅炉的研制成功,将为国民经济提供一种能燃用多煤种的高效低污染的电站锅炉品种,可用于热电和电网调频。

4.2 国际上,为保护生态环境,很多国家对排气和大气污染制定了严格的控制标准。在我国,能源短缺和燃煤带来的大气污染问题的妥善解决更显得重要和迫切,我国高硫煤产量较大,占电站用煤的 1/3,致使一些地区酸雨危害严重。而循环流化床电站锅炉可减少因二氧化硫、氧化氮的排放所造成的大气污染和酸雨的危害。

4.3 通过攻关,发展了一种更为实用,易于大型化的新炉型结构,可形成 **CFB**电站锅炉系统。国内已引进几台 220 **t/h CFB**锅炉,但价格昂贵,因而该炉的研制成功具有很广的国内市场和出口潜力。◀

联产机组供热单耗的"单耗分析"方法= **"Unit Comsumption Aanlysis" of CHP Heat Supply**〔刊,中〕/Song Z. P., Zhang G. (North China University of Electric Power)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -1~ 4

On the basis of a paper entitled "Unit consumption analysis model of a heat supply system" and by utilizing modern energy saving theory the authors have set up a generalized discrete model for the unit consumption of a cogeneration turbine set heat supply. This not only provides a basis for developing further a continuous model but also by way of calculating specific examples makes it possible to investigate the multifarious factors affecting the unit consumption of CHP heating on the basis of a totally new quantitative index analysis. Practice has shown that this is a useful study, enlightening authors in the creation of a new mode of combined heat and power generation. **Key words** heat supply, unit consumption, cogeneration, energy-saving, exergy

管簇结构腔体式吸收器总热阻所受环境条件的影响= **The Influence of Environmental Conditions on the Total Heat Resistance of Solar Cavity Receiver with a Tube Bundle Construction**〔刊,中〕/Chou Qiaoli, Ge Xinshi, et al. (Chinese University of Science & Technology)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -5~ 7

An analysis is conducted of the thermal performance of a novel solar cavity receiver with a bundle of tubes serving as an absorber. On the basis of a heat resistance network and the general control equations of solar energy a numerical analysis is performed of the influence on the heat resistance of such environmental conditions as solar direct irradiation, ambient temperture and wind velocity. **Key words** solar cavity receiver with a tube bundle as its abosorbe, solar energy, heat resistance, boundary condition

双燃料煤粉流化床复合燃烧锅炉的物质平衡与热量平衡= **The Material and Heat Balance of a Dual-fuel Pulverized Coal-fired Fluidized Bed Multiple Combustion Boiler**〔刊,中〕/Zhao Guangbo, Zhu Qunyi, Yun Xiaoyin, at al. (Harbin Institute of Technology), Ren Youbao, Ye Jiyi (Jiamusi Paper Making Co. Ltd.)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -8~ 10

An analysis is made of the material and heat balance for a dual-fuel pulverized coal-fired fluidized bed multiple combustion boiler. Obtained are a material balance equation for the boiler furnace and air heater, a heat balance equation for the fluidized bed and the pulverized coal-fired furnace and a calculation formula for furnace outlet excess air faclor, unburned flue gas heat loss and unburned carbon heat loss. **Key words** mixed fuel, multiple combustion, material balance, heat balance

中冷再热 **STIG**循环的㶲分析= **Exergy Analysis of an Intercooled Reheat STIG Cycle**〔刊,中〕/Wang Yongqing, et al. (Harbin Institute of Technology)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -11~ 14

The exergy analysis of an intercooled reheat steam injected gas turbine cycle has shown that such a cycle has a significantly higher exergy efficiency as compared with a simple STIG cycle. Also analysed in this paper are the effect on exergy efficiency of the equipment performance and various cycle parameters, and the locations where various kinds of irreversible losses took place. As a result, intrinsiclly different conclusions in respect of heat balance are obtained. **Key words** intercooled reheat STIG Cycle, irreversible loss, exergy efficiency

220 **t/h**百叶窗分级循环流化床投资成本分析= **Investment Cost Analysis of a** 220 **t/h Louver Stepped Cycle fluidized Bed**〔刊,中〕/Chen Yulin, Li Yuying (Jiamusi Thermal Power Station)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -15~ 18

This paper deals with the investment cost of a 220 t/h louver stepped cycle fluidized bed installed at Jiamusi

Thermal Power Station. Acost analysis is performed in comparison with a cyclone-furnace. **Key words** louver stepped cycle, circulating fluidized bed, cost analysis

煤的太阳能干馏的可行性及干馏炉的设计探讨= **The Feasibility of Destructive Distillation by the Use of Solar Energy and the Design Study of a Furnace of Destructive distillation**〔刊,中〕/Wang Zhuliang(Jiangsu University of Science& Engineering)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -19~22

The author has proved that it is feasible to use solar energy as a high-temperature heat source for a destructive distillation furnace. Through a heat transfer analysis and comprehensive review the merits of a new type of solar energy-based destructive distillation furnace are demonstrated with some issues to be solved during practical applications also pinpointed. **Key words** solar energy, destruction distillation furnace. destructive distillation

高温吸收式热泵的生态学准则优化= **The Optimization of Ecological Criteria for High-temperature Absorption Heat pumps**〔刊,中〕/Chen Tianze, Yan Zijun (Shamen University)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -23~ 25

With an objective being the ecological criteria which enables the cycle heat supply rate and heat supply rate dissipation attain an optimum compromise the paper presents the study results of the optimization of a high-temperature absorption heat pump. Some new performance parameters of the heat pump are derived and several interesting aspects of the issue discussed. The conclusions obtained can serve as a new theoretical guide for the optimized design and the selection of optimum operating condition of the high-temperature triple heat source heat pumps and heat engines. **Key words** finite time thermodynamics, high-temperature absorption heat pump, ecological criteria, performance optimization

塔型飞灰浓缩器阻力特性的试验研究= **An Experimental Study of the Resistance Characteristics of a Tower-type Fly ash Concentrator**〔刊,中〕/Li Gongbo (Xi' an Thermotechnical Research Institute), Wen Long (Xi' an Jiaotong University)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -26~ 29

On the basis of the cold-state Model Test of a tower-type fly ash concentrator and an exploratory analysis of the resistance variation relationship under various operating regimes and geometric parameter test conditions as well as a multidimensional linear regression analytical calculation of a vast amount of test data, given in this paper is a multidimensional regression formula for calculating the resistance of the tower-type fly ash concentrator, therepy providing a technical basis for its design, evaluation and application in engineering practice. **Key words** tower-type fly ash concentrator , resistance, characteristics, regression analysis

130 t/h锅炉结渣及稳燃问题的研究= **The Study and solution of a Slagging and Stable Combustion Problem for a 130 t/h Boiler**〔刊,中〕/Chen Gang, Qiu Jihua, Li Fojin, et al. (Central China University of Science& Engineering)// Journal of Engineering for Thermal Energy & Power. -1997, 12(1). -30~ 32

The underlying causes leading to slagging and poor combustion stability of a 130 t/h boiler are analysed. After a redesign and modification of its burners with the adoption of pulverized coal burners incorporating a combustion stabilization cavity very good results have been attained. The combustion efficiency is enhanced by 6% and the boiler can maintain a stable combustion when operating at 60% loal without using oil. **Key words** boiler, slagging, combustion stability, pulverized coal combustion, burner with a combustion stabilization cavity

燃用固体燃料电厂环境负压吸尘系统的选择与设计= **The Selection and Design of a Negative-Pressure Dust Collecting System for a Solid Fuel-Fired Power Plant Environment**〔刊,中〕/Iü tai, Hao Chunhai (Northeast