

# HAT 循环的一种改型 ——CHAT 循环

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〔摘要〕 本文介绍了 HAT 循环的一种改型 CHAT 循环。该循环属于再热型的 HAT 循环,并在文中对 CHAT 循环的特点进行了简要介绍。

关键词: HAT 循环 CHAT 循环 特点

分类号: TK479.1

## 1 引言

大家知道,对于单一的热力循环(如 Brayton 循环和 Rankinet 循环),它们的热力学效率并不太高,想要继续提高它们的热效率在技术上也存在不少困难。

要提高热力循环效率,需要遵循“温度对口,梯级利用”的总能系统原则,把有关循环有机地结合起来形成联合循环或复合循环,从而改善循环的热力性能。HAT 循环即为复合循环的一种,而 CHAT 则是 HAT 循环的改型<sup>(1)</sup>。

## 2 HAT 循环及其特点

HAT 循环是一种回热循环,它是利用循环中从中冷器、后冷器及热水器等返回的低品位热水来加热加湿压力空气,形成的湿化空气在回热器中回热后进入燃烧室,从而使透平工质大幅度增加。透平发出的功增加,而高压与低压压气机间存在间冷器,因此压缩机的压缩耗功减小,HAT 循环的比功可以大

幅度提高<sup>(2)</sup>。在  $TIT=1533\text{ k}$  时,其最大热力学效率可突破 60%,达到 60.33%<sup>(3)</sup>。

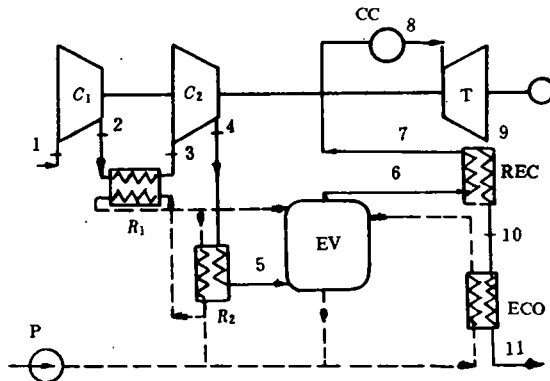


图 1 HAT 循环热力系统图

— 空气    ..... 湿空气或湿燃气  
 --- 水    C1—压气机低压段  
 EV—蒸发器可饱和器    C2—压气机高压段  
 REC—回热器    R1—间冷器    CC—燃烧室  
 R2—后冷器    T—透平    P—水泵    ECO—经济器

该循环中,可以利用饱和器来控制压力空气的加温加湿效果,从而适应该循环所要求的负荷变化<sup>(4)</sup>。由于进入燃烧室的是湿化空气,因此可大幅度降低  $\text{NO}_x$  等污染物的发生量,具有优越的环保优势。

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### 3 CHAT 循环

CHAT 循环是 HAT 循环的一种改型。其主要部件包括高、中、低压空气压缩机，级间存在级间冷却器，两个燃烧室，两个透平，一个回热器，一个空气饱和器和一个冷却塔。类似于 HAT 循环，压缩空气在循环中被加温加湿，经回热器回热后进入燃烧室和透平。

看出：通常所讲的 HAT 为单轴系安排，而 CHAT 循环为双轴系安排；HAT 循环中有高、低压压气机，而 CHAT 循环中有高、中、低压压气机；HAT 循环中为单个透平，而 CHAT 循环为高压和低压透平。

可以讲，CHAT 循环在原理方面与 HAT 循环完全一致，它与 HAT 循环最大区别是在轴系安排上作了改进，CHAT 循环在结构及性能上的变化都是由此引起的。

### 4 CHAT 循环的特点

大家知道，双轴系循环的变工况性能比单轴系循环要好。同样可以肯定，CHAT 循环变工况性能比 HAT 循环优越，这正是 CHAT 循环的突出特点。

在相同条件下，CHAT 循环的比功要高于“F”技术联合循环。在没有进口冷却，当环境温度为 37.8℃ 时，对于“F”技术联合循环，其发出功为 210 MW，而对 CHAT 循环，其发出功约为 280 MW。

在 ISO 情况下，满负荷时 CHAT 循环的热耗率一定程度上高于“F”技术联合循环，但由于其单位千瓦的较低投资而得到补偿。这使得 CHAT 循环在承担基本负荷时可与相当规模的联合循环相竞争，尤其是在较高环境温度情况下。

在部分负荷时，CHAT 循环的热耗率并不太高，当负荷下降到满负荷的 60% 时，CHAT 循环热效率无显著下降。另外，CHAT 循环的过渡工况性能也较优越，它在 10 分钟之内即可联网发电，而在 30 分钟之内即可达到满负荷。

鉴于 CHAT 循环的这些特点，对 CHAT 循环深入研究也是十分必要的。

目前，美国西屋公司正在建造 CHAT 循环示范厂，预计 1998 年即可投入商业运行。

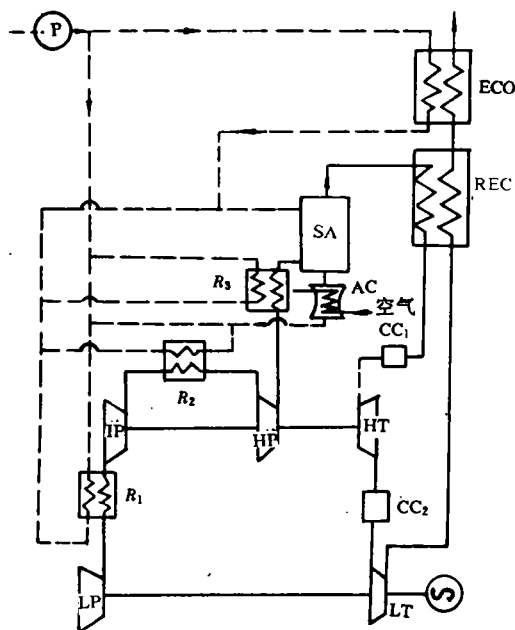


图 2 CHAT 循环热力系统图

— 空气 ..... 湿空气或湿燃气 --- 水  
 LP、IP、MP—低、中、高压压气机 HT、LT—高、低压透平  
 R1、R2—间冷器 R3—后冷器 SA—饱和器  
 CC1、CC2—燃烧室 REC—回热器  
 ECC—经济器或热水器 P—水泵 AC—冷却塔

CHAT 循环可安排为两轴系，低压透平带动低压压气机，而高压透平带动中高压压气机，负荷安排在低压轴上。CHAT 循环的热力循环图参看图 2。

由 HAT 循环与 CHAT 循环热力循环图

美国加州 Fluor Daniel 公司的 Ashok. D. Rao 先生提供了有关的技术资料,致谢。

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## 军转民高科技产品

——MVC-2M 电站锅炉风机振动保护系统通过两部评审验收

1995 年 9 月 20 日,由上海电力局和哈尔滨七〇三研究所率全国同行之先联合组织的电站锅炉风机振动监测与超限保护试点攻关项目的评审会在上海举行。会议由电力部和中船总公司联合主持。电力部科技司巡视员王汉生、中船总公司科教局总工程师程天柱、上海电力局总工程师高正秋等领导以及上海交大徐敏教授等全国著名故障诊断专家共七人组成评委会。提供评审的“MVC-2M 电站锅炉风机振动监测与超限保护系统”系由我 MVC-2M 课题组根据“七五”“八五”国防科技重点预研成果——“MVC-2M 故障诊断系统”和“MVC-2M 燃气轮机故障诊断专家系统”衍化而成的军转民高科技产品,具有对风机实施振动在线监测,振动数据日报和故障数据自动存贮,振动故障的精密诊断以及振动超限紧急停机等功能。

国际国内联机检索结果表明,就国际范围而言,有电站锅炉风机振动保护系统但存在较多误动作,也没有诊断功能;而国内则尚属首次。据此,评审结论也对 MVC-2M 电站锅炉风机振动监测与超限保护系统作出了高度的评价。

MVC-2M 课题组(1995. 10. 05)

Li Zhongqi, Sun Enzhao (Harbin Institute of Technology) // Journal of Engineering for Thermal Energy & Power. -1996, 11(1). -20~24

Described in this paper is a combustion technique involving a combination of travelling grate and pulverized coal firing, i. e. , the travelling grate firing and the pulverized coal firing take place in one and the same boiler furnace. Briefly discussed are the mechanism of such a kind of combustion technique and the related boiler structural design features along with a description of a new type of 58 MW hot water boiler incorporating the combined firing technique. Key words; combined firing, grate stoker, pulverized coal fired boiler

污泥流化床焚烧技术研究和环境影响分析 = A Study on Fluidized Bed Sludge Combustion Technology and Analysis of Environmental Impacts [刊/中]/Yan Jianhua, Jiang Xuguang, Chi Yong, Zeng Tinghua, Ni Mingjiang, Cen Kefa (Zhejiang University) // Journal of Engineering for Thermal Energy & Power. -1996, 11(1). -25~29

On the basis of analysing the various methods for the disposal of sludge, such as agricultural land filling, throwing into sea and burning in revolving kilns, the authors have come up with a new type of sludge heterospecific-gravity based fluidized bed combustion technology with emphasis on the analysis of sludge energy utilization. An experimental investigation is performed of the sludge caking and ignition characteristics when burned in the fluidized bed. Also analysed and tested are the emissions of  $\text{SO}_2$ ,  $\text{NO}_x$ , fluorine, chlorine and heavy metals following the combustion of sludge, which show that the sludge combustion in the fluidized bed is technically feasible and the emissions of pollutants are within the limits demanded by environmental protection requirements with no risk of secondary pollution arising therefrom. One can therefore conclude the above-mentioned technology can be advantageously applied for the disposal of sludge. Key words; sludge disposal, fluidized bed, combustion technology, environment

论发展超临界参数锅炉 = On the Development of Boilers of Supercritical Parameters [刊, 中]/Li Zhiwang, Sun Qingfu, et al (Heilongjiang Electric Power Test Institute) // Journal of Engineering for Thermal Energy & Power. -1996, 11(1). -30~32

Based on the operation practice and performance of home made 600 MW boilers of supercritical and subcritical steam conditions the authors have analysed the reliability and economics resulting from the use of power generating unit of supercritical parameters. The merit of a lower steel consumption enjoyed by supercritical pressure boilers as compared to subcritical pressure ones testifies to the great significance of developing supercritical pressure boilers. Key words; supercritical pressure, steel consumption, reliability, economics

垃圾的焚烧处理 = Garbage Disposal by way of incineration [刊, 中]/He Weical, Xuan Yinong, Lu Naixuan (Guangzhou Design Institute under the Ministry of Light Industry) // Journal of Engineering for Thermal Energy & Power. -1996, 11(1)-33~36

This paper gives a brief account of the new developments in garbage disposal by way of incineration and related incineration technology. Key Words; garbage, disposal by incineration

HAT 循环的一种改型—CHAT 循环 = CHAT Cycle-A Modified Version of Humid Air Turbine Cycle

[刊,中]/Jin Haiming(Xi'an Jiaotong University)//Journal of Engineering for Thermal Energy & Power. -1996,11(1). -37~39

CHAT cycle, a modified version of HAT cycle is described in this paper. It pertains to a reheat version of the HAT cycle. The outstanding features of the CHAT cycle are also briefly presented. Key words: HAT cycle,CHAT cycle features

微机监测分析系统在火电厂 125MW 机组中的应用=The Application of Microcomputer-based Monitoring System for a Thermal Power Plant 125 MW Generating Set[刊,中]/Chen Liqiang, Ren Haoren, Sheng Deren, Chen Jianhong (Zhejiang University)//Journal of Engineering for Thermal Energy & Power. -1996,11(1)-40~44

Described in this paper is a practical MAS microcomputer-based monitoring/analysing system which the authors have designed, installed and commissioning-tested for a thermal power plant 125 MW generating set. The hardware configuration, software organization and the functions and outstanding features of the said system are presented. Also dealt with are the putting into operation of the system and its application prospects. Key words: thermal power plant, microcomputer-based monitoring/analysing system, application

燃气幅射管壁温计算数学模型=A Mathematical Model for Calculating the Outside wall Temperature of a Gas Radiating Tube [刊,中]/Liu Cunfang, Zhang Mengahu (Shandong University of Science & Technology)//Journal of Engineering for Thermal Energy & Power, 1996,11(1). -45~48

Based on some rational assumptions, the present paper presents a mathematical model for calculating the outside wall average temperature of a gas radiating sleeve tube. Through the use of the said model it is also possible to calculate the inner tube wall temperature, the exhaust gas temperature, the heat input and the thermal efficiency of the said tube. The calculation results are in good agreement with those obtained by experiments, thus confirming the rationality of the proposed mathematical model. Key words: combustor, gas radiating tube, wall temperature, mathematical model, calculation

HG-CFB 35-3. 82/450-1 型循环流化床锅炉的启动调试研究及改进分析=A Study on the Start-up Commissioning Test of a HG-CFB 35-3. 82/450-1 Circulating Fluidized Bed Boiler Followed by an Analysis of Improvement Measures[刊,中]/Dang Li jun, Zhang Wenjing, Wang Jubao//Journal of Engineering for Thermal Energy & Power. -1996,11(1). -49~52

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