管簇结构腔体式吸收器总热阻所受环境条件的影响

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〔摘要〕 本文分析槽形抛物聚光集热器中管簇结构腔体式吸收器的热物理特性,依据其热阻网络、太阳能一般性控制方程对热阻所受边界条件的影响作了数值分析。

关键词　管簇结构腔体式吸收器　太阳能　热阻　边界条件
分类号　TK513

0 管簇结构腔体式吸收器的热阻网络稳态分析模型

文献〔1〕中讨论的管簇结构腔体式吸收器热阻网络如图 1所示。其中, Q_{CO} 为腔体式吸收器内表面所吸收的太阳能, $T_{ico,m}$ 为吸收器内表面在向管簇中流过的工质提供有用热流 Q_u 及存在热损 Q_{LOSS} 情况下达到的平衡温度。热损 Q_{LOSS} 中一部分通过传导(热阻 K_{cog})、对流(热阻 H_{coag})、辐射(热阻 R_{cog})向热镜窗散热,使其温度达到 $T_{g,m}$,再通过对流(热阻 H_g)、辐射(热阻 R_g)向环境散热;另一部分通过传导(热阻 K_c)向保温层散热,使其外表面温度达到 $T_{s,m}$,再通过对流(热阻 H_S)、辐射(热阻 R_S)向环境散热。图 1中 Q_{ss} 和 Q_{gg} 分别代表保温层外表面和热镜窗吸收的太阳辐射能流。T_a 为环境空气温度, T_{sky} 为天空温度, U_{om} 为环境风速, I_b 为太阳直射辐射强度, F 为抛物镜开口接光面积, P_{op} 为集热器光学效率。$T_{fm,m}$ 为工作介质进、出口平均温度, H_f 为管簇管壁至工作介质对流热阻。各项分热阻计算可查阅文献〔1〕。

由图 1可得确定热损的总热阻 K_{tot} 计算式

$$K_{tot}=\left\{\left[K_C+\frac{1}{\frac{1}{R_S}+\frac{1}{H_S}}\right]^{-1}+\left[\frac{1}{\frac{1}{R_g}+\frac{1}{H_S}}+\frac{1}{\frac{1}{K_{cog}}+\frac{1}{H_{coag}}+\frac{1}{R_{cog}}}\right]^{-1}\right\}^{-1} \quad (1)$$

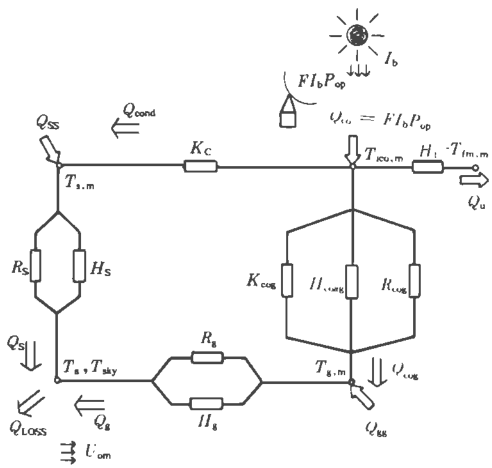

图 1　管簇结构腔体式吸收器热阻网络图

1 平衡方程

对吸收器表面列出能量平衡方程,在稳态时,有

$$Z_{op}I_bF=\dot{m}C_p(T_{fm,o}-T_{fm,i})+\frac{T_{ico,m}-T_a}{K_{tot}} \quad (2)$$

等式左边代表吸收器接收的太阳能,右边第一项代表工作介质带走的热量,第二项代表吸收器的热损。式中: $\dot{m}$— 工作介质质量流量, C_P— 工作介质定压比热, $T_{fm,o}$、$T_{fm,i}$— 工作介质出口、进口温度。式(2)及以后各式中出现的符号参见表 1中的说明。对采用腔体式吸收器的槽形抛物镜集热器,其光学效率 Z_{op} 为

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$$Z_{op} = X_{a}\left[1 - \frac{2(r_i + W)}{B}\right] f p t_g \quad (3)$$

式(3)中，X_a为腔体式吸收器的有效黑度。上述各式及热阻表达式构成太阳能集热器的一般性控制方程组。

集热器集热效率的定义为

$$Z_{tot} = \frac{\dot{m}C_p(T_{fm,o} - T_{fm,i})}{I_b F} \quad (4)$$

2　算例

某槽形抛物镜——腔体式吸收器太阳能集热器，设计参数如表1所示。依据计算模型求得的计算结果如图2至图6所示。

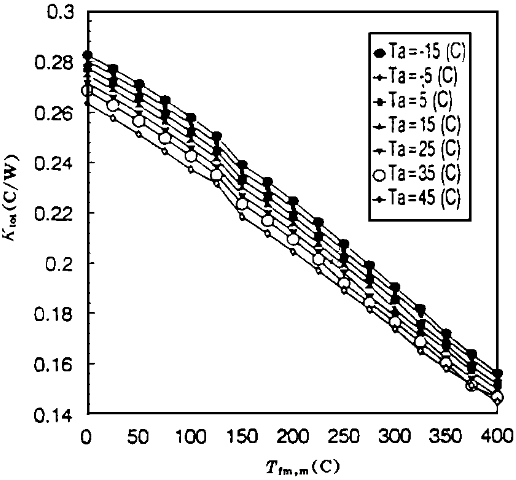

图2　环境空气温度 T_a 对总热阻 K_{tot} 的影响

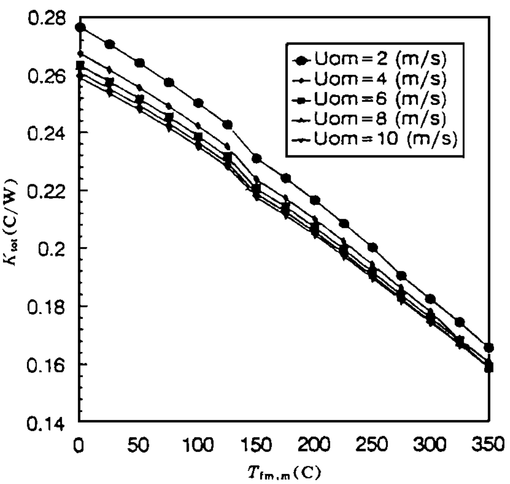

图3　环境风速 U_{om} 对总热阻 K_{tot} 的影响

表1　槽形抛物镜——腔体式吸收器太阳能集热器设计参数

序号	项目名称	符号	单位	数值
1	抛物镜开口宽度	B	m	4
2	抛物镜长度	L	m	5
3	抛物镜集距	L_f	m	1.80
4	抛物镜聚焦比	E	倍	40
5	吸收器开口宽度	g	cm	10
6	抛物镜开口半张角	J_m	°	58.1
7	吸收器开口圆心角	j	°	60
8	吸收器腔体半径	r_i	m	0.1
9	吸收器圆管根数	n_1	根	7
10	吸收器圆管内径	$2r_1$	mm	15
11	抛物镜光学修正系数	f		0.9
12	抛物镜反射率	p		0.9
13	腔体窗透过率	t_g		0.9
14	腔体窗热辐射透过率	t_h		0.01
15	腔体窗仅考虑吸收时的透过率	t_a		0.97
16	腔体内表面对可见光的吸收率	e_{rei}		0.5
17	腔体内表面发射率	e_{co}		0.9
18	管簇外表面发射率	e_o		0.7
19	腔体窗发射率	e_g		0.20
20	隔热层外表面发射率	e_s		0.05
21	隔热层厚度	W	mm	80
22	隔热材料导热系数	k_c	$\frac{W}{m \cdot ℃}$	0.043
23	太阳直射辐射强度	I_b	W/m^2	800
24	环境空气温度	T_a	℃	20
25	有效天空温度	T_{sky}	℃	$0.0552T_a^{1.5}$
26	环境风速	U_{om}	m/s	2.5
27	工作介质平均温度	$T_{fm,m}$	℃	200
28	工作介质在管簇内流速	U_{fm}	m/s	1.0

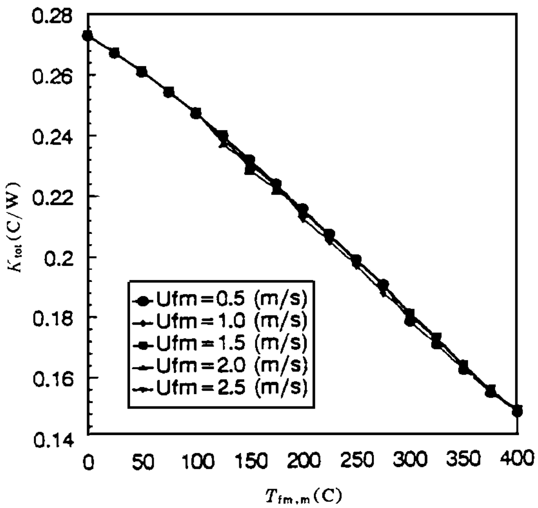

图 4　工作介质流速 U_{fm} 对总热阻 K_{tot} 的影响

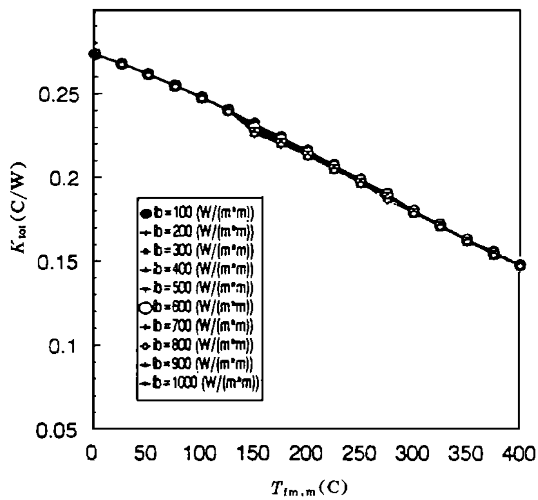

图 5　太阳直射强度 I_b 对总热阻 K_{tot} 的影响

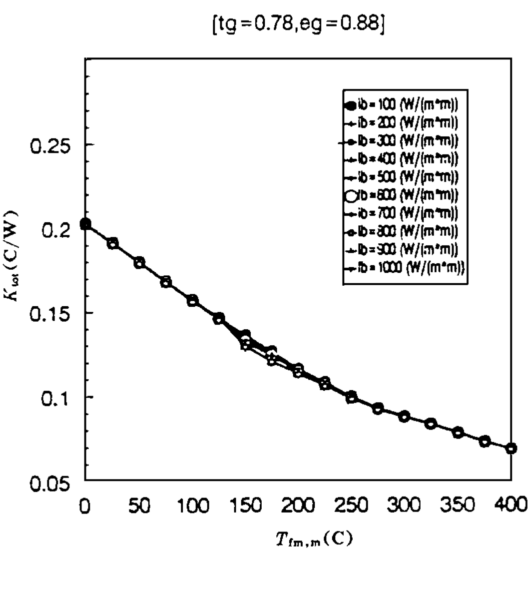

图 6　腔体窗为普通玻璃时太阳直射辐射强度 I_b 对总热阻 K_{tot} 的影响

3　结论

在表 1中所取参数的典型工况下 ,当只改变 T_a、U_{om}、U_{fm}、I_b 的取值时 ,得出相应 $K_{tot}-T_{fm,m}$ 曲线对应典型工况时的偏移规律。

(1) 环境空气温度 T_a 对总热阻 K_{tot} 影响较大 ,其影响程度随 $T_{fm,m}$ 的增大而略有减小;

(2) 环境风速 U_{om} 对总热阻 K_{tot} 的影响较大 ,影响程度随着 $T_{fm,m}$ 的增大而减弱 ,并且 U_{om} 取值较低时的影响大于 U_{om} 取值较高时的影响;

(3) 工作介质流速 U_{fm} 对总热阻 K_{tot} 的影响甚微;

(4) 太阳直射辐射强度 I_b 对总热阻 K_{tot} 的影响甚微。

当表 1中 t_g 取 0. 78和 e_g 取 0. 88,即腔体不是热镜而为普通玻璃时 , K_{tot} 大为降低 ,并且随 $T_{fm,m}$ 的增大 , K_{tot} 下降的速率加快。

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祝各位读者、作者新春快乐！

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