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线性菲涅尔式聚光系统的镜场布置与优化

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Arrangement and optimization of mirror field for linear Fresnel reflector system

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摘要 单根真空集热管和复合抛物面聚光器(CPC)组成的接收器(单管接收器)对线性菲涅尔式聚光系统的镜场布置有特殊要求.本文根据单管接收器的特点,提出了利用CPC最大接受半角控制镜场高宽比实现镜场无阴影布置的方法.利用几何关系推导了镜场无阴影布置的数学表达式,并给出了数值计算方法.通过算例,将一次反射镜和镜场中心的距离与镜场地面覆盖率相结合对镜场布置进行了优化.研究结果表明:对于CPC最大接受半角为45°、反射镜宽度为380 mm、而反射镜列数为21的镜场,当系统无阴影工作时间确定为6 h时,相邻一次反射镜间距最大为537 mm较为合理,而此时地面覆盖率为73.28%.该方法对于单管接收器线性菲涅尔聚光镜场的布置具有普适性,对线性菲涅尔式聚光系统的设计具有较好的指导意义.

关键词 : 太阳能聚光系统, 线性菲涅尔系统, 真空集热管, 复合抛物面聚光器, 镜场布置

Abstract : The single tube receiver consisting of a vacuum tube and a Compound Parabolic Concentrator(CPC)has special requirements for the mirror field arrangement of a linear Fresnel reflector system. According to the characteristics of the single tube receiver, a method of mirror field arrangement without shading was successfully presented by using CPC maximum acceptance angle to control the aspect ratio of mirror field. Practical mathematical expressions of the mirror field arrangement without shading were derived by geometric method, and concrete numerical method was given. The mirror field arrangement was optimized through combining the distance between the reflector and the center of mirror field with the ratio of ground coverage. The experiment results for the CPC with 45° maximum acceptance angle and a mirror field with 21-mirrors and 380 mm width show that when the working time of the system without shading is set to 6 hours, the relative reasonable maximum spacing between two mirrors will be 537 nm and the corresponding ground coverage is 73.28%. For the linear Fresnel reflector system with a single tube receiver, the method of mirror field arrangement has universality and guiding significances.

Key words : solar energy collector linear Fresnel reflector system vacuum tube Compound Parabolic Concentrator(CPC) mirror field arrangement

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