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DESIGN OF HELIOSTAT FIELD FOR A CENTRAL RECEIVER SYSTEM AND SOLAR FLUX ENERGY CALCULATION

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ระบบรับส่วนกลางสำหรับรวมแสงอาทิตย์ได้รับการศึกษาและจำลองขึ้น งานวิจัยนี้มุ่งศึกษา 2 ประเด็นหลักคือ ประเด็นแรก ใช้วิธีติดตามรังสีเพื่อหาตำแหน่งที่แสงอาทิตย์สะท้อนจากกระจกขนาด 0.2×0.3 ตารางเมตรไปตัดบนระนาบภาพและการกระจายของฟลักซ์พลังงานแสงอาทิตย์บนระนาบภาพถูกคำนวณโดยใช้วิธีการซ้อนทับ ผลการคำนวณพบว่าฟลักซ์พลังงานจะมีค่าสูงที่สุดบริเวณกลางของภาพและลดลงจนเป็นศูนย์บริเวณขอบของภาพ ระยะห่างระหว่างกระจกกับตัวรับมีผลต่อปริมาณและลักษณะการกระจายของฟลักซ์พลังงาน กล่าวคือเมื่อกระจกอยู่ไกลจากตัวรับมากขึ้นปริมาณฟลักซ์พลังงานจะเปลี่ยนการกระจายตัวจากรูปสี่เหลี่ยมเป็นรูปโค้งที่กว้างออก ประเด็นที่สอง คำนวณการกระจายของฟลักซ์พลังงานบนผิวตัวรับซึ่งเป็นทรงกระบอกโดยการรวมฟลักซ์พลังงานที่ได้จากกระจกจำนวน 5,844 บานที่กระจายเป็นวงกลมจำนวน 36 วง ล้อมรอบเสาตรงกลางที่มีทรงกระบอกรวมแสงอยู่สูง 10 เมตร ตำแหน่งของจุดเล็งแบ่งเป็น 2 แบบคือ เล็งไปที่จุดศูนย์กลางของทรงกระบอก และเล็งไปที่ผิวของทรงกระบอก วิธีแรกพบว่าฟลักซ์พลังงานมีการกระจายบนผิวของทรงกระบอกทำให้ปริมาณฟลักซ์พลังงานสูงสุดมีค่าน้อยกว่าจำนวนวงของกระจก วิธีที่สองได้ค่าฟลักซ์พลังงานสูงสุดเท่ากับจำนวนดวงอาทิตย์ประมาณ 60 ดวง

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Central receiver system for a collection of solar energy is studied and simulated. The main task of this research focus on two issues. Firstly, the reflected solar beams from the mirror of 0.3 m in width and 0.2 m in height are studied by using ray tracing. The flux density distribution is calculated by superposition technique. The result of a single heliostat is that a peak locates at the central area of the distribution and it falls to zero at the boundaries. The flux density distribution depends on distance from heliostat to receiver. As the mirror is moved further away from the receiver the distribution spread out and the shape changes from a rectangle to smooth curve. Secondly, the whole system is simulated by summation of flux density distribution from 5,844 mirrors placed into 36 circles around the tower. The tower height is 10 m and cylindrical receiver situated on top the tower. With a single aim-point strategy, the distributions spread over the cylindrical surface with maximum flux dimensionless less than the number of the heliostat rings. With multiple aiming point strategies, by changing aim point from the center of cylinder to surface of the cylinder, the solar flux density can be further increased up to 60 suns.

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LIST OF SYMBOLS

ϕ	solar altitude angle, angle between the horizontal plane and the direction of beam,see Figure 3.3
Ψ	solar azimuth angle, measured from south in eastward direction, see Figure 3.3
θ_z	solar zenith angle
φ_p	mirror position angle, measured from south in eastward direction, see Figure 3.8
φ_m	mirror azimuth angle, measured from south in eastward direction
α_m	mirror altitude angle, measured from south in eastward direction
D_H	length of the horizontal side of the mirror
D_T	length of the tilted side of the mirror
d	distance between mirror center and image plane center
F	flux density distribution on the image plane
G_{bn}	solar beam irradiance received by a surface normal to solar ray
H	height of the tower
θ_r	tower altitude angle, see Figure 3.8
$\bar{h}_j$	coordinate for the position of the mirror, $j = 1,2,3$
$\bar{i}_j$	coordinate for the image plane, $j = 1,2,3$
$\bar{m}_j$	coordinate for the mirror plane, $j = 1,2,3$
P	principal image of the mirror surface on the image plane, see Figure 3.11
R_s	radius of solar disk on image plane
α_s	solar angle
S	solar intensity
$\bar{\eta}$	coordinate along the length L_T of the principal image, see Figure 3.9
$\bar{\xi}$	coordinate along the length L_H of the principal image, see Figure 3.9
η^*	normalized distance along $\bar{\eta}$ coordinate

ξ^*	normalized distance along $\bar{\xi}$ coordinate
θ^*	corner angle of the principal image P, i.e. angle between two side of principal image, see Figure 3.9
θ_1	angle between $\bar{\xi}$ and $\bar{i}_1$ coordinates on the image plane, see Figure 3.9
ρ	average reflectivity of the heliostat surface
Φ	dimensionless flux density function at a point on the image plane
Γ	flux density distribution on the receiver surface
θ_R	surface angle measured from south in eastward direction, see Figure 3.17