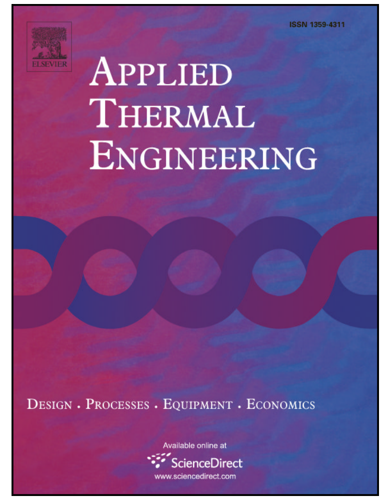

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THERMODYNAMICS ANALYSIS OF A STRATOSPHERIC AIRSHIP WITH HOVERING CAPABILITY

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Abstract: A new fixed-point adjustment method for an airship is proposed to solve the problem of height instability due to dramatic daily-temperature swings. The airship membrane was discretized into a triangular element in this paper to enhance the computing accuracy of the method, and the multi-node thermodynamic model of the airship is established. The thermal performance of the airship is obtained using the Runge–Kutta method. The influences of season and latitude on the membrane, helium temperature and exhaust/inflation performance were investigated. The effect of the film elements on thermal performance is also discussed in detail. These results are helpful for the optimal design and operation of stratospheric airships.

Keywords: stratosphere airship; thermal performance; thermodynamics analysis; additional helium bag

Nomenclature

A	contact area between the bags, m^2	p	atmospheric pressure, Pa
c	specific heat, J/(kg·K)	q_D	direct solar radiation heat flux, W/m^2
D_0	Day constant	q_s	diffuse solar radiation heat flux, W/m^2
D_1	number of days in one year	q_R	reflected heat flux, W/m^2
FR	slenderness ratio of ellipsoid	q_{IRS}	sky long wave radiation heat flux, W/m^2
g	gravitational acceleration, m/s^2	q_{IRG}	ground long wave radiation heat flux, W/m^2
H	height, m	q_{IRE}	internal membrane radiation heat flux, W/m^2
h	convective heat transfer coefficient, W/(m^2·K)	q_{CE}	external combined convective heat flux, W/m^2
I_0	solar constant, W/m^2	q_{CI}	internal free convection heat flux, W/m^2
I_D	direct solar radiation intensity, W/m^2	Q_{CI}	convective heat flux from the membrane, W
I_d	diffuse solar radiation, W/m^2	Q_{12}, Q_{21}	heat transfer between main and additional helium bags, W
I_{gr}	ground reflection radiation, W/m^2	R	molar gas constant,
I_{gr0}	the ground reflection, W/m^2	$R_{g,He}$	gas constant of helium, J/(kg·K)
I_{skin}	membrane thermal radiation, W/m^2	Re	Reynolds number