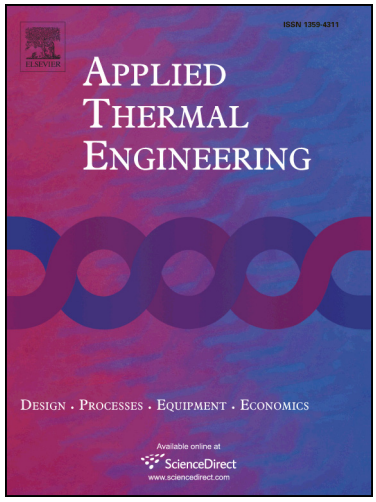

Numerical research on the thermal performance of high altitude scientific balloons

Qiumin Dai, Daoming Xing, Xiande Fang, Yingjie Zhao

PII: S1359-4311(16)33695-X
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.193
Reference: ATE 9604

To appear in: *Applied Thermal Engineering*

Received Date: 18 September 2016
Revised Date: 9 November 2016
Accepted Date: 27 November 2016

Please cite this article as: Q. Dai, D. Xing, X. Fang, Y. Zhao, Numerical research on the thermal performance of high altitude scientific balloons, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.193

Numerical research on the thermal performance of high altitude scientific balloons

Qiumin Dai[a,*], Daoming Xing[a], Xiande Fang[b] , Yingjie Zhao[b]

[a] School of Energy and Power Engineering, Nanjing University of Science and Technology, Nanjing 210094, PR China

[b] College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, PR China

Abstract

Internal infrared (IR) radiation is an important factor that affects the thermal performance of high altitude balloons. The internal IR radiation is commonly neglected or treated as the IR radiation between opaque grey bodies. In this paper, a mathematical model which considers the IR transmissivity of the film is proposed to estimate the internal IR radiation. Comprehensive ascent and thermal models for high altitude scientific balloons are established. Based on the models, thermal characteristics of a NASA super pressure balloon are simulated. The effects of film IR property on the thermal behaviors of the balloon are discussed in detail. The results are helpful for the design and operation of high altitude scientific balloons.

Keywords: High altitude scientific balloon; thermal performance; infrared transmissivity; internal infrared heat transfer

1. Introduction

High altitude scientific balloons are un-powered lighter-than-air (LTA) vehicles. They are considered as the ideal low cost observation platforms for scientific research, such as cosmology [1], astrophysics [2] and aerophysics [3]. In recent years, high altitude scientific balloons have attracted growing interests all around the world.

The lift of a high altitude scientific balloon is mainly derived from the density difference between the internal buoyancy gas and the ambient air. Therefore, in order to accomplish the mission of a high altitude scientific balloon successfully and safely, it is important to predict the buoyance temperature and film temperature distribution of the balloon before it is launched.

In the past several decades, many investigations have been carried out on the thermal characteristics of high altitude balloons. Kreith and Kreider [4] proposed a simple model to evaluate the thermal behaviors of high altitude balloons. It was considered to be the starting point for the

* Corresponding author.
E-mail addresses: daiqiumin@njust.edu.cn (Q. Dai)