Research status of heat transfer characteristics of heat shield plate composites

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Abstract

The research status of heat transfer characteristics of composite heat shield plate was summarized, the influencing factors, research methods and relevant conclusions of heat transfer characteristics of composite heat shield plate and carbon fiber reinforced composite plate were introduced, and the research direction of heat transfer characteristics of composite heat shield plate was prospected.

Keywords

Composite materials, heat shield plate, heat transfer characteristics.

1. Introduction

The heat shield plate is made of two kinds of composite materials with different physical and chemical properties bonded together in a macroscopic form. Cork is reinforced with cork particles and phenolic resin as the matrix of cork composite, while CFRP is reinforced with carbon fiber and epoxy resin as the matrix of composite. To describe the research status of heat transfer characteristics of heat shield plate, the heat transfer characteristics of cork with its composite materials and carbon fiber epoxy composite materials can be described respectively.

Cork is the cork carlesii or one part of cork oak, the cork of our country basically comes from cork oak, and it is mainly distributed in Southwest China[1]. Domestic and foreign scholars have found that the chemical composition of cork from different regions is different, mainly composed of suberin, lignin, cellulose, hemicellulose and other substances, among which the content of suberin and lignin is higher[2-4].The microscopic structure of cork shows, neither clearance also does not have capillary between cork cell, however was full of glue-like resin, it is almost a complete closed "chamber", this makes cork has good heat preservation, insulation performance[5-7].

With the development of cork industry, more and more cork products are widely used in architectural decoration, style, military and aerospace fields. Cork products are directly processed by cork or particles, and composite materials are processed by particles, adhesives and rubber, such as rubber cork, coalescence cork and cork paper, etc, which are quite common.

CFRP is mainly composed of matrix and fiber. Matrix is mainly resin base, such as epoxy resin, bismaleimide resin, polyimide, etc. Carbon fiber is mainly made of viscose fiber, asphalt fiber and other high temperature firing. The heat transfer of CFRP mainly consists of solid and gas heat transfer, which depends on fiber and resin matrix. Air transfer heat depends on pores formed in the manufacturing process, pores are small and few; Both heat transfer is closely related to the heat protection of the material.

2. The Research Status

2.1 Cork with Composite Materials

Kamke and TenWolde et al[8,9] proposed the equivalent thermal conductivity model of wood and wood board considering the temperature, moisture content and density of materials, and the results showed that the thermal conductivity of materials was positively linear correlated with temperature, moisture content and density.

Castro Osvaldo et al[10] measured the thermal conductivity of two cork/epoxy composite core materials (small cork particles, large and small particles, mixed cork particles) with improved mechanical properties by using the transient hot plate method. It is found that their heat insulation performance is slightly better than that of traditional cork core materials (8123, 8810, 8303, 8822, NL30), especially the low density cork has better heat insulation performance.

Matias et al[11] realized the inhomogeneity and variability of cork materials and believed that density could become a parameter sensitive to the corresponding thermal conductivity. The relationship between thermal conductivity and density showed that thermal conductivity had a certain trend with the increase of density.

Olivares et al[12] measured the thermal conductivity of three kinds of cork composites with different densities, and the results showed that the thermal conductivity of materials was positively correlated with the density.

Wei Xinli[13] studied the cork board produced in Gansu and found that the thermal insulation performance of the cork board with different particle sizes was different. The cork board made with large particles had the best thermal insulation performance under the same density. There was a limit for the influence of particle size on the thermal insulation performance of the cork board, beyond which the influence would become smaller. The cork board that same grain makes, increase coefficient of thermal conductivity as density increases significantly, cork grain is smaller coefficient of thermal conductivity increases smaller.

Lu Quanji et al[14] used quasi-steady state method to measure the thermal conductivity of cork and its composite materials, and explored the influence of moisture, density and mixing ratio on the thermal insulation performance of cork products. The results show that the thermal conductivity of cork rubber composite board has a strong positive linear relationship with single density or moisture, and the thermal conductivity of cork rubber composite board increases with the increase of rubber proportion.

Limam et al[15] found that the thermal conductivity of black coalescence cork, Aleppo pine and pine/cork sandwich were all strongly affected by water content, and the increase of water content would lead to the increase of thermal conductivity and the decrease of thermal resistance.

Simoes et al[16] measured the change of thermal conductivity of medium-density expanded cork board with moisture content after a dry-wet cycle, and found that the movement of liquid had no significant influence on the measurement of thermal conductivity.

Sergi Claudia et al[17] studied the influence of density and humidity on the heat transfer characteristics of coalescence corks and found that the increase of density would lead to an increase in the thermal conductivity of coalescence corks. The thermal conductivity of coalescence cork also depended on humidity, and the thermal conductivity of dried samples decreased.

Haiyan Fu et al[18] measured the thermal conductivity of insulating cork boards and found that it was positively correlated with univariate temperature or humidity.

2.2 Carbon Fiber Epoxy Resin Composite Material

Within a certain temperature range, Qiu Xueqiong et al[19] measured the thermal conductivity of a T800 carbon fiber reinforced resin matrix composite with unidirectional, orthogonal and quasi-isotropic layers along the thickness and surface direction by flash method, and found that the thermal conductivity of the material would increase slightly with the increase of test temperature, but was not affected by the layer method.

Zhang Jianke[20] study found M55J carbon fiber resin base layer board of X and Y direction coefficient of thermal conductivity will increase with the rising of temperature, and growth is faster and faster, the superposition model calculation of thermal conductivity measurement data, on the single layer plate of low temperature coefficient of thermal conductivity and actual measured values differ by about 18%, change layer mode can better heat transfer properties of CFRP.

Li Bin et al[21] took different filled polymer matrix composites as research objects and found that the thermal conductivity of different filler materials would increase with the increase of content, and the thermal conductivity of filler materials with the same content and type of large particle size was higher than that of filler materials with small particle size.

Hai Ran et al[22] studied the thermal conductivity of carbon fiber cement-based composites and found that, different from resin-based CFRP, the thermal conductivity of cement-based CFRP decreased with the increase of carbon fiber content, mainly because carbon fiber was also introduced into the air bubble.

Yang Fan et al[23] used a combination of finite element experiment, studied a fiber reinforced composite material single pieces of board, laminated and heat transfer performance, the results show that vertical and parallel to the fiber direction of different material coefficient of thermal conductivity, are related to fiber volume, linear and nonlinear relations respectively, is consistent with the results of calculation and test.

R.d. Weeting et al[24] found that for the thermal conductivity of a fiber reinforced composite laminates, both the values in the parallel and vertical plane directions have a linear relationship with temperature, but the increase of the latter is much smaller than that of the former.

3. The Research prospect

As can be seen from the previous text, the heat transfer characteristics of cork mainly consider water molecules, particles and other influencing factors, the next cork study of the heat transfer characteristics should consider more microscopic factors, such as porosity, cork cells, in-depth cork study of the heat transfer mechanism. The research on heat transfer characteristics of CFRP considers the influence of different fiber ratio, layer and matrix content on the thermal conductivity of materials. The next step is to explore the heat transfer mechanism of CFRP from the microscopic composition of materials.

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