FIRE RETARDANT BASALT FIBER-REINFORCED POLYMER COMPOSITES

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Main message:
The overview of the literature reveals that there is a lack of comprehensive research on alternative fiber-reinforced polymers. In this present study, we have investigated the fire resistance of basalt fiber polymer composites (BFRP). Different forms of basalt fiber reinforcement (plain woven fabric, chopped strands, milled fibers) was used with an epoxy polymer matrix. The fire resistance of the produced composite materials was evaluated by horizontal burning test and mass loss cone calorimetry.

Keywords: basalt fiber, composites, mass loss cone calorimetry

Introduction

Inorganic basalt fibers are produced from natural, sustainable sources and obtain comparable mechanical performance to commercial glass fibers [1,2]. Basalt fibers possess higher thermal stability than glass fibers and have high chemical resistance due to the chemical structure originating from the volcanic gabbro. These favorable properties and moderate cost make BFRP composites an attractive group of structural materials for application in power, civil-construction and transport industries [3,4].

Experimental

Three different types of basalt fiber reinforcements were used in our experiments: milled fibers (Basaltex, Belgium, average fiber length: 108.57±57.09 µm), chopped fibers (Kamenny Vek, Russia, nominal fiber length: 12.7 mm), and plain-woven basalt fabrics (Kamenny Vek, Russia, areal density: 210 gsm). A common laminating epoxy system of component A-IPOX MR 3010 modified bisphenol A/F resin and component B-IPOX MH 3124 modified cycloaliphatic amine hardener (Ipox Chemicals GmbH, Germany) with mixing ration of 100:33 by mass, was used as polymer matrix. In the case of milled and chopped basalt fibers 10; 20; 30 m/m% fiber content was maintained, and dispersion of fibers was measured on five samples per material selected from different places of the plates. The short fibers were well dispersed as the standard deviation of the measured fiber content was below 0.5 m/m%.
Fiber distribution and interlaminar properties of hybrid laminates are compared with the plain-woven reinforced specimens by short beam shear tests and optical microscopy. The fire behavior of the materials was investigated by UL-94 horizontal burning tests and mass loss cone calorimetry.

Results and Discussion

Previously, the mechanical, thermo-mechanical and thermal shielding properties of the BFRP composites was investigated [5]. Fabric reinforced BFRP specimens achieved a flexural modulus of 15.54 GPa and strength of 336.40 MPa. Higher fiber content in hybrid laminates decreased the linear burning rate by 8%, and the maximum surface temperature was approximately 80 °C lower after jet fire impingement compared to woven reinforcement structure.
UL-94 horizontal burning test results show that the BFRP composites are rated HB according to the standard, but the linear burning rate of the different reinforcements varied significantly. Lower burning rates were achieved at higher fiber content. Highest flame spread was examined at the woven textile reinforced specimens due to the so-called candle-wick effect. The presence of milled fibers in hybrid

laminates decreased the burning rate by up to 19%. The mass loss cone calorimetry test show that the total heat release rate (THR) of the specimens decreased with the increasing fiber content.

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