Application of CFCC Technology to Hot Gas Filtration Applications

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Introduction

U.S. industry has a critical need for materials that are light, strong, corrosion resistant, and capable of performing in high temperature environments. Although many ceramics perform well at considerably higher temperatures than conventional metal alloys, they are generally brittle, and as a result can undergo catastrophic failure in service. The goal of the Continuous Fiber Ceramic Composite Program is to develop materials that will overcome these limitations,

The CFCC Program is a collaborative effort between industry, national laboratories, universities, and the government to develop advanced composite materials to a point at which industry will assume the full risk of further development. There are currently eight industry teams comprised of 50 members (led by AlliedSignal, Amercom, Babcock & Wilcox, Dow Corning, Dupont Lanxide, General Electric, and Textron) developing more than 20 applications for continuous fiber ceramic composite materials. Oak Ridge National Laboratories leads a team of other laboratories and universities in conducting performance evaluations and developing supporting technologies (e.g., material design, processing methods, manufacturing techniques, and codes and standards),

CFCC Hot Gas Filters

The CFCC program is working on a number of applications including the hot gas filters, Three of the industry teams are developing hot gas filters, and another will be demonstrating filters in an industrial application, The use of CFCC filters will be in the form of tubular sheets and/or plenums. For example, ceramic components are being developed for hot gas filters to be installed ahead of the turbines in industrial systems to protect the turbines from impingement of particulate. The cleaning system would help industries and utilities meet stringent emission control regulations, and increase the efficiency of processing and power generating facilities. Candle filters will be used in advanced coal combustion combined cycle plants.

Babcock & Wilcox--Sol Gel Impregnation

The objective of B&W's CFCC effort is to develop advanced ceramic composite materials which should be ideal for the oxide-based composite system and allow scaling to cost-effective manufacturing operations, The focus is on a liquid-to-solid-based processing

method, referred to as sol-gel impregnation. B&W is working with Westinghouse on a candle filter configuration, which is a porous closed end tube that will be fabricated at B&W using filament winding. The candidate CFCC is alumina fibers in an alumina matrix. Prototype components will be tested, and models developed to demonstrate the properties and reliability of CFCCs to manufacturers and end-users.

Near-term emphasis will be on the development and testing of hot gas filters, intended for application in advanced fossil energy systems. The project focuses on (1) improving properties, (2) reducing cost by decreasing infiltration cycles and developing filament winding, (3) generating a property data base suitable for design modeling, and (4) evaluating and selecting viable applications and fabrication/test initial representative components.

Du Pent Lanxide Composites--CVI

The objective of Du Pent Lanxide's CFCC effort is to develop Chemical Vapor Infiltration (CVI) of silicon carbide (SiC) CFCC components and incorporate them into a variety of high-temperature, heat-management, and power generation equipment including hot gas filters.

The team is now fabricating, exposing, and testing CVI SiC/SiC CFCC materials in simulated application conditions to prove their suitability for the selected applications, Du Pent Lanxide produces CFCCS by first fabricating ceramic fiber preforms in the shape of final parts. These preforms are infiltrated with chemical vapors that react to form a dense SiC matrix between the fibers. Du Pent operates commercial-scale CVI facilities capable of producing parts 1.2m in diameter and 2m high. Du Pent Lanxide's hot gas filters were successfully tested for 800 hours in the high-pressure, high-temperature rig by Westinghouse.

Amercom--Chemical Vapor Infiltration

Amercom/Atlantic Research and Industrial Filter and Pump Manufacturing are collaborating on development of a CFCC candle filter for hot gas filtration to support DOE's clean coal technology needs. The CFCC candle filter potentially will allow direct removal of particulate pollutants from 1500-1800° F gas streams in advanced pressurized fluidized bed and coal gasification systems. This will enable efficient direct use of the cleaned high temperature gas streams to power a gas turbine.

Amercom is using silicon carbide as the base matrix material and reinforcing it with carbide, nitride, or oxide fibers. This effort involves the Chemical Vapor Infiltration (CVI) of ceramic matrices into net or near-net-shape preforms of continuous, multifilament ceramic fibers. Potential solutions are being investigated to overcome key technical problems so that the CVI silicon carbide fiber reinforced silicon carbide matrix (SIC/SIC) composites can be commercialized.