AlliedSignal Ceramic Components

Diesel Engine Valve Guide

Objective

The industry team led by AlliedSignal is developing methods for the fabrication of a CFCC low-heat rejection diesel engine exhaust valve guide.

Cast iron valve guides currently used in engines cannot operate at temperatures above 300°C and require regular lubrication. The CFCC valve guide under development has the structural integrity to operate at higher temperatures and is self-lubricating.

Materials and Processes

The team is developing a chopped carbon fiber-reinforced silicon nitride ceramic composite. Silicon nitride is a ceramic with excellent mechanical properties, and is corrosion resistant. The carbon fibers provide self-lubrication and toughness, and is economical. This material wears at a much lower rate than metal, and produces less wear on the valve stem.

Cold isostatic pressing is used to form the composite valve guides, and glass encapsulation, hot isostatic pressing is employed to densify them. In-depth experimental analysis and design studies guide the direction of the processing work. The project involves friction and wear property measurements, performance targets and criteria determination, economic assessment, and component and system design. The team has fabricated prototype CFCC valve guides and has tested them in an engine. The laboratory fabrication process is to be scaled-up for low-cost production of the components.

Applications and Benefits

This process has a high potential for economically fabricating net-shape components, especially those that require little or no post-process machining to meet final design specifications. The technology has the potential for cost-effective use in high-load-factor industrial and agricultural applications where operating costs are driven by engine fuel costs. Applications for the CFCC diesel engine valve guides include natural gas fueled diesels in the chemical industry, for natural gas pumping, and for oil pumping. This technology also has the potential for mobile applications.

Because these guides require no oil for lubrications, their use could result in fuel savings of 30%, reduction of particulate emissions by 25%, and increased engine reliability.

Challenges

The team is currently emphasizing in-service environmental and durability testing using diesel engine test stands, and exploring methods to reduce fabrication costs for the valve guides.

The self-lubricating CFCC valve guide, shown with valve stem inserted, reduces wear on the valve stem and the guide compared to the currently used cast iron guide.

Team Members

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CFCC

Continuous Fiber Ceramic Composite Program

A 10-year joint R&D effort initiated in 1992 to develop processing methods to produce reliable and cost-effective CFCC components for industrial applications.

CFCCs are light, strong, and corrosion-resistant materials capable of performing at high temperatures.

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