PB.25 Development of Material and Process for Oxide-Based Filters

Jeffrey Bolebruch (jbolebruch@blaschceramics.com; 518-436-1263)
David A. Larsen (dlarsen@blaschceramics.com; 518-436-1263)
Blasch Precision Ceramics, Inc.
580 Broadway
Albany, NY 12204

Abstract

Ceramic hot gas filters have been used, primarily on a development scale, to provide high temperature, high pressure removal of particulates from hot gas streams in coal fueled power systems. Currently, there are several ceramic material compositions and processes used to manufacture ceramic hot gas filters. However, many of the available ceramic material compositions contain silicon carbide, which has been proven to oxidize and grow under typical service conditions. Hence, a thermal shock resistant, oxide-based ceramic composition would appear to be desirable for this environment.

A mullite-bonded aluminum oxide ceramic composition was developed which had gas permeability less than 1 iwg/fpm. This material was used in a unique ceramic processing method to produce 1.5-meter long ceramic candle filters for trials as well as monolithic crossflow filters. A general overview of this forming process will be shown, in addition to measured properties of this permeable ceramic composition. These properties will include permeability, strength, XRD phase analyses, pore size, apparent porosity, and density.

Acknowledgments

This project is funded by the Department of Energy (DOE), Federal Energy Technology Center (DE-FG02-94ER81718) to Blasch Precision Ceramics, Albany, NY. The authors gratefully acknowledge the technical assistance of Theodore J. McMahon, the FETC Contracting Officer's Representative.

Development of Material and Process for Oxide-Based Filters

By: Jeffrey Bolebruch
David A. Larsen
Blasch Precision Ceramics, Inc.
Albany, NY

July 22, 1998

Objective Statement

The objective of this project is to develop a thermal shock resistant, oxide-based permeable ceramic material, utilizing a production process that will enable the manufacture of hot gas filter elements in both conventional geometries as well as a variety of complex, high surface area shapes.

Major Tasks

- Produce non-laminating monolithic crossflow filter elements in a cost-effective manner.
- Produce multiple 1.5 meter long ceramic candle filters for trial in PCFBC at Foster Wheeler in Karhula, Finland.
- Produce multiple 1.5 meter long ceramic candle filters for trial at PSDF Facility in Wilsonville, Alabama.
- Participate in extended accelerated lifing of PCFBC aged elements at the Westinghouse STC HTHP facility.

Flowchart: Blasch Process

Batch

Wet Mix

Inject into Mold

Solidify by freezing

Demold

Dry

Fire

Table 1. Properties of Selected Compositions

Mix No.	BPC Perm (cd)	Whse Perm (wg/fpm)	BPC MOR @70deg F (psi)	Whse MOR @870deg C (psi)	BPC APP Porosity (%)	BPC Bulk Density (g/cc)
4-270	268	0.69	1011	686	45.6	1.84
4-300	271	0.43-0.58	1218	650	46.5	1.80

Notes: "BPC Perm" is permeability in centidarcies measured by Blasch
"Whse Perm" is permeability in inches water pressure difference per feet/minute velocity measured by Westinghouse Science & Technology Center.

Table 2. Semi-Quantitative XRD Analyses

Mix No.	Firing Temp (F)	% Alumina	% Mullite	% Crys-talline Silica
4-270	2,700	80	20	0
4-300	3,000	75	25	0

Figure 1. Incremental Intrusion vs. Pore Diameter by Mercury Porosimetry for Composition 4-270

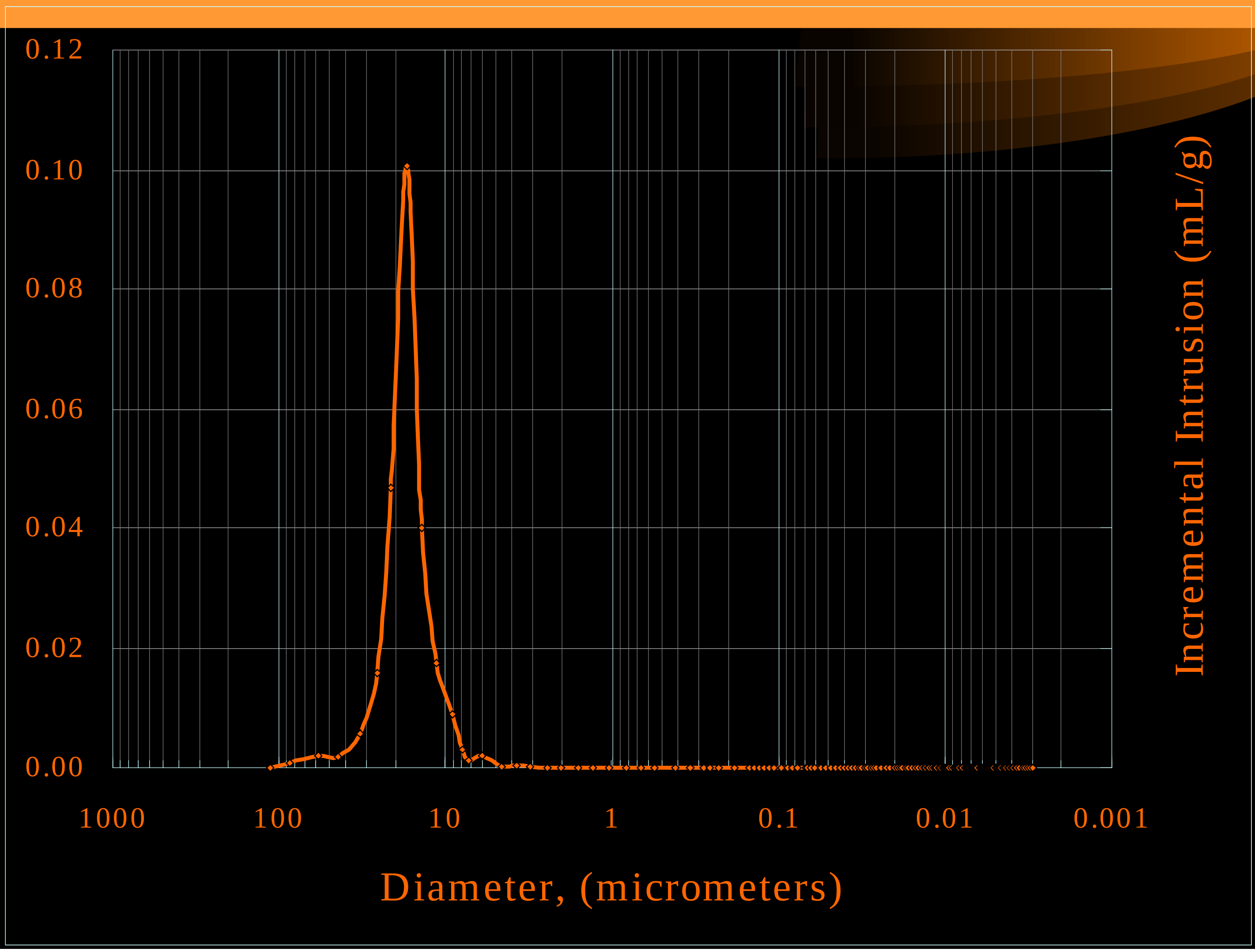


Figure 2. Incremental Intrusion vs. Pore Diameter by Mercury Porosimetry for Composition 4-300

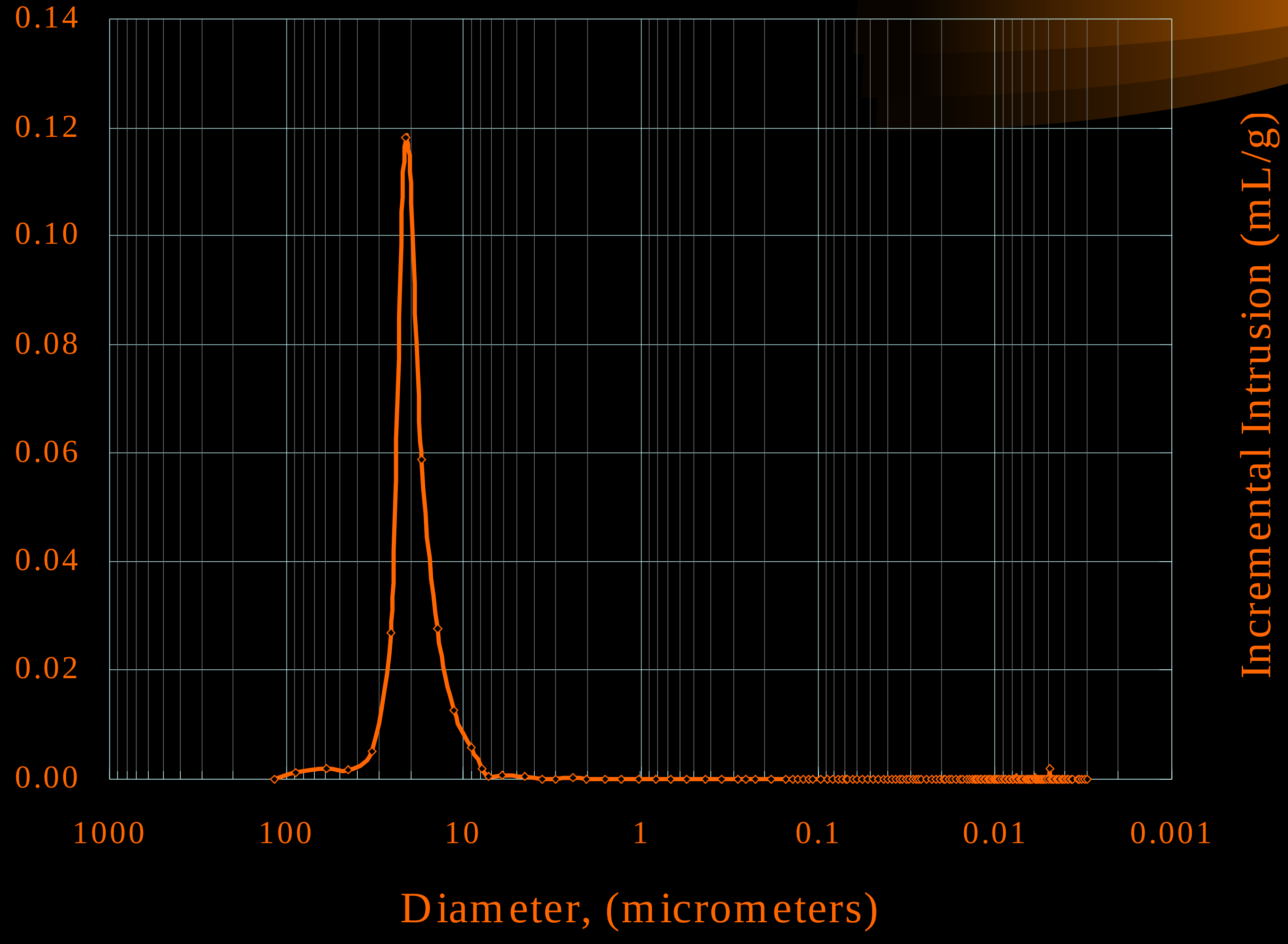


Table 3. Physical Properties by Micromeretics, Inc.

Mix No.	Bulk Density (g/cc)	Open Porosity (%)	Median Pore Dia. (microns)
4-270	1.86	47.5	18.8
4-300	1.78	47.9	22.4

Figure 3. Photo of Permeable Mullite-Bonded Alumina (#4-270) Ceramic Candle Filters

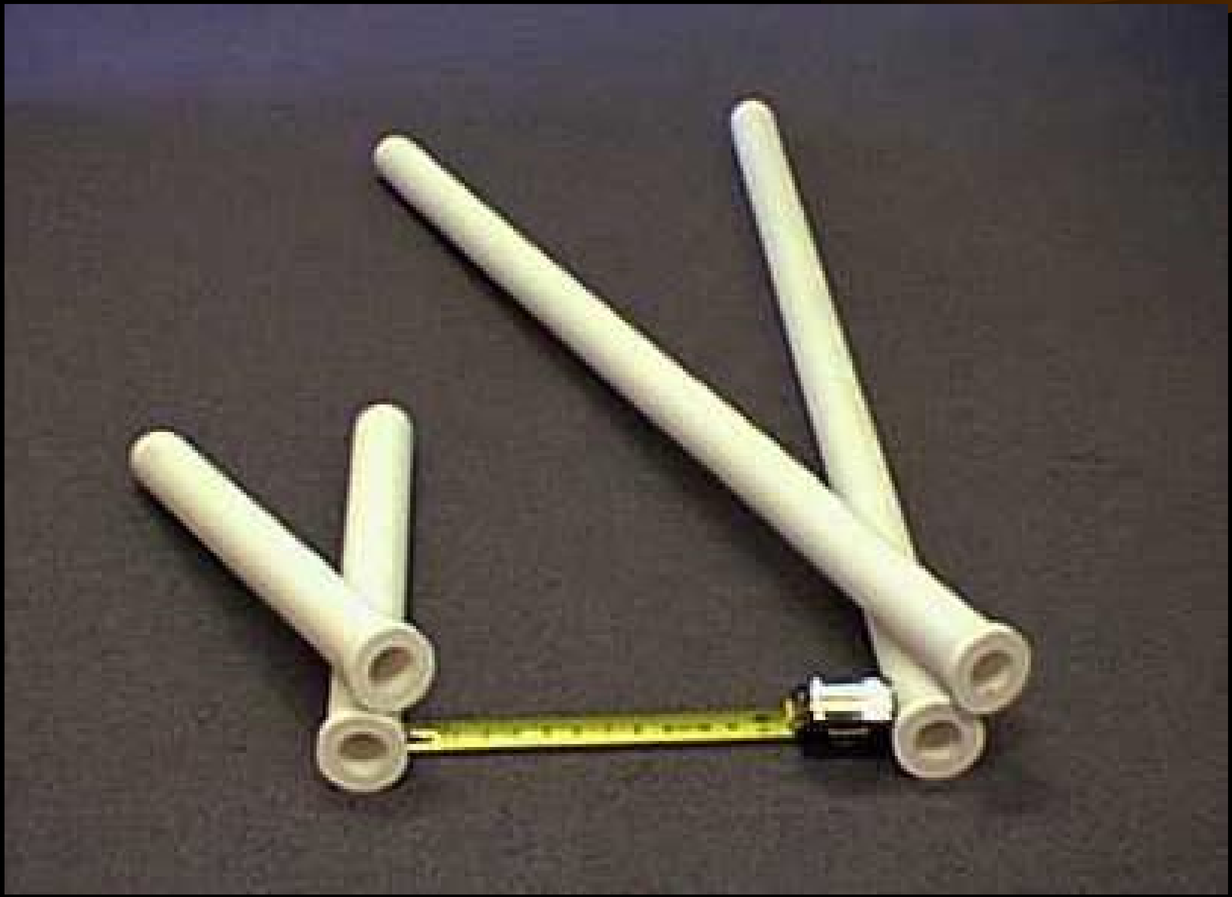
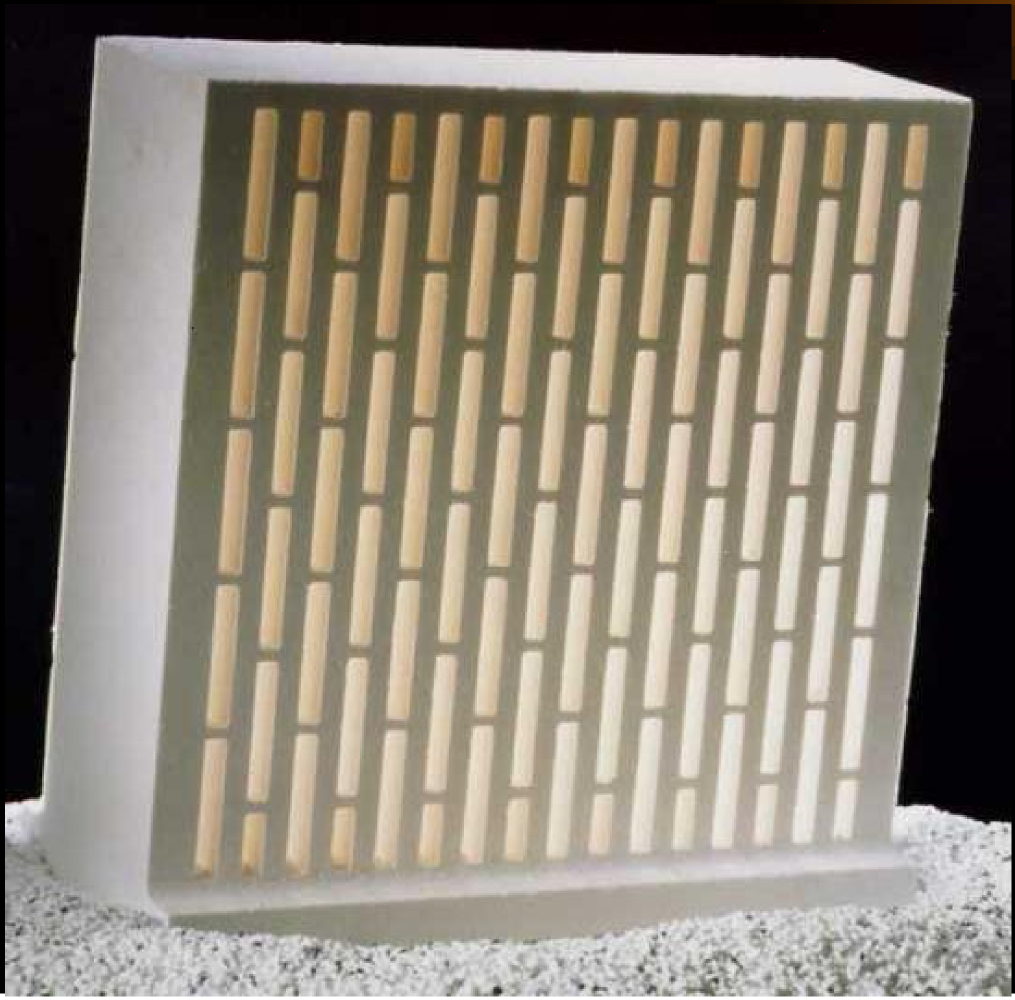


Table 4. Conditions Experienced by Blasch Mullite-Bonded Alumina Candle Filters at Foster-Wheeler Test Facility, Karhula, Finland

Date	September 4, 1997 - November 1997
Number of filter elements tested	6
Filter operating temperature deg. C	700-750
Filter operating pressure, bar	9.5-11
Coal feed	Eastern Kentucky
Sorbent	Florida Limestone
Time, hrs	581 (3)*, 342(3)
Face Velocity, cm/sec	2.8-4.0
Particle Load, PPM w	6,000-9,000
Particle size, microns	<1-150
Thermal excursions	None
Number of startup/shutdown cycles	7

* All elements remained intect. The number in parentheses indicates the number of elements exposed for the respective PCFBC operating hours.

Figure 4. Photo of Permeable Mullite-Bonded Alumina (#4-270) Ceramic Cross-Flow Filters



Conclusions

- Oxide-based mullite-bonded, porous, permeable alumina ceramics can be successfully formed on both lab scale and full production scale with the proprietary Blasch ceramic forming process.
- Candles successfully performed in PCFBC test facility for 581 hours, then subsequently run in accelerated lifing at the Westinghouse STC.
- Both standard candle geometries and monolithic crossflow filter shapes can be manufactured via the freeze casting process.