Research institute:

PTS München
Heßstr. 134
80797 München

Internet: www.ptspaper.de

Head of the research institute:

Dr. Frank Miletzky

Project leader:

Dr. Reinhard Grenz
Tel: 089 / 12146-272
Fax: 089 / 12146-36
E-Mail: reinhard.grenz@ptspaper.de

Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

Pre-ceramic papers, porous burners, heat resistant materials

TITLE:

Extremely temperature and corrosion resistant highly-porous (fibre-based) ceramics for energy-efficient combustion processes

Background/Problem area

Porous burners show high potential for energy and emission savings. Pollutant emissions can be cut in half to be well below legal limit values. Problems of current combustion technologies caused by high flow rates can be avoided. Core components of the porous burner are the combustion zone made from a porous ceramic material, and an upstream flame blocking zone. To ensure the reliable long-term operation of porous burners, it is necessary to develop materials with improved thermo-shock resistance capable of resisting aggressive atmospheres and temperatures up to 1600 °C.

Paper-derived corrugated ceramic structures offer an elegant option for the production of thin-walled complex-shaped ceramic structures. Papers can be charged with pre-ceramic fillers already during papermaking to an extent that makes them sinterable. They can be formed to paper-based construction elements (e. g. corrugated structures) by means of traditional paper-technological forming methods, and thermally converted to ceramics. Pre-ceramic papers can be die-cut and shaped to paper-typical corrugated structures that can then be laminated to obtain highly porous ceramics with defined porosity, pore geometry and bar geometry which are suitable for the construction of porous burners.

Objectives/Research results

The overall objective of the project was to develop porous ceramic materials to be used in energy-efficient gas combustion systems such as porous burners and combustion chamber liners. They shouldl be suitable for operating temperatures up to 1600 °C in oxidizing and reducing gas atmospheres.

The role of PTS was to develop paper-based materials (“pre-ceramic papers”) serving as precursors for sintered materials for the development of porous burners. This required the following steps: development and lab-scale production of papers highly filled with SiC and ZrO_2 and conversion to ceramic materials, up-scaling from laboratory to pilot scale, development of forming and joining methods, production of first components and optimized functional samples.

Using the experience available at PTS, highly filled papers based on aluminium oxide, silicon carbide and zirconia were produced in laboratory scale. Sintering trials using these papers were carried out by the project partners. Forming tests of calendered laboratory sheets were performed on a laboratory corrugating machine. Subsequently, trials were carried out to optimize the joining technology. Various porous burner models were produced from the papers made in laboratory scale, and tested by the project partners for suitability. The paper recipes were improved to avoid microcracks, and the geometry of models was modified based on the results of burner tests. The optimized laboratory models were sintered by the project partners and tested for their suitability as porous burners. The experimental results showed good burning properties. Long-term tests revealed a good burner stability. A trial on the pilot paper machine of PTS validated the transferability of the laboratory results to continuous paper production. The paper produced during the pilot trails was sintered by the project partners and showed a good sintering performance necessary for the application as a burner material.

Application/Economic benefits

The present demand for more energy-efficient, flexible heating methods can be met by porous burners in a variety of applications. As a precondition, the operating temperature, durability and reliability of porous burner systems must be enhanced. This will enable the increased use of porous burners in combustion and high-temperature systems as well as energy savings due to higher efficiency and emission reductions. The porous burner system addresses issues and enables solutions in a highly sensitive area of energy and environmental policy.

In the case of success, the materials developed for porous burner technology and improved oxidation-protective coatings may also be used for other high-temperature applications such as gas turbines, industrial heat treatment plants, filters and components of exhaust systems in automotive or aerospace sectors.

Period of time: 01.10.2009 – 30.06.2013

Remarks

The research project BMBF 03X3543 HÖCKER was funded in the framework of the program „Höchstleistungswerkstoffe für mehr Energieeffizienz und CO_2-Einsparung: Leistungssprünge in energetischen Umwandlungsprozessen“ by the German Federal Ministry of Education and Research (BMBF). It is carried out in cooperation with Schunk Kohlenstofftechnik GmbH, Evonik Degussa GmbH, Walter E. C. Pritzkow Spezialkeramik, Orion engineered carbons, Ingenieurbüro Issendorf, Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (IWM) and Friedrich-Alexander University Erlangen-Nuremberg (LSTM).