METHOD OF FABRICATING MACRO POROUS CERAMIC BODIES WITH PREDETERMINED POROSITY

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Introduction

Production of macro porous ceramic bodies is a rapidly developing technology due to its ability to perform internal burning with high efficiency. In addition this burning process is completely environment friendly. It reduces the emission of CO and NO_X by considerable amounts.

In this work it was attempted to improve the properties of porous ceramic structures which are especially designed for the internal burning processes. The available porous ceramic structures are made by high tech ceramics such as Al_2O_3 and Y_2O_3. In addition, they are also made by methods such as polymer sponge method, polymer impregnating method and CO_2 bubbling method in which the porosity is uncontrollable.

Therefore, in this work it was mainly aimed to produce macro porous ceramics with controllable porosity. The produced porous ceramic structures have two components which affect their porosity. Those are the connecting pores and the internal cavities. These two factors have been introduced for porous ceramic bodies in order to enhance the properties of porous medium burners (PMB). As the said cavities are of spherical shape, it is possible to predetermine the internal void volume. In addition, by this method of production, it is possible to control the internal connectivity of neighboring pores. In this paper we discuss a method of fabricating pores and cavities inside a ceramic structure and thereby producing a macro porous ceramic structure having controlled porosity and connectivity.

Materials and Methods

A cavity former was used to fabricate cavities inside the ceramic structures. Polystyrene beads were used as cavity forming agent and they were in different sizes of spheres ranging from 3 mm –9 mm in diameter. These polystyrene beads were used to fabricate porous ceramic bodies of different cavity sizes.

First the polystyrene beads were coated with polyurethane. Then the coated, wet polystyrene beads were packed into a cylindrical mould. After that the polystyrene beads were pressed. The pressing causes to change the connectivity of neighboring beads. In this work different sizes of polystyrene beads were subjected to a pressure of 66 Nm^{-2}. The compressed polystyrene beads were left for 24 h until they were bonded well by polyurethane.

After the polystyrene structure was fabricated, the prepared ceramic slurry was poured into the bonded polystyrene structure. The said ceramic slurry contained 36.6 % of feldspar, 20.8 % of Quartz, 21.8 % of Kaolin and 20.8 % of Ball clay Then the ceramic slurry was left to air drying for two to three days. After the air drying is finished, the dried ceramic mixture together with the polystyrene structure was removed from cylindrical mould. Finally, the green ceramic body was oven dried and then sintered at 1250 °C.

Results

The properties of prepared porous ceramic structures were investigated by analyzing the permeability of porous ceramic bodies. The following equation, called Darcy-Forchheimer equation which explains the permeability of porous bodies, was used to analyze the data.

Darcy's equation:

$$\Delta P/\Delta X = K_1 \mu U_o + K_2 \rho U^2{}_o$$

where , $\Delta P/\Delta X$: pressure gradient, K_1: Resistance at low air flow, K_2: Resistance at high air flow, ρ: density of air mixture, μ : viscosity of air mixture, U_o: velocity of air flow.

Different porous ceramic bodies having cavity diameters of 3 mm - 9 mm were tested for the Darcy-Forchheimer behaviour and the obtained graphs (Figure 1) show behaviour similar to the behaviour obtained by *S.M.H.Olhero et al.,*

According to their investigations, the shape of the Graph of ΔP versus U should be parabolic. Therefore, from figure 1 we can say that the prepared porous ceramic structures behave according to the Darcy's equation.

Figure 2 shows a photograph of three dimensional open pore networks fabricated in a ceramic body using the method explained. Each cavity can have a maximum of 12 interconnecting pores.

Conclusions

In this work, macro porous ceramic bodies having predetermined porosities were fabricated. By introducing the polystyrene beads as a cavity former, the internal surface area of porous ceramic bodies was controlled. This method also provides a better way of fabricating isotropic and anisotropic open pore ceramic networks. Moreover, due to the high controllability of this method of fabricating macro porous ceramics, it is possible to produce porous ceramic bodies having predetermined bulk properties.

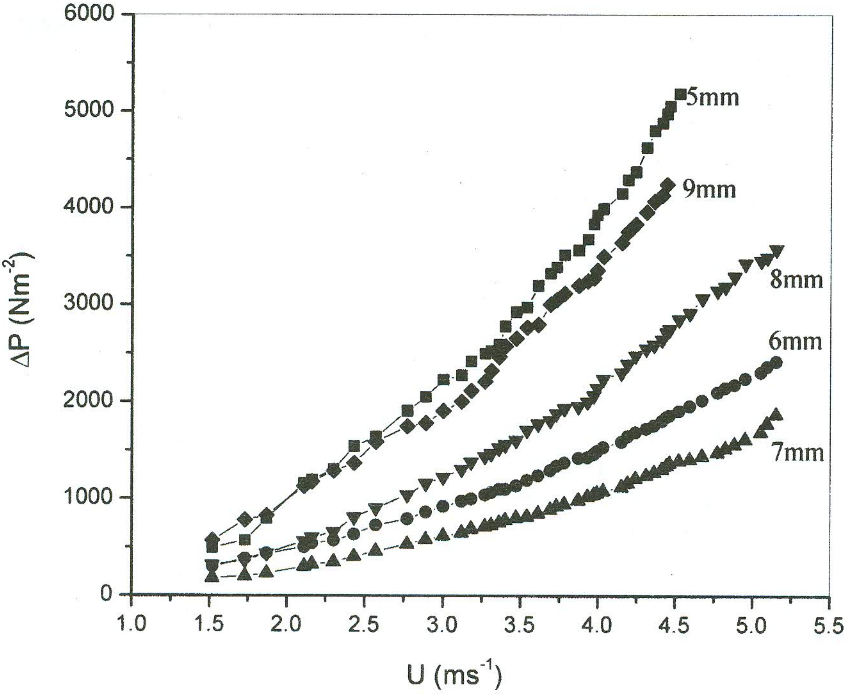

Figure 1. Analysis of pressure drop variation with supplied air flow across the prepared porous ceramic bodies

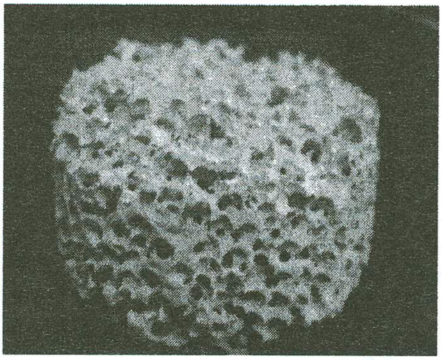

Figure 2. Fabricated porous ceramic body

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