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Effects of Extruder Head's Geometry on the Properties of Extruded Ceramic Products

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
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Keywords [Brick](#), [Ceramic Extrusion](#), [Clay](#), [Extruder Head](#), [Lamination](#)

Abstract A plastic brick clay with high clay mineral content was selected and the effects of different extruder heads on the main physical properties of the extruded products were investigated. The raw material was processed by a laboratory extruder after homogenization and wetting. Extruder heads with conical and special (spherical and torus) inner shape were applied to form and produce the green products which were examined after drying and firing. The rotation of the extruder screw was also varied between 15-55 1/min. Applying optical microscopy and SEM, the structure of the green products was analyzed. In addition to the physical properties of the products, the pressure caused by the extruder heads was determined by theoretical calculation and measurement. The results revealed that the physical properties of the products could be changed only by changing the shaping die geometry when the product size and production method remained unchanged. Maximal compressive strength of fired brick products (35.45 MPa) was obtained in case of the spherical head while the use of torus head caused some 5% decrease in the power consumption of the extruder. The density of fired products decreased and water adsorption increased when the rotation speed of the extruder screw was increased. The measurements confirmed the theoretical order of the applied extruder heads in terms of capability of pressure generation.

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First page example

Effects of Extruder Head's Geometry on the Properties of Extruded Ceramic Products

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Keywords: clay, ceramic extrusion, extruder head, lamination, bricks

Abstract. A plastic brick clay with high clay mineral content was selected and the effects of different extruder heads on the main physical properties of the extruded products were investigated. The raw material was processed by a laboratory extruder after homogenization and wetting. Extruder heads with conical and special (spherical and torus) inner shape were applied to form and produce the green products which were examined after drying and firing. The rotation of the extruder screw was also varied between 15-55 1/min. Applying optical microscopy and SEM, the structure of the green products was analyzed. In addition to the physical properties of the products, the pressure caused by the extruder heads was determined by theoretical calculation and measurement. The results revealed that the physical properties of the products could be changed only by changing the shaping die geometry when the product size and production method remained unchanged. Maximal compressive strength of fired brick products (35.45 MPa) was obtained in case of the spherical head while the use of torus head caused some 5% decrease in the power consumption of the extruder. The density of fired products decreased and water adsorption increased when the rotation speed of the extruder screw was increased. The measurements confirmed the theoretical order of the applied extruder heads in terms of capability of pressure generation.

Introduction

In traditional ceramics industry, extrusion is applied to process plastic ceramic pastes like clays. Worldwide, the production of brick and roof-tiles requires the highest volume of clay as plastic raw material. There are several methods for optimizing the process parameters of extrusion such as output rate, optimal rotation of extruder screw or inner shape of the extruder heads. The results obtained through an optimized inner geometry or rotation speed of the extruder screw have beneficial effects on product properties or reduce power consumption [1, 2, 3, 4]. Mounted on the end of the cylinder, the extrusion head gives the final shape of green products and its own form affects the quality of the products and the pressure developed in the extruder. Pressure depends not only on the geometry of the screw and the head, but the on rheological properties of the clays used [5, 6]. Clays are considered to be Bingham-fluids described by the relevant material law. Generally Bingham-fluids have their own plastic limit and when the shear stress exceeds this stress value (τ_0), the fluid becomes plastic and flow occurs. Pressure belonging to the limit of plastic deformation has to be achieved in the extrusion head. Plastic flow must take place in the total cross-section of the products. If this does not happen, then the product does not possess a homogenous structure resulting in cracks during firing [5, 6]. The purpose of this study is to examine the effects of special extruder heads on the main physical properties of the fired brick products and on lamination defects in the structure of the green products. The second objective was to confirm the theoretical calculation of the pressure developing capability of extruder heads.

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