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Applicability of sugarcane bagasse waste in the manufacturing of porous ceramic support for filtration membrane

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Brazil is the world's largest producer of sugarcane, whose activities generate significant amounts of solid waste, including sugarcane bagasse residue, which has attractive potential for reuse. A substantial portion of these residues is improperly managed, resulting in various significant environmental impacts. On the other hand, ceramic membrane separation technology is a continuously growing scientific field, driven by the versatility in manufacturing these materials and their wide range of potential applications. However, the high cost of raw materials and the substantial energy expenditures involved in manufacturing processes limit large-scale industrial production. This study aimed to evaluate the physical, mechanical, and microstructural properties of ceramic supports produced from clay and sugarcane bagasse residue from the Campos dos Goytacazes-RJ region. The ceramic masses prepared consisted of mixtures of gray clay incorporated with 0, 15, 20, and 25% by weight of sugarcane bagasse residue. Initially, the raw materials were dried at 110 °C, disaggregated, and sieved (< 100 µm). The ceramic supports were manufactured by tubular matrix extrusion and sintered at temperatures of 950, 1000, and 1050 °C. The following technological properties were determined: water absorption, apparent porosity, apparent density, linear shrinkage, mechanical strength, and microstructural analysis by scanning electron microscopy. The results showed that water absorption and apparent porosity increased with the amount of sugarcane bagasse residue and temperature, increasing by up to 22% and 14%, respectively. In contrast, apparent density decreased by up to 0.60 g/cm³. Linear shrinkage remained relatively constant with an increase in the amount of sugarcane bagasse residue, tending to increase by up to 7% with an increase in temperature. Mechanical strength indicated that as the residue was added, the ceramic supports became more fragile, with a decrease in strength of up to 42 N/mm². Moreover, mechanical strength also helped determine the optimal sintering temperature. In particular, the microstructural analysis of ceramic supports indicated that sugarcane bagasse residue acts as an efficient pore-forming agent, with more porous surfaces corresponding to higher amounts of residue, supporting the increase in apparent porosity. Finally, experimental data indicated that formulations containing 20% by mass of sugarcane bagasse residue and sintered at 1000 ºC proved to be attractive for the production of porous ceramic supports for use in low-cost ceramic membrane filtration.