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The influence of porosity parameters of natural carbonate sorbents on SO_2 sorption efficiency under fluidized bed combustion conditions

Magdalena Sęk and Elżbieta Hycnar

AGH University of Science and Technology, Faculty of Geology, Geophysics and Environment Protection, Department of Mineralogy, Petrography and Geochemistry, Poland (mmsek@agh.edu.pl)

The use of limestone sorbents in fluidized bed combustion allows the in-situ desulphurization in power industry. This study analyzes the effects of natural sorbent porosity on the SO_2 capture properties. For this purpose, limestone was examined experiments of sulphation process corresponding to fluidized bed conditions. The chemical and phase composition and parameters of the porosity of samples in each stage of the experiment (natural, calcined and sulphated samples) were determined. The porosity was characterized by the low temperature nitrogen adsorption method and mercury porosimetry including the specific surface area (A [m^2g^{-1}]), pore volume (V [cm^3g^{-1}]), pore diameter (D [μ]), and the coefficient of effective porosity (φ [%]). It has been proved that the high content of $CaCO_3$ and relatively high specific surface area in a natural state aren't decisive parameters for the high desulphurization efficiency. The efficiency of the desulfurization process is determined by the expansion of the sorbent porosity based on the pores from the mezo- and macropores grout during the thermal decomposition process of calcite. An analysis of the pore volume distributions of natural samples after the decarbonization and SO_2 sorption processes, suggests that pores with a diameter above 0.06 μm (i.e. mezo- and macropores) take part in the SO_2 sorption process. If the surface is made of pores with smaller diameters (from the assumed 0.06 μm) then it will be inaccessible for SO_2. The sorption process will occur only on the outer surface of the sorbent grains. The outer grain surface will be coated by the resulting desulphurization product and the interior of the grain will become inaccessible to the SO_2 particles and will remain unused. The porous texture of calcium sulphate produced on the grain surface is also of key importance. The porosity guarantees the free flow of SO_2, resulting in a uniform sulphation of grains during the sorbent residence time in the installation. If a pore-free sulphate is formed on the surface of sorbent grains, the SO_2 sorption will be stopped at the initial stage of desulphurization process, resulting in low use of the sorbent manifested by the occurrence of unreacted centers of grains (Hycnar 2018).

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References:

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