Options for sulfur dioxide removal using oil shale waste and natural materials: An experimental study

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Oil shale combustion is a promising option for Jordanian oil shale utilization. Restrictions on the exploitation and utilization of this resource are partly due to the high sulfur content of the oil shale, which leads to production of large quantities of sulfur dioxide during combustion. Mitigation of sulfur dioxide prior to effluent gas release is important for maintaining air quality and preventing environmental problems like acid rain. A number of effluent gas desulfurization techniques are available. These can be broadly classified into four categories: absorption of SO_2 in liquids, absorption by moist particles, gas phase conversion of SO_2, and sorption by solids. Solid-phase sorption has been examined in this study for SO_2 removal during oil shale combustion using oil shale ash and Jordanian zeolitic tuff. Jordanian oil shale contains large quantities of carbonate minerals and when combusted a highly alkaline ash is produced that can be used as a sorbent for SO_2 abatement. Jordan also has considerable reserves of zeolitic tuff containing a variety of zeolite minerals including phillipsite, chabazite and faujasite. Oil shale ash combusted over a range of temperatures (550-950°C) and zeolitic tuff samples were sieved into different particle size fractions and the fractions of both materials were characterized by X-ray Diffraction (XRD) , X-Ray Fluorescence (XRF) and Scanning Electron Microscopy (SEM). The surface area was also measured. Samples were placed in quartz tubes and heated to a specified temperature and then held for 15 minutes. SO_2 gas was passed through the tube and the concentration of non-adsorbed sulfur dioxide was measured at the outlet. The adsorption capacity of zeolitic tuff was found to increase with increasing temperature up to 200-250°C and then decreased at higher temperatures. It was also found that drying zeolitic tuff had a considerable affect on SO_2 adsorption capacity and breakthrough time. The adsorption capacity of zeolitic tuff increased with the decreasing particle size due to the increase of active surface area. For SO_2 sorption to oil shale ash, it was found that maximum SO_2 uptake occurred in the presence of O_2. The formation of $CaSO_4$ was confirmed in oil shale ash sorption experiments. Finally, the uptake capacity of oil shale ash was found to be highest at 700°C.