Sulfur dioxide uptake by Jordanian oil shale ash

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Combustion of oil shale is one promising option for utilization of oil shale in Jordan. However, exploitation and utilization is restricted for several reasons, including the high sulfur content of Jordanian oil shale. When combusted, Jordanian oil shale releases large quantities of sulfur dioxide. Sulfur dioxide must be mitigated prior to release of effluent gas to the atmosphere. At the same time, Jordanian oil shale contains large quantities of carbonate minerals ranging from 30 to 70% depending on location and depth. When combusted, alkaline ashes are formed which could be used as sorbents for abatement of SO_2 emissions. In this study, Jordanian oil shale ash was used for adsorption of sulfur dioxide. Oil shale samples were ashed at different temperatures (550, 650, 750, 850 and 950°C) and sieved into different particle size fractions (250-500, 500-1000, 1000-2000, 2000-4000 μm). These fractions were characterized by X-Ray Diffraction, X-Ray Fluorescence and Scanning Electron Microscopy. The surface area of these fractions was also measured. The uptake capacity of oil shale ash was measured in the presence and absence of oxygen at different temperatures. The concentration of sulfur dioxide and its flow rate were kept constant (5000 ppm in balance of N_2, and 30 ml/min respectively). About 3 g of oil shale ash of a particular particle size range was placed in a quartz tube (internal diameter 10 mm) and heated to a specified temperature then held for about 15 minutes. SO_2 gas, with and without O_2, was then passed through the tube containing the sample. The concentration of the non-adsorbed sulfur dioxide was measured using a UIC Sulfur Coulometer (Model CM5015S). This coulometer measures sulfur in the form of SO_2, therefore any SO_3 formed in the presence of O_2 was first reduced to SO_2 over a bed of copper wires. It was found that the presence of O_2 in the gas stream is essential to maximize SO_2 uptake. The formation of $CaSO_4$ was confirmed in our experiments. Additionally, the uptake capacity of the oil shale ash was found to be highest at 700°C.