

Geochemical characterization and extraction of rare earths from coal washery rejects

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Coal washing is one of the essential steps of coal technology, which aims to reduce the high ash content of the coal. Coal washing leads to the generation of clean coal which is used in steel and thermal industries. During coal washing, inorganic constituents such as clay, quartz, sulfur and other minerals are separated as impurities and reported as “Coal Washery Rejects (CWR)”. India’s Ministry of Coal (2021) indicates a total coal washing capacity of 138 MTPA for coking and non-coking coal which generates a huge amount of CWR. Among several minerals present in CWR, rare earths minerals are one of them. Monazite is a primary resource of rare earth elements (REEs). Due to its unique properties, rare earths are highly important in wide application of technological, industrial, and scientific applications. Furthermore, the resources of rare earths are confined and the supply chain is at risk. These scenarios created the necessity to explore for other resources and CWR may be one of those potential resources. In the present research work, CWR has been characterized and extraction methods were developed for the recovery of valuable REEs. Insights in mineralogical perspective unveils that CWR have major mineral phases such as quartz, kaolinite, monazite etc. Furthermore, it has good concentration of total rare earth elements (TREE) ranging from 300-500 ppm. The hydrometallurgical extraction methods have been developed using direct leaching step to recover these valuable elements from CWR. Direct leaching was performed in presence of inorganic acids (HCl, HNO₃ and H₂SO₄). In HCl, highest recovery of TREE (32%) was achieved. Process optimization has been conducted to enhance the recovery of remaining TREEs which is still left in CWR. Therefore, particle size reduction and pre-thermal treatment (alkali roasting) has been opted for CWR in presence of HCl leaching agent. By following this process, the recovery of TREE was enhanced upto 50%. Thus, the present studies not only focuses on characterization but also extraction methods for resource utilization. The development of indigenous extraction methods for recovery of REEs from CWR may be helpful for securing the increasing demands of rare earths in the country.